ENERGY COMPLETE MONOGRAPH

Code Changes and Public Comments to the 2022 IECC Commercial Public Comment Draft #1

INTERNATIONAL CODE COUNCIL®

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INTRODUCTION

Following an extensive review and feedback process, on March 4, 2021 the Code Council Board (Board) released a new framework to address energy efficiency. This new framework includes a revised process for the development of the energy provisions with a new scope and intent and optional requirements aimed at achieving net zero energy buildings presently and by 2030. This framework includes using the Code Council's American National Standards Institute (ANSI) approved standards process to update the energy provisions contained in the IECC, Chapter 11 of the IRC and Chapter 15 of the International Code Council Performance Code (ICC PC). The results of this process will be the publication of the energy provisions in the 2024 IECC, IRC and ICC PC as part of the family of I-Codes in the fall of 2023.

The following has occurred since the March 4, 2021 release:

- June 22, 2021: Board appoints two new committees: Commercial Energy Code Consensus Committee and Residential Energy Code Consensus Committee following a Call for Committee members on March 19, 2021 and an application deadline of April 22, 2021.
- July 16, 2021: cdpACCESS opened for Public Input code change submissions, with a deadline of October 12, 2021.
- November 2021 to June 15, 2022 the IECC Commercial Consensus Committee with recommendations from 4 Subcommittees took action on approximately 250 code change proposals.
- The Committee Action Report for the IECC Commercial was released July 1, 2022 along with the initial ballot to the IECC-Consensus committee. Ballot #1 was due on August 1, 2022. The report of Ballot #1 and the release of the Recirculation ballot #2 were issued on August 2, 2022. The Recirculation ballot #2 was collected on August 16, 2022. The results of the balloting concluded that all proposals included in the IECC-C Committee Action Report received a 2/3 affirmative vote and would be included in the IECC-C Public Comment Draft #1.
- The IECC-C Public Comment Draft #1 was posted for comment in energy.cdpaccess on September 6, 2022. Public Comments were due on October 21, 2022.

As noted previously, the update process will follow the Code Council's standards development procedures entitled the "ICC Consensus Procedures" (ICC CP). The current version was approved by ANSI on August 2, 2021. Further to this process and in accordance with Section 3.1(c) of the ICC CP, the Board has adopted the "IECC Committee Procedures" for the development of the energy provisions of the 2024 editions and future editions. See document links on page iii.

In accordance with Section 8.2 of the ICC CP, the 2021 edition of the energy provisions (with the Board approved scope and intent) was used as the Initial Draft in order to solicit Public Input in the form of code change submittals. Following the deadline of October 12th, the proposed code change submittals were compiled, published and posted. The publication of these changes constitutes neither endorsement nor question of them but is in accordance with established procedures so that any interested individuals may make their views known to the relevant Subcommittee, Consensus Committee and others similarly interested. In furtherance of this purpose, the Subcommittees and Consensus Committees will hold open virtual meetings as noted below for the purpose of receiving comments and arguments for or against such proposed changes. Those who are interested in speaking on any of the published changes are expected to participate at these meetings.

This compilation of code change proposals is available in electronic form only.

SUBCOMMITTEES AND CONSENSUS COMMITTEES

Subcommittees

In accordance with Section 6 of the ICC Consensus Procedures, Subcommittees have been established and approved by the Consensus Committees following a public notice and application process. The objective of Subcommittees is to provide for broad participation and develop consensus on an issue(s) and report the findings to the Consensus Committee for review and final determination. Voting members are comprised of both Consensus Committee members and interested parties.

Consensus Committees

The Board appointed Consensus Committees will determine the final code content of the energy provisions in accordance with the ICC Consensus Procedures.

All Subcommittee and Consensus Committee meetings are open meetings to all participants (voting and non-voting) with adequate public notice provided in accordance with the ICC Consensus Procedures.

ANTITRUST COMPLIANCE

ICC brings together numerous government officials and industry members to participate in the code and standard development process. ICC provides basic guidance on the antitrust laws that may be applicable to these and other activities sponsored by ICC ("ICC Activities"). Click here to view ICC's policy on Antitrust Compliance.

ANALYSIS STATEMENTS

Code changes may contain an "analysis" that appears after the proponent's reason. These comments do not advocate action by the Subcommittees or Consensus Committees for or against a proposal. The purpose of such comments is to identify pertinent information that is relevant to the consideration of the proposed change by the Subcommittees, Consensus Committees and interested parties. Staff analyses customarily identify such things as: conflicts and duplication within a proposed change and with other proposed changes and/or current code text; deficiencies in proposed text and/or substantiation; text problems such as wording defects and vagueness; background information on the development of current text; and staff's review of proposed new reference standards for compliance with procedures. Lack of an analysis indicates neither support for, nor opposition to a proposal.

NEW REFERENCE STANDARDS

Reference standards provide a very important role in ICC's Codes. As stipulated in Sections C108 and R108 of the IECC and Section R102.4 of the IRC, "….standards referenced in this code……shall be considered as part of the requirements of this code to the prescribed extent of each such reference…".

The I-Code process includes criteria for staff to evaluate the non-technical aspects of the standard, such as mandatory language and a consensus process for development. As an extension of the code, the code change submittal process for proposed new reference standards (a standard not currently referenced in one of the I-Codes) requires that the proponent identify the title and edition of the new standard as well as making the standard available for review. This is typically done in one of three ways:

1. The proponent secures a copy of the standard from the Standards Developing Organization (SDO) and sends it to staff for record retention. The proponent also requests that the SDO execute an ICC "Permission to Post Form", provided by the proponent, that allows ICC to post the standard on a password protected website for both staff and the Consensus Committees.
2. The proponent contacts the SDO and is informed that the standard is available on their website for free download. The download is typically specific only to the individual downloading the standard (in other words it cannot be sent electronically to another person). In addition, ICC administration will obtain a copy of the standard for internal purposes by accessing the SDO's website to download the standard.
3. The SDO tells the proponent the standard is available on their website for free access in a "read-only" format. The proponent provides ICC with the link to access the standard and ICC administration confirms that the standard is available in "read-only" format.

Where necessary, ICC will work with proponents and SDO's to help secure the standard in a reviewable format. It is still the responsibility of the proponent to contact the SDO to determine how the standard can be provided to support its potential inclusion in the code.

Proposed new reference standards must be completed and readily available in a timely fashion in order to facilitate the Consensus Committee approval process. New standards which are approved by the Consensus Committee will be listed in the "Referenced Standard" chapter of the applicable code(s).

REFERENCED STANDARDS UPDATES

Updates to currently referenced energy standards in the 2021 IECC, IRC and ICC PC will be considered by the Administrative Code Development Committee in the 2022 Group B Cycle of the ICC Code Development Process. Public Comment Draft #1 Proposals that reference updated standards that were not included in the 2022 Group B Cycle will be acted on by the Consensus Committee as new reference standards.

In accordance with I-Code procedures, an updated standard to the energy provisions of the IECC, IRC, and ICC PC must be finalized and published by December 1, 2023. If the standard update is not finalized and published by December 1, 2023, the affected energy provisions will be revised to reference the previously listed year edition of the standard and an errata issued.

PROPONENT CONTACT INFORMATION

In accordance with procedures, proponents are under no obligation to provide an email address for their posted proposal. For most of the code change proposals, an email address for the proponent has been provided. In an effort to continue to provide for proponent's privacy and at the same time allow an initial contact between an interested party and the proponent, we will be utilizing energy.cdpACCESS to allow an interested party to initiate contact with the proponent without identifying the proponent's email address. The process is follows:

- Interested party logs into energy.cdpACCESS and searches for the subject code change.
- Interested party locates the button "Contact the Proponent" to request that energy.cdpACCESS contact the proponent, providing the interested party's name and email address.
- Energy.cdpACCESS uses the proponent email address on file and sends a notification to the proponent indicating the name of the interested party and their email address and that the interested party would like to discuss the code change.
- The interested party receives an email noting that the energy.cdpACCESS system has sent the request to the proponent.
- It is up to the proponent to determine if they would like to respond and contact the interested party.
- The proponent is under no obligation to respond to the energy.cdpACCESS request for contact or to contact the interested party. The proponent's contact information is not revealed to the interested party as part of this initial contact.

CODE CHANGE SUBMITTALS WITH TABLES

Staff is aware that some of the code change proposals with tables may require additional formatting. In an effort to post these code changes as soon as practical in order to start the discussions at the Subcommittee level, the decision was made to post these proposals now and staff will continue to reformat the tables and re-post when reformatted. All interested parties who have signed up for the email distribution list for notifications (see below) will be notified when the code changes are re-posted.

ICC ENERGY WEBSITES/DOCUMENT POSTINGS

ICC websites are used extensively for access to documents which support the update of ICC's Codes. This current update of the energy provisions is no different. Postings include:

- This code change document
- Code change errata, if any, will be posted
- The "IECC Committee Procedures" previously mentioned will be posted
- Process information such as a flowchart of the key steps currently under development will be posted
- Additional documents/information to support the process will be posted

Links to websites:

- “Leading the Way to Energy Efficiency”
- Commercial: Commercial Energy Consensus Committee
- Residential: Residential Energy Consensus Committee

Users are encouraged to periodically review the websites.

ICC CONSENSUS PROCEDURES

Click here to download the current ICC Consensus Procedures

ICC ENERGY SECRETARIAT/EMAIL DISTRIBUTION LIST

The ICC Secretariat is Kristopher Stenger, AIA, CBO, LEED AP Director of Energy Programs at kstenger@iccsafe.org. Be sure to contact Kris in order to be placed on the email distribution list in order to receive timely meeting information, notices, etc.

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Proponents: Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org); **Anthony Floyd,** representing Chair of SEHPCAC (sehpcac@iccsafe.org)

2024 International Energy Conservation Code [CE Project]

SECTION C101
SCOPE AND GENERAL REQUIREMENTS

C101.1 Title. This code shall be known as the Energy Conservation Code of [NAME OF JURISDICTION], and shall be cited as such. It is referred to herein as "this code."

C101.2 Scope. This code applies to *commercial buildings* and the buildings' sites and associated systems and equipment.

C101.3 Intent. This code shall regulate the design and construction of buildings for the effective use and conservation of energy over the useful life of each building. This code is intended to provide flexibility to permit the use of innovative approaches and techniques to achieve this objective. This code is not intended to abridge safety, health or environmental requirements contained in other applicable codes or ordinances.

Revise as follows:

~~C101.5~~ C101.4 Compliance. *Residential buildings* shall meet the provisions of IECC—Residential Provisions. *Commercial buildings* shall meet the provisions of IECC—Commercial Provisions.

~~C101.5.1~~ C101.4.1 Compliance materials. The *code official* shall be permitted to approve specific computer software, worksheets, compliance manuals and other similar materials that meet the intent of this code.

Add new text as follows:

SECTION C102
APPLICABILITY

Revise as follows:

~~C101.4~~ C102.1 Applicability. Where, in any specific case, different sections of this code specify different materials, methods of construction or other requirements, the most restrictive shall govern. Where there is a conflict between a general requirement and a specific requirement, the specific requirement shall govern.

~~C101.4.1~~ C102.1.1 Mixed residential and commercial buildings. Where a building includes both *residential building* and *commercial building* portions, each portion shall be separately considered and meet the applicable provisions of IECC—Commercial Provisions or IECC—Residential Provisions.

~~C108.3~~ C102.2 Other laws. The provisions of this code shall not be deemed to nullify any provisions of local, state or federal law.

~~C108.2~~ C102.3 Applications of references. References to chapter or section numbers, or to provisions not specifically identified by number, shall be construed to refer to such chapter, section or provision of this code.

~~C108.1~~ C102.4 Referenced codes and standards. The codes and standards referenced in this code shall be those listed in Chapter 6, and such codes and standards shall be considered as part of the requirements of this code to the prescribed extent of each such reference and as further regulated in Sections ~~C108.1.1~~ C102.4.1 and ~~C108.1.2~~ C102.4.2.

~~C108.1.1~~ C102.4.1 Conflicts. Where conflicts occur between provisions of this code and referenced codes and standards, the provisions of this code shall apply.

~~C108.1.2~~ C102.4.2 Provisions in referenced codes and standards. Where the extent of the reference to a referenced code or standard includes subject matter that is within the scope of this code, the provisions of this code, as applicable, shall take precedence over the provisions in the referenced code or standard.

~~C107.1~~ C102.5 ~~General~~ Partial invalidity. If a portion of this code is held to be illegal or void, such a decision shall not affect the validity of the remainder of this code.

Delete without substitution:

~~SECTION C107~~
~~VALIDITY~~

~~SECTION C108~~

~~REFERENCED STANDARDS~~

Reason: Right now many jurisdictions delete Chapter 1 of the codes and write their own unified Administrative provisions. Part of the reason for this is that it is not easy to see where the administrative provisions are similar or different. Chapter 1 of the I-codes should be different where applicable. However, if the administrative provisions are the same, it is important for the authority having jurisdiction to be able to identify that quickly. As we work on this throughout the codes, it is hoped that jurisdictions will use the Chapter 1's in the relative code.
The intent of this change is to have the provision in Section 101, Scope and General Requirements, and Section 102, Applicability, to contain the same basic points for all the codes. This will make compliance easier. For the IECC, this would involve some reorganization, including movement of the sections dealing with references standards (C108) and validity (C107). There are no changes to requirements. A similar proposal will be submitted for IECC Residential.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is a reorganization of administrative provisions with no change to technical requirements.

Workgroup Recommendation

Proposal # 644

CED1-2-22

Proponents: Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org)

2024 International Energy Conservation Code [CE Project]

SECTION C101
SCOPE AND GENERAL REQUIREMENTS

C101.2 Scope. This code applies to *commercial buildings* and the buildings' sites and associated systems and equipment.

Add new text as follows:

101.2.1 Appendices. Provisions in the appendices shall not apply unless specifically adopted.

Reason: Appendices are in all of the codes except for IZC. The intent is to put information about their adoption for inclusion in the same location in all of the codes immediately following the section on scope. This is already the case in the IBC, IFC, IMC, IPSDC and IWUIC. ADM7-22 has added this section to ICCPC, IGCC, IPMC, and ISPSC. This section was relocated in the IEBC, IFGC, IPC and IRC.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an editorial coordination item.

Workgroup Recommendation

Proposal # 641

CED1-3-22

Proponents: Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org); **Anthony Floyd**, representing Chair of SEHPCAC (sehpcac@iccsafe.org)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

<u>**SECTION 103**</u>
<u>**CODE COMPLIANCE AGENCY**</u>

<u>**103.1**</u> <u>**Creation of enforcement agency.**</u> <u>The [INSERT NAME OF DEPARTMENT] is hereby created and the official in charge thereof shall be known as the authority having jurisdiction (AHJ). The function of the agency shall be the implementation, administration and enforcement of the provisions of this code.</u>

<u>**103.2**</u> <u>**Appointment.**</u> <u>The authority having jurisdiction (AHJ) shall be appointed by the chief appointing authority of the jurisdiction.</u>

<u>**103.3**</u> <u>**Deputies.**</u> <u>In accordance with the prescribed procedures of this jurisdiction and with the concurrence of the appointing authority, the authority having jurisdiction (AHJ) shall have the authority to appoint a deputy authority having jurisdiction (AHJ) , other related technical officers, inspectors and other employees. Such employees shall have powers as delegated by the authority having jurisdiction (AHJ).</u>

Reason: This section include provisions for the creation of the code compliance agency. Similar language is in the IBC, IFC, IPC, IMC, IFGC, IEBC, IPMC, IPSDC, IWUIC, IRC and IGCC.
The department's responsibilities are more than just 'enforcement' of the code. The fill in the blank for the name allows for the agency to develop a name appropriate to their jurisdiction and responsibilities. This also allows for the code official to appoint staff where needed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an editorial change with no change to construction requirements.

Workgroup Recommendation

Proposal # 643

CED1-4-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.

~~5.~~ 7. Mechanical system design criteria.

~~6.~~ 8. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.

~~7.~~ 9. Economizer description.

~~8.~~ 10. Equipment and system controls.

~~9.~~ 11. Fan motor horsepower (hp) and controls.

~~10.~~ 12. Duct sealing, duct and pipe insulation and location.

~~11.~~ 13. Lighting fixture schedule with wattage and control narrative.

~~12.~~ 14. Location of *daylight* zones on floor plans.

~~13.~~ 5. Air barrier and air sealing details, including the location of the air barrier.

~~14.~~ 15. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical distribution equipment.

~~15.~~ 6. Thermal bridges as identified in Section C402.6.

16. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable energy system to the point of interconnection with the electrical service and the ESS.
17. Location and layout of a designated area for ESS.
18. Rated energy capacity and rated power capacity of the installed or planned ESS.

Reason: This proposal does not change the listed items for construction documents, but it does re-order them so that envelope-related items are grouped together and the list more closely follows the sequencing of topics in the code.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal is editorial and simply re-orders the listed requirements for construction documents.

Workgroup Recommendation

Proposal # 711

CED1-5-22

Proponents: Greg Johnson, representing Johnson & Associates Consulting Services (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Delete and substitute as follows:

~~**C105.2.2 Thermal envelope.** Inspections shall verify the correct type of insulation, *R*-values, location of insulation, fenestration, *U*-factor, SHGC and VT, and that air leakage controls are properly installed, as required by the code, *approved* plans and specifications.~~

C105.2.2 Thermal envelope. Inspections shall verify the type of insulation, *R*-values, location of insulation, fenestration, *U*-factor, SHGC and VT, and that air leakage controls are installed, as required by the code, *approved* plans and specifications.

~~**C105.2.4 Mechanical system.** Inspections shall verify the installed HVAC equipment for the correct type and size, controls, insulation, *R*-values, system and damper air leakage, minimum fan efficiency, energy recovery and economizer as required by the code, *approved* plans and specifications.~~

C105.2.4 Mechanical system. Inspections shall verify the installed HVAC equipment for the type and size, controls, insulation, *R*-values, system and damper air leakage, minimum fan efficiency, energy recovery and economizer as required by the code, *approved* plans and specifications.

Reason: The stricken terms are subjective - always problematic - and unneeded. Inspections according to the approved plans addresses 'correct' and 'proper' installations.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an administrative issue. There is no impact on construction.

Workgroup Recommendation

Proposal # 855

CED1-6-22

Proponents: Mike Nugent, representing Building Code Action Committee (bcac@iccsafe.org); **Anthony Floyd**, representing Chair of SEHPCAC (sehpcac@iccsafe.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

SECTION C110
~~BOARD~~ MEANS OF APPEALS

C110.1 General. In order to hear and decide appeals of orders, decisions or determinations made by the *code official* relative to the application and interpretation of this code, there shall be and is hereby created a board of appeals. ~~The *code official* shall be an ex officio member of said board but shall not have a vote on any matter before the board.~~ The board of appeals shall be appointed by th~~e applicable~~ governing ~~body~~ authority and shall hold office at its pleasure. The board shall adopt rules of procedure for conducting its business, and shall render all decisions and findings in writing to the appellant with a duplicate copy to the *code official*.

C110.2 Limitations on authority. An application for appeal shall be based on a claim that the true intent of this code or the rules legally adopted thereunder have been incorrectly interpreted, the provisions of this code do not fully apply or an ~~equally good~~ equivalent or better form of construction is proposed. The board shall not have authority to waive requirements of this code.

C110.3 Qualifications. The board of appeals shall consist of members who are qualified by experience and training on matters pertaining to the provisions of this code and are not employees of the jurisdiction.

Add new text as follows:

110.4 Administration. The code official shall take action without delay in accordance with the decisions of the board.

Reason: ADM40-19 was approved for IBC, IEBC, IFC, IWUIC, IPC, IMC, IFGC, ISPSC, IPMC, IPSDC, IECC-R and IGCC for revisions to the section on Means of Appeals. This item was disapproved for IECC Commercial and IRC. The result is an inconsistency with IECC Commercial and IRC.
The intent of this proposal is coordination for the means of appeals within the family of codes. Most of this was accomplished through ADM40-19 during the last cycle. Comments during the testimony, from the code development committees and subsequent discussions have suggested some minor improvements that were accomplished in ADM48-22 As Modified by Public Comments 1 and 2.

The change to the title is because the Administrative Chapter sets up the process and right to appeal. IECC-Commercial (and all the I-Codes) have an appendix for the Board of Appeals that can be use for guidance for forming that board.

General: The sentence about the code official not being a voting member of the board of appeals is proposed to be deleted. The fact about city employees not being a voting member of the board is already included in the section on qualifications. The code official is an important advisor for the Board of Appeals and this is addressed in the Appendix. The deletion of this sentence will not change that.

Limitation on authority. This is an editorial change for better English and code language.

Qualifications: The phrase for experience and training is slightly different in each code. Adding this idea to all codes would provide consistency.

Administration: The board, or jurisdiction can set a reasonable timeframe for the code official to act on the boards decision.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
These are administration requirements, so there will be no change in construction requirements.

Workgroup Recommendation

Proposal # 642

CED1-7-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

CONSTRUCTION DOCUMENTS. Written, graphic and pictorial documents prepared or assembled for describing the design, location, and physical characteristics of the elements of a project as necessary to ~~for~~ obtain~~ing~~ a building permit and to support construction and inspections.

Reason: This proposal changes the CONSTRUCTION DOCUMENTS definition to recognize that construction documents are not just for the purpose of getting a permit. They are also used for construction and inspections.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal just clarifies a definition without changing its use or related requirements.

Workgroup Recommendation

Proposal # 718

CED1-8-22

Proponents: Daniel Carroll, representing Department of State DBSC (daniel.carroll@dos.ny.gov); Hendrik Shank, representing NYS Department of State - Division of Building Standards and Codes (hendrikus.shank@dos.ny.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.1.3 Equipment Building. Buildings that comply with <u>all of</u> the following shall be exempt from the *building thermal envelope* provisions of this code:

1. Are separate buildings with floor area not more than 1,200 square feet (110 m^2).
2. Are intended to house electric equipment with installed equipment power totaling not less than 7 watts per square foot (75 W/m^2) and not intended for human occupancy.
3. Have a heating system capacity not greater than (17,000 Btu/hr) (5 kW) and a heating thermostat setpoint that is restricted to not more than 50°F (10°C).
4. Have an average wall and roof *U*-factor less than 0.200 in *Climate Zones* 1 through 5 and less than 0.120 in *Climate Zones* 6 through 8.
5. Comply with the roof solar reflectance and thermal emittance provisions for *Climate Zone* 1.

Reason: This change will make it clear that equipment buildings need to comply with all five requirements to be exempt from the building thermal envelope provisions.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change is editorial.

Workgroup Recommendation

Proposal # 852

CED1-9-22

Proponents: Michael Myer, representing Pacific Northwest National Laboratory (michael.myer@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

CHAPTER 4 [CE]
COMMERCIAL ENERGY EFFICIENCY

SECTION C405
ELECTRICAL POWER AND LIGHTING SYSTEMS

Revise as follows:

C405.1 General. Electrical power and lighting systems and generation shall comply with this section. ~~*Sleeping units* shall comply with Section C405.2.5 and with Section C405.1.1~~ . *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

C405.1.1 Lighting for dwelling units. No less than 90 percent of the permanently installed lighting serving sleeping units and dwelling units shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W.

Exceptions:

1. Lighting integral to a kitchen appliance or exhaust hood.
2. Antimicrobial lighting used for the sole purpose of disinfecting.

Revise as follows:

C405.3.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-12.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}] \quad \textbf{(Equation 4-12)}$$

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Emergency lighting that is automatically off during normal operations.
2. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
3. Casino gaming areas.
4. Mirror lighting in makeup or dressing areas used for video broadcasting, video or film recording, or live theatrical and music performance.
5. Task lighting for medical and dental purposes that is in addition to general lighting.

6. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
7. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.
8. Lighting for photographic processes.
9. Lighting integral to equipment or instrumentation and installed by the manufacturer.
10. Task lighting for plant growth or maintenance.
11. Advertising signage or directional signage.
12. Lighting for food warming.
13. Lighting equipment that is for sale.
14. Lighting demonstration equipment in lighting education facilities.
15. Lighting approved because of safety considerations.
16. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
17. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
18. Exit signs.
19. Antimicrobial lighting used for the sole purpose of disinfecting a space.
20. Lighting in ~~sleeping units and~~ dwelling units.

C405.3.2 Interior lighting power allowance. The total interior lighting power allowance (watts) for an entire building shall be determined according to Table C405.3.2(1) using the Building Area Method or Table C405.3.2(2) using the Space-by-Space Method. The interior lighting power allowance for projects that involve only portions of a building shall be determined according to Table C405.3.2(2) using the Space-by-Space Method. Buildings with unfinished spaces shall use the Space-by-Space Method.

TABLE C405.3.2(1) INTERIOR LIGHTING POWER ALLOWANCES: BUILDING AREA METHOD

For SI: 1 watt per square foot = 10.76 watts per square meter.

Revise as follows:

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	0.41
Greater than 40 feet in height	0.51
Audience seating area	
In an auditorium	0.57
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.56
In a performing arts theater	1.09
In a religious building	0.72
In a sports arena	0.27
Otherwise	0.33
Banking activity area	0.56
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.74
Otherwise	0.72
Computer room, data center	0.75
Conference/meeting/multipurpose room	0.88
Copy/print room	0.56
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	0.61
Otherwise	0.44
Courtroom	1.08
Dining area	
In bar/lounge or leisure dining	0.76
In cafeteria or fast food dining	0.36
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.22
In family dining	0.52
In a penitentiary	0.35
Otherwise	0.42
Electrical/mechanical room	0.71
Emergency vehicle garage	0.51
Food preparation area	1.19
Laboratory	
In or as a classroom	1.05
Otherwise	1.21
Laundry/washing area	0.51
Loading dock, interior	0.88
Lobby	
For an elevator	<u>0.64</u>
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.44
In a hotel	0.48
In a motion picture theater	0.20

In a performing arts theater	1.21
Otherwise	0.80
Locker room	0.43
Lounge/breakroom	
In a healthcare facility	0.77
Mother's Wellness Room	0.68
Otherwise	0.55
Office	
Enclosed	0.73
Open plan	0.56
Parking area daylight transition zone	1.06
Parking area, interior	0.11
Pharmacy area	1.59
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	0.96
Otherwise	0.74
Sales area	0.85
Seating area, general	0.21
Security screening general areas	0.64
Security screening in transportation facilities	0.93
Security screening transportation waiting area	0.56
Stairwell	0.47
Storage room	0.35
Vehicular maintenance area	0.59
Workshop	1.17
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.50
Dormitory - Living Quarters	0.48
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.58
In a recreation room (and not used primarily by the staff)	1.20
Fire Station - Sleeping Quarters	0.23
Gaming establishments	
High limits game	1.68
Slots	0.54
Sportsbook	0.82
Table games	1.09
Gymnasium/fitness center	
In an exercise area	0.82
In a playing area	0.82
Healthcare facility	
In an exam/treatment room	1.33
In an imaging room	0.94
In a medical supply room	0.56
In a nursery	0.87
In a nurse’s station	1.07

In an operating room	2.26
Patient Room	0.78
In a physical therapy room	0.82
In a recovery room	1.18
In a telemedicine room	1.44
Library	
In a reading area	0.86
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	0.75
In an equipment room	0.73
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.36
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	1.24
Performing arts theater—dressing room	0.39
Post office—sorting area	0.71
Religious buildings	
In a fellowship hall	0.50
In a worship/pulpit/choir area	0.75
Retail facilities	
In a dressing/fitting room	0.45
Hair salon	0.65
Nail salon	0.75
In a mall concourse	0.57
Massage space	0.81
Sports arena—playing area	
For a Class I facility [c]	2.86
For a Class II facility[d]	1.98
For a Class III facility[e]	1.29
For a Class IV facility[f]	0.86
Sports arena-Pools	
For a Class I facility	2.20
For a Class II facility	1.47
For a Class III facility	0.99
For a Class IV facility	0.59
Transportation facility	
Airport hanger	1.36
At a terminal ticket counter	0.40
In a baggage/carousel area	0.28
Passenger loading area	0.71
In an airport concourse	0.49
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 watts per square meter.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

d. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

e. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

f. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

C405.3.2.1 Building Area Method. For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an “area” shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.
2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the allowed lighting power (watts) for each building area type. ~~Sleeping units and dwelling~~ Dwelling units are excluded from lighting power allowance calculations by application of Section C405.1.1. The area of sleeping units and dwelling units is not included in the calculation.
3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

C405.3.2.2 Space-by-Space Method. Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.1 watts per square foot (1.08 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.
2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the allowed lighting power (watts) for each space type. ~~Sleeping units and dwelling~~ Sleeping units are excluded from lighting power allowance calculations by application of Section C405.1.1. The area of ~~sleeping units and~~ dwelling units is not included in the calculation.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

Reason: The 2021 version had a provision that allowed lighting power density to not be determined for sleeping unit spaces; however there was no clear efficacy requirement. A 2024 proposal removed the lighting power density values for dormitory, fire quarters - sleeping units, and patient rooms. This 2024 proposal required sleeping unit spaces to have luminaires with an efficacy of not less than 45 lm/W.
45 lm/W is very low - linear fluorescent, CFL, HID, and LED luminaires all can meet this requirement. The models used to develop the LPD for those spaces used luminaires ranging from 80 - 120 lm/W. Removing the LPD requirement and establishing a luminaire efficacy minimum is expected to result in a decrease in energy efficiency in two different ways.

Reduction in energy efficiency #1: Luminaires providing the same amount of light would could use 1.9x more power. For example, a 3,000 lumen fixture at 83 lm/W would draw 36 W. The 2024 proposal would allow a fixture with a 45 lm/W minimum. Thus, the new 3,000 lumen fixture could draw 66 W. This represents a 1.8x increase in power assuming the 2021 and 2024 project were providing the same amount of light and similar type of fixtures.

Reduction in energy efficiency #2: Removes the LPD altogether. Spaces are allowed to trade power between the different spaces and do not need to meet each LPD value per space. However, the overall lighting power allowance limits the total amount of power. Removing the LPD requirement for these sleeping units no longer sets a limit on the total amount of power that could be installed in a space. If a designed space exceeds the LPD value in the table, the exceeded power must be offset elsewhere in the building. Removing the LPD requirement eliminates the offset elsewhere in the building. Therefore, those spaces could use more power regardless of the luminaires installed.

Beyond the reduction in energy efficiency considerations, there is a secondary issue. The Building Area Method values (Table C405.3.2(1)) are developed by applying a weighted average of the space LPD values (Table C405.3.2(2)). Eliminating the specific space LPD values would require the Building Area Method LPD values for Dormitory, Fire Station, Hospital, and Hotel all to be changed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Proposed code change restores text omitted - no cost impact.

Bibliography: No bibliography

Workgroup Recommendation

Proposal # 733

CED1-10-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C407.3.2 Additional documentation. The *code official* shall be permitted to require the following documents:

1. Documentation of the building component characteristics of the *standard reference design*.
2. Thermal zoning diagrams consisting of floor plans showing the thermal zoning scheme for *standard reference design* and *proposed design*.
3. Input and output reports from the energy analysis simulation program containing the complete input and output files, as applicable. The output file shall include energy use totals and energy use by energy source and end-use served, total hours that space conditioning loads are not met and any errors or warning messages generated by the simulation tool as applicable.
4. An explanation of any error or warning messages appearing in the simulation tool output.
5. A certification signed by the builder providing the building component characteristics of the *proposed design* as given in Table C407.4.1(1).
6. Documentation of the reduction in energy use associated with ~~*on-site*~~ *renewable energy*.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the hydrocarbon resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first ("bottom-up inorganic recovery") case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second ("top-down inorganic recovery") case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third ("organic recovery") case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into fuels”, https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will decrease the cost of construction.
This code change proposal can decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

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Workgroup Recommendation

Proposal # 929

CED1-11-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C409.6.1.9 ~~On-site~~ renewable energy systems. ~~On-site~~ Renewable Energy Systems shall not be modeled.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the hydrocarbon resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first (“bottom-up inorganic recovery”) case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second (“top-down inorganic recovery”) case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third (“organic recovery”) case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

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[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into

fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will decrease the cost of construction.
This code change proposal will decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

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[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

Proposal # 930

CED1-12-22

Proponents: Daniel Carroll, representing Department of State DBSC (daniel.carroll@dos.ny.gov); Emma Gonzalez-Laders, representing Dept. of State/DBSC (emma.gonzalez-laders@dos.ny.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C505.1 General. Spaces undergoing a change in occupancy from F, H, S or U occupancy classification shall comply with Section C503. Buildings or portions of buildings undergoing a change of occupancy without alterations shall comply with Section ~~C502.2~~ C505.2.

Exception: Where the total building performance option in Section C407 is used to comply with this section, the annual energy cost of the proposed design shall not be greater than 110 percent of the annual energy cost otherwise permitted by Section C407.3.

C505.2 Energy use intensities. Building envelope, space heating, cooling, ventilation, lighting and service water heating shall comply with Sections C505.2.1 through C505.2.4.
Exceptions:

1. Where it is demonstrated by analysis approved by the *code official* that the change will not increase energy use intensity.
2. Where the occupancy or use change is less than 5,000 square feet (464 m^2) in area.

Reason: Section C505.1 currently references Section C502.1, which addresses nonconditioned and low-energy space altered to become conditioned space, an addition. The correct reference should be Section C505.2, which addresses energy use intensities.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change is editorial.

Workgroup Recommendation

Proposal # 806

CED1-13-22

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

140 ~~—2014~~ 2020: ~~Standard~~ Method of Test for Evaluating~~the Evaluation of~~ Building Performance Simulation Software~~Energy Analysis Computer Programs~~

Reason: Since publication of ANSI/ASHRAE 140-2014 (the most recently referenced version by IECC 2021), the following major revisions have occurred:

- Air-Side HVAC Equipment Analytical Verification Tests (140-2020 Section 5.5) are added
- Building Thermal Envelope and Fabric Load Tests (140-2020, Sections 5.2.1, 5.2.2, and 5.2.3) are updated with new test cases included.

Cost Impact: The code change proposal will increase the cost of construction.
The expected additional cost impact on the software development industry is minimal for updating the reference in IECC 2024 to Standard 140-2020. The primary cost of applying the Standard 140 test suites is for software developers to create input files for the new test cases, analyze the results, and then report their output. However, most major software developers have already run the new and updated test suites, either during simulation trials of the new and updated test suites or as part of other software qualification requirements (e.g., forthcoming updates to Standard 140 acceptance criteria).

Workgroup Recommendation

Proposal # 792

CED1-14-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org); Michael Waite, representing American Council for an Energy-Efficient Economy (mwaite@aceee.org); John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com); Rachael Dorothy, representing self (dorothy.2@osu.edu); Erin Sherman, representing RMI (esherman@rmi.org); Melissa Kops, representing CT Green Building Council (melissa@ctgbc.org); Thomas Nagy, representing enVerid Systems (tnagy@enverid.com); Carlos Augusto Garcia, representing Brooks + Scarpa (garcia@brooksscarpa.com); Andy Woommavovah, representing Healthcare (andy.woommavovah@trinity-health.org); Jenny Hernandez, representing Las Cruces Sustainability (jehernandez@las-cruces.org); Khaled Mansy, representing self (khaled.mansy@okstate.edu); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Brad Hill, representing Honeywell International Inc. (brad.hill@honeywell.com); David Goldstein, representing Natural Resources Defense Council (dgoldstein.nrdc@gmail.com)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

103.2.2 Electrification System. The construction documents shall provide details for additional electric infrastructure, including branch circuits, conduit, pre-wiring, panel capacity, and electrical service capacity, as well as interior and exterior spaces designated for future electric equipment, in compliance with the provisions of this code.

Revise as follows:

C105.2.5 Electrical system. Inspections shall verify lighting system controls, components ~~and~~ meters , and additional electric infrastructure as required by the code, *approved* plans and specifications.Where an electrical energy storage system area is required, inspections shall verify space availability and pathways to electrical service.

C405.5.3 Fuel ~~G~~ gas lighting. *Fuel gas*~~Gas~~-fired lighting appliances shall not be ~~equipped with continuously burning pilot ignition systems~~ permitted.

Add new text as follows:

403.15 Hydronic Heating Design Requirements. For all hydronic space heating systems, the design entering water temperature for coils, radiant panels, radiant floor systems, radiators, baseboard heaters, and any other device that uses hot water to provide heat to a space shall be not more than 130°F (55°C).

405.17 Additional electric infrastructure. Buildings that contain *combustion equipment* shall be required to install electric infrastructure in accordance with this section.

405.17.1 Combustion space heating. Spaces containing *combustion equipment* for space heatingshall comply with Sections C405.17.1.1, C405.17.1.2 and C405.17.1.3.

405.17.1.1 Designated exterior locations for future electric space heating equipment. Spaces containing *combustion equipment* for space heating shall be provided with designated exterior location(s) shown on the plans and of sufficient size for outdoor space heating heat pump equipment, with a chase that is sized to accommodate refrigerant lines between the exterior location and the interior location of the space heating equipment, and with natural drainage for condensate from heating operation or a condensate drain located within 3 feet (914 mm) of the location of the space heating heat pump equipment.

405.17.1.2 Dedicated branch circuits for future electric space heating equipment. Spaces containing *combustion equipment* for space heating shall be provided with a dedicated branch circuit rated and sized in accordance with Section C405.17.1.3, in compliance with NFPA70 Section 424.4 and terminating in a junction box within 3 feet (914 mm) of the location the space heating equipment without obstructions. Both ends of the branch circuit shall be labeled "For Future Electric Space Heating Equipment."
Exceptions:

1. Where a branch circuit provides electricity to the space heating *combustion equipment* and is rated and sized in accordance with Section C405.17.1.3
2. Where a branch circuit provides electricity to space cooling equipment and is both in compliance withNFPA70 Sections 440.4(B) and 440.35 and is rated and sized in accordance with Section C405.17.1.3.
3. Where future electric space heating equipment would require three-phase power and the space containing *combustion equipment* for space heating is provided with an electrical panel with a label stating, "For Future Electric Space Heating Equipment" and with a bus bar rated and sized in accordance with Section C405.17.1.3.

405.17.1.3 Additional space heating electric infrastructure sizing. Electric infrastructure forfutureelectricspace heatingequipment shall be sized to accommodate at least one of the following:

1. An electrical capacity not less than the space heating *combustion equipment* heating capacity multiplied by the value in Table C405.17.1(1) based on the climate zone and building occupancy group served by the space heating equipment. Where the space heating equipment serves multiple occupancies, the values in Table C405.17.1(1) shall be weighted by the gross floor area of each occupancy served by the space heating equipment and multiplied by the space heating *combustion equipment* heating capacity, or

2. An electrical capacity not less than the peak space heating load of the building areas served by the space heating *combustion equipment*, calculated in accordance with Section C403.1.1, multiplied by the value in Table C405.17.1(2) based on the climate zone and building occupancy group served by the space heating equipment. Where the space heating equipment serves multiple occupancies, the values in Table C405.17.1(2) shall be weighted by the gross floor area of each occupancy served by the space heating equipment and multiplied by the peak space heating load of the building areas served by the space heating equipment, or
3. An alternate design that complies with this code, that is approved by the authority having jurisdiction, and that uses no energy source other than electricity or *on-site renewable energy*.

Revise as follows:

TABLE C405.17.1(1) ALTERNATE ELECTRIC SPACE HEATING EQUIPMENT CONVERSION FACTORS (VA/kBtu/h) - CAPACITY BASIS

Building Occupancy Group	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1																			
I-2																			
R-1																			
B																			
A-2																			
M																			
E																			
S-1 and S-2																			
All Other																			

TABLE C405.17.1(2) ALTERNATE ELECTRIC SPACE HEATING EQUIPMENT CONVERSION FACTORS (VA/kBtu/h) - LOAD BASIS

Building Occupancy Group	Climate Zone																			
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1																			
I-2																			
R-1																			
B																			
A-2																			
M																			
E																			
S-1 and S-2																			
All Other																			

Add new text as follows:

405.17.2 Combustion water heating. Spaces containing *combustion equipment* for water heatingshall comply with Sections C405.17.2.1, C405.17.2.2 and C405.17.2.3.

405.17.2.1 Designated locations for future electric water heating equipment. Spaces containing *combustion equipment* for water heating shall be provided with one of the following:

1. Designated exterior location(s) shown on the plans and of sufficient size for outdoor water heating heat pump equipment, with a chase that is sized to accommodate refrigerant lines between the exterior location and the interior location of the water heating equipment.
2. An interior location with a minimum volume the greater of 700 cubic feet (2000 L) or 7 cubic feet (200 L) per 1,000 Btu/h *combustion equipment* water heating capacity.
3. An interior location with sufficient airflow to exhaust cool air from future water heating heat pump equipment provided by no less than one 16-inch (406 mm) by 24-inch (610 mm) grill to a heated space and one 8-inch (203 mm) duct of no more than 10 feet (3048 mm) in length for cool exhaust air.

Spaces containing *combustion equipment* for water heating shall be provided with a condensate drain located within 3 feet (914 mm) of the location of the water heating equipment. The condensate drain shall maintain a minimum horizontal slope in the direction of discharge of not less than one-half unit vertical in 12 units horizontal (4-percent slope) and include a “P” trap or vent “t”.

405.17.2.2 Dedicated branch circuits for future electric water heating equipment. Spaces containing *combustion equipment* for water heating shall be provided with a dedicated branch circuit rated and sized in accordance with Section C405.17.2.3, in compliance with NFPA70 Section 424.4 and terminating in a junction box within 3 feet (914 mm) of the location the water heating equipment without obstructions. Both ends of the branch circuit shall be labeled “For Future Electric Water Heating Equipment.”

Exception: Where future electric water heating equipment would require three-phase power and the main electrical service panel has a reserved space for a bus bar rated and sized in accordance with Section C405.17.2.3 and labeled “For Future Electric Water Heating Equipment.”

405.17.2.3 Additional water heating electric infrastructure sizing. Electric infrastructure water heatingequipment shall be sized to accommodate one of the following:

1. An electrical capacity not less than the *combustion equipment* water heating capacity multiplied by the value in Table C405.17.2 based on the climate zone and building occupancy group served by the water heating equipment. Where the water heating equipment serves multiple occupancies, the values in Table C405.17.2 shall be weighted by the gross floor area of each occupancy served by the water heating equipment and multiplied by the *combustion equipment* water heating capacity, or
2. An alternate design that complies with this code, that is approved by the authority having jurisdiction, and that uses no energy source other than electricity or *on-site renewable energy*.

Revise as follows:

TABLE C405.17.2 ALTERNATE ELECTRIC WATER HEATING EQUIPMENT CONVERSION FACTORS (VA/kBtu/h)

Building Occupancy Groups	Climate Zone																	
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1																			
I-2																			
R-1																			
B																			
A-2																			
M																			
E																			
S-1 and S-2																			
All Other																			

Add new text as follows:

405.17.3 Combustion cooking. Spaces containing combustion equipment for cookingshall comply with either C405.17.3.1 orC405.17.3.2

405.17.3.1 Commercial cooking. Spaces containing *commercial cooking appliances*shall be provided with a dedicated branch circuit with a minimum electrical capacity in accordance with Table 405.17.3.1 based on the appliance in the space. The branch circuit shall terminate within 3 feet (914 mm) of the appliance with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Cooking Equipment” and be electrically isolated.

Revise as follows:

TABLE C405.17.3.1 COMMERCIAL COOKING MINIMUM BRANCH CIRCUIT CAPACITY

Commercial Cooking Appliance	Minimum Branch Circuit Capacity
Range	114 VA/kBtu/h
Steamer	469 VA/kBtu/h
Fryer	200 VA/kBtu/h
Oven	266 VA/kBtu/h
Griddle	195 VA/kBtu/h
All other commercial cooking appliances	114 VA/kBtu/h

Add new text as follows:

405.17.3.2 All other cooking. Spaces containing all other cookingequipmentnot designated as*commercial cooking appliances*shall be provided with a dedicated branch circuitin compliance with NFPA 70 Section422.10. The branch circuitshall terminate within 6 feet (1829 mm) offossil fuelranges, cooktops and ovens and be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future ElectricCookingEquipment” and be electrically isolated.

405.17.4 Combustion clothes drying. Spaces containing combustion equipment for clothes dryingshall comply with either C405.17.4.1 or C405.17.4.2

405.17.4.1 Commercial drying. Spaces containing clothes dryingequipment,and end-usesfor commercial laundry applicationsshall be provided with conduit that is continuous between a junction box located within 3 feet (914 mm) of theequipmentand an electrical panel. The junction box, conduit and bus bar in the electrical panel shall be rated and sized to accommodate a branch circuit with sufficient capacity for an equivalent electricequipmentwith an equivalent equipment capacity. The electrical junction box and electrical panel shall have labels stating, “For Future ElectricClothes DryingEquipment.”

405.17.4.2 Residential drying. Spaces containing clothes dryingequipment, *appliances*,and end-uses serving multiple*dwelling units*or sleeping areaswith a capacity less thanor equal to9.2 cubicfeetshall be provided withadedicated 240-volt branch circuit with a minimum capacity of 30 amps shallterminate within 6 feet (1829 mm) offossil fuelclothes dryers and shall be accessible with no obstructions. Both ends of the branch circuit shall be labeled with the words “For Future Electric Clothes DryingEquipment” and be electrically isolated.

Add new definition as follows:

ALL-ELECTRIC BUILDING. A *building* that contains no *combustion equipment*, or plumbing for *combustion equipment,* installed within the *building* or *building site.*

APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

COMBUSTION EQUIPMENT. Any equipment or *appliance* used for space heating, *service water heating*, cooking, clothes drying and/or lighting that uses *fuel gas* or *fuel oil.*

COMMERCIAL COOKING APPLIANCE. Appliances used in a commercial food service establishment for heating or cooking food and which produce grease vapors, steam, fumes, smoke or odors that are required to be removed through a local exhaust ventilation system. Such appliances include deep fat fryers, upright broilers, griddles, broilers, steam-jacketed kettles, hot-top ranges, under-fired broilers (charbroilers), ovens, barbecues, rotisseries, and similar appliances. For the purpose of this definition, a food service establishment shall include any building or a portion thereof used for the preparation and serving of food.

FUEL GAS. A natural gas, manufactured gas, liquified petroleum gas or a mixture of these.

FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

Reason: In order for the U.S. to reach net zero carbon emissions, the country must not only reduce energy use through energy efficiency and move to utility scale and on-site renewable energy, but also begin to transition away from using combustion equipment in buildings that run on fossil fuels to electric equipment. In 2021, combustion equipment in commercial and residential buildings accounted for 35% of US greenhouse gas emissions.[1] The cost of installing electric-ready infrastructure when a building is under construction, walls are open, and the trades are already on-site, is small in comparison to the cost of retrofitting a building to install the same level of electric equipment. Having electric-ready infrastructure in place gives building owners or occupants the choice to shift to electric appliances at time of replacement or retrofit without incurring the costs and delays of retrofitting panels, opening walls to install conduit, etc. The residential 2024 IECC has included mandatory electric-ready requirements for water heating, cooktops and clothes drying into the public comment review draft #1. The California Building Energy Efficiency Standards 2022 update (Title 24, Part 6) has also moved in this direction, including electric-ready requirements for heat pump space heating, cooktops and clothes drying in both single family homes and multifamily buildings, and for water heating in single family homes. The Chicago Energy Transformation Code has also included electric-ready requirements for residential single family and multifamily buildings in their energy code. Attached is a letter with others stating the support for this proposal from 50 organizations, 16 of which are from local or state governments and universities, 12 of which are from NGOs, and 22 of which are from design and construction industry.

Requiring buildings to be electric-ready will not only reduce costs for building owners who choose to electrify their building at a later date but it will also give building residents the option to improve their own health. Gas appliances release harmful pollutants like nitrogen dioxide (NO2) and carbon monoxide (CO) either indoors because of gas stoves or outdoors because of space-heating and water heating equipment. A recent study from the Harvard Chang School of Public Health and RMI shows that in Illinois in 2017, air pollution from burning fuels in buildings led to an estimated 1,123 early deaths and $12.574 billion in health impact costs.[2] These emissions can particularly affect children. In a meta-analysis analyzing the connections between gas stoves and childhood asthma, children in homes with gas stoves were 42% more likely to experience asthma symptoms, and 32% more likely to be diagnosed with asthma. [3]Therefore, ensuring all-electric appliances can be installed in our buildings in the future is critical to reducing air pollution, protecting public health, reducing utility and construction costs, and meeting climate goals.NBI, ACEEE, and 2050 Partners on behalf of the California Investor Owned Utilities worked together to address many of the technical concerns raised when NBI's original proposal, CEPI-22, was discussed by the Commercial Consensus Committee in June of 2022. The main revisions to this proposal include:

1. Separating the original CEPI-22 proposal into three pieces, an electric-ready proposal, an all-electric appendix, and a requirement for more energy efficiency credits in buildings that do not primarily use heat pumps for space and water heating. Each piece stands alone with its own independent support, so each proposal can be discussed and voted on separately.
2. Requiring buildings with central water heating or space heating systems to have the electrical capacity but not conduit for a new system to ensure that unnecessary conduit is not placed in buildings that choose to install distributed and not central systems at a future date.
3. Clear electrical capacity requirements for electric-ready space and water heating based on occupancy type and climate zone to ensure that there is sufficient capacity to install efficient heat pumps for space heating and water heating without requiring full design and sizing of an all-electric alternative to a fuel-based system (though that option remains for flexibility). 2050 Partners is conducting energy modeling to determine capacity requirements. This modeling is not yet complete but will be complete before this proposal is considered by the commercial consensus committee.
4. Clear capacity requirements for commercial cooking appliances based on research conducted by NBI on the minimum branch circuits needed for a variety of commercial cooking appliances.
5. Additional flexibility that allows designers to submit an alternate design for the electrical infrastructure needed for water and space heating that would allow the building to use no energy source other than electricity or on-site renewable energy in the future.
6. Restructuring of the proposal to make it easier to understand and enforce.

Cost Impact: The code change proposal will increase the cost of construction.
Recent analysis by NBI and partners using cost data from RSMeans for a medium office indicates that additional electrical infrastructure costs for water-heating and space-heating would cost a typical office building an additional $0.09 per square foot of conditioned floor area. [4] However, if a building owner were to have to retrofit their building from using combustion equipment to natural gas equipment costs without these requirements in place, costs could be exorbitant. California Energy Codes & Standards "2021 Reach Code Cost-Effectiveness Analysis: Non-Residential Alterations" report estimated labor costs for electrification retrofit of mechanical systems as a 25 to 50% increase from new construction labor cost due to building-specific considerations such as tight conditions, prepping surfaces, elevated work, material handling, specialty rigging, and protecting existing finishes that can vary building to building. [5]

Bibliography: [1] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *Energy and the Environment Explained: Where Greenhouse Gases Come From*, U.S. Energy Information Administration (EIA), https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php#:~:text=In%202021%2C%20petroleum%20accounted%20for,energy%2Drelated%20CO2%20emissions.
[2] *Health Air Quality Impacts of Buildings Emissions*. RMI, 5 May 2021, rmi.org/health-air-quality-impacts-of-buildings-emissions#MI.

[3] *Gas Stoves: Health and Air Quality Impacts and Solutions.* RMI, 1 Feb. 2021, rmi.org/insight/gas-stoves-pollution-health/.

[4]*Cost Study of the Building Decarbonization Code* , New Buildings Institute, Apr. 2022, https://newbuildings.org/wp-content/uploads/2022/04/BuildingDecarbCostStudy.pdf.

[5] *2021 Reach Code Cost-Effectiveness Analysis: Non-Residential Alterations*, California Energy Codes and Standards, 27 Jan. 2022, https://localenergycodes.com/.

Attached Files

- **Commercial Electrification Sign On Letter 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/809/1705/files/download/385/

Workgroup Recommendation

CED1-15-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org); Michael Waite, representing American Council for an Energy-Efficient Economy (mwaite@aceee.org); John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com); Rachael Dorothy, representing self (dorothy.2@osu.edu); Erin Sherman, representing RMI (esherman@rmi.org); Melissa Kops, representing CT Green Building Council (melissa@ctgbc.org); Andy Woommavovah, representing Healthcare (andy.woommavovah@trinity-health.org); Jenny Hernandez, representing Las Cruces Sustainability (jehernandez@las-cruces.org); Khaled Mansy, representing self (khaled.mansy@okstate.edu); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Brad Hill, representing Honeywell International Inc. (brad.hill@honeywell.com); David Goldstein, representing Natural Resources Defense Council (dgoldstein.nrdc@gmail.com)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

APPENDIX CG
ALL-ELECTRIC COMMERCIAL BUILDING PROVISIONS

SECTION CG101
GENERAL

CG101.1 Intent. The intent of this Appendix is to amend the *International Energy Conservation Code* to reduce greenhouse gas emissions from buildings and improve the safety and health for commercial building occupants by requiring new *all-electric buildings* and efficient electrification of existing buildings.

CG101.2 Scope. The provisions in this appendix are applicable to commercial buildings. New construction shall comply with Section CG103. *Additions*, *alterations*, *repairs* and *changes of occupancy* to existing buildings shall comply with Chapter 5 and Section CG104.

SECTION CG102
DEFINITIONS

CG102 ALL-ELECTRIC BUILDING. A *building* that contains no *combustion equipment*, or plumbing for *combustion equipment*, installed within the *building* or *building site.*

CG102 APPLIANCE. A device or apparatus that is manufactured and designed to utilize energy and for which this code provides specific requirements.

CG102 COMBUSTION EQUIPMENT. Anyequipment or *appliance* used for space heating, *service water heating*, cooking, clothes drying, humidification, or lighting that uses *fuel gas* or *fuel oil.*

CG102 FUEL GAS. Natural gas, manufactured gas, liquified petroleum gas or a mixture of these.

CG102 FUEL OIL. Kerosene or any hydrocarbon oil having a flash point not less than 100°F (38°C).

CG102 SUBSTANTIAL ENERGY ALTERATION. An *alteration* that includes replacement of two or more of the following:

1. 50 percent or greater of the area of interior wall-covering material of the b*uilding thermal envelope* or *fenestration.*
2. 50 percent or greater of the area of the exterior wall-covering material of the *building thermal envelope* or *fenestration.*
3. Space-conditioning equipment constituting 50 percent or greater of the total input capacity of the space heating or space cooling equipment serving the *building.*
4. Water-heating equipment constituting 50 percent or greater of the total input capacity of all the water heating equipment serving the *building.*
5. 50 percent or greater of the luminaires in the *building.*

CG102 SUBSTANTIAL IMPROVEMENT. Any *repair*, reconstruction, rehabilitation, *alteration*, *addition* or other improvement of a building or structure, the cost of which equals or exceeds 50 percent of the market value of the structure before the improvement or repair is started. If the structure has sustained *substantial damage*, any repairs are considered substantial improvement regardless of the actual *repair* work performed. The term does not, however, include either:

1. Any project for improvement of a *building* required to correct existing health, sanitary or safety code violations identified by the *building official* and that are the minimum necessary to assure safe living conditions.
2. Any *alteration* of a *historic structure* provided that the *alteration* will not preclude the structure’s continued designation as a historic structure.

SECTION CG103
NEW COMMERCIAL BUILDINGS

CG103.1 Application. New commercial buildings shall be *all-electric buildings* and comply with Sections C401.2.1 or C401.2.2.

CG103.2 Electric resistance heating equipment. The sole use of electric resistance equipment and appliances for space and water heating shall be prohibited other than for *buildings* or portions of *buildings* that comply with not less than one of Sections CG103.2.1 through CG103.2.8.

CG103.2.1 Low space heating capacity. Buildings or areas of buildings not served by a mechanical cooling system and with a total space heating capacity not greater than 4.0 BTU/h (1.0 watts) per square foot of *conditioned space* are permitted to be heated using electric resistance *appliances* or equipment.

CG103.2.2 Small systems. Buildings in which electric resistance *appliances* or equipment comprise less than 5 percent of the total system heating capacity or serve less than 5 percent of the *conditioned floor area*.

CG103.2.3 Specific conditions. Portions of buildings or specific equipment and appliances that require electric resistance heating that cannot practicably be served by electric heat pumps as approved by the code official.

CG103.2.4 Kitchen make-up air. Make-up air for commercial kitchen exhaust systems required to be tempered by Section 508.1.1 of the International Mechanical Code is permitted to be heated by electric resistance.

CG103.2.5 Freeze protection. Use of electric resistance heat for freeze protection shall comply with Sections CG103.2.5.1 through CG103.2.5.2.

CG103.2.5.1 Low indoor design conditions. Space heating systems sized for spaces with indoor design conditions of no higher than 40°F (4.5°C) and intended for freeze protection, including temporary systems in unfinished spaces, are permitted to use electric resistance. The building envelope of any such space shall be insulated in compliance with Section C402.1.

CG103.2.5.2 Freeze protection systems. Freeze protection systems shall comply with Section C403.13.3.

CG103.2.6 Pre-heating of outdoor air. Systems with energy recovery ventilation are permitted to utilize electric resistance to preheat outdoor air for defrost or temper supply air to not more than 45°F (7.2°C). Hydronic systems without energy recovery ventilation are permitted to utilize electric resistance to temper supply air to not more than 40°F (4.5°C).

CG103.2.7 Small buildings. Buildings with a conditioned floor area of not more than 250 square feet (23.2 m^2) and not served by a mechanical space cooling system shall be permitted to use electric resistance *appliances* or equipment for space heating.

CG103.2.8 Supplemental heat. Electric resistance heat shall be permitted as supplemental heat when installed with heat pumps sized in accordance with Section CG103.3 and when operated only when a heat pump cannot provide the necessary heating energy to satisfy the thermostat setting.

CG103.3 Heat pump sizing for space heating. Heat pump space heating systems shall be sized to meet the *building* heating load at the greater of 0°F (-18°C) or the 99 Percent Annual Heating Dry-Bulb for the nearest weather station provided in the ASHRAE Handbook of Fundamentals. The heat pump space heating system shall not require the use of supplemental electric heat at or above this temperature other than for defrosting. Lower capacity heat pumps that operate in conjunction with thermal storage shall be permitted if the system meets the requirements of this section.

CG103.4 Heat pump sizing for water heating. Heat pump *service heating system*s shall be sized to meet the *building service water heating* load at the greater of 15°F (-18°C) or the 99 Percent Annual Heating Dry-Bulb for the nearest weather station provided in the latest edition of the ASHRAE Fundamentals Handbook. Supplemental electric heat shall not be required at or above this temperature other than for temperature maintenance in recirculating systems and defrosting.

CG103.5 Heating outside a building. Systems for heating outside a building shall comply with C403.13.1.

CG103.6 Cooling equipment. New unitary air conditioners shall be electric heat pump equipment sized and configured to provide both space cooling and space heating.

SECTION CG104
EXISTING COMMERCIAL BUILDINGS

CG104.1 Combustion equipment in additions. *Additions* shall not be permitted to contain *combustion equipment* and new equipment installed to serve *additions* shall not be *combustion equipment*. Where systems with *combustion equipment* are extended into an addition, the existing *building* and addition together shall use no more fossil fuel energy than the existing *building* alone.

CG104.2 Substantial improvement. Buildings undergoing *substantial improvements* shall be *all-electric buildings*, comply with C402.5 and meet a site EUI by building type in accordance with ASHRAE Standard 100 Table 7-2a.
Exception: Compliance with Standard 100 shall not be required where Group R occupancies achieve an ERI score of 80 or below without on-site renewable energy included in accordance with RESNET/ICC 301, for each dwelling unit.

CG104.3 Additional energy efficiency credits for substantial energy alterations. *Substantial energy alterations* of *all-electric buildings* shall comply with Section C503.6 and *mixed-fuel* buildings shall achieve not less than two times the number of required efficiency credits from Section C503.6.
Exceptions:

1. Alterations that are part of an addition complying with section CG104.1.
2. Alterations that comply with Section C407.
3. Alterations that comply with Section CG104.2.

CG104.4 Cooling equipment. New and replacement unitary air conditioners shall be electric heat pump equipment sized and configured to provide both space cooling and space heating. Any existing space heating systems other than existing heat pump equipment that serve the same zone as the new equipment shall be configured as supplementary heat in accordance with Section CG104.7.

CG104.5 Service water heating equipment. Where service water heating equipment is added or replaced, new service hot water equipment shall not be *combustion equipment.*

CG104.6 Furnace replacement. Newly installed warm air furnaces provided for space heating shall only be permitted as supplementary heat controlled in accordance with Section CG104.7.

CG104.7 Heat pump supplementary heat. Heat pumps having *combustion equipment* or electric resistance equipment for supplementary space or *service water heating* shall have controls that limit supplemental heat operation to only those times when one of the following applies:

1. The heat pump is operating in defrost mode.
2. The vapor compression cycle malfunctions.
3. For space heating systems, the thermostat malfunctions.
4. For space heating systems, the vapor compression cycle cannot provide the necessary heating energy to satisfy the thermostat setting.
5. The outdoor air temperature is less than the design temperature determined in accordance with Section CG103.3.
6. For *service water heating*, the heat pump water heater cannot maintain an output water temperature of at least 120°F (49°C) .
7. For temperature maintenance in *service water heating* systems.

New supplementary space and *service water heating* systems for heat pump equipment shall not be permitted to have a heating input capacity greater than the heating input capacity of the heat pump equipment.

Add new standard(s) as follows:

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

100-2018 Energy Efficiency in Existing Buildings

Reason: In order for the U.S. to reach net zero carbon emissions, the country must not only reduce energy use through energy efficiency and move to utility scale and on-site renewable energy, but also begin to transition away from using combustion equipment in buildings that runs on fossil fuels to electric equipment. In 2021, combustion equipment in commercial and residential buildings accounted for 35% of US greenhouse gas emissions.[1] The purpose of a model code is to provide cities and states with a starting point on which each jurisdiction can base their energy code. Growing interest in establishing all-electric building requirements is evidenced by several cities and states passing ordinances banning fossil fuel combustion equipment in buildings including Washington DC, New York City, Ithaca, New York; Brookline, Massachusetts; Berkeley, Los Angeles, Sacramento, San Francisco, Oakland and San Jose, California; and Washington State. Including an appendix in the 2024 IECC that specifies requirements for all-electric commercial construction will streamline adoption and implementation of all-electric construction for policy makers and the building industry. We strongly encourage that the code language in this appendix minimizes the use of inefficient electric resistance heat for space heating in new buildings to avoid an unintended consequence of higher operational costs and carbon emissions for the life of the building. Attached is a letter with others stating the support for this proposal from 50 organizations, 16 of which are from local or state governments and universities, 12 of which are from NGOs, and 22 of which are from design and construction industry. In addition to the letter of support, this proposal includes more than 30 co-proponents.
All-electric buildings not only reduce carbon emissions but are also healthier for building occupants. Gas appliances release harmful pollutants like nitrogen dioxide (NO2) and carbon monoxide (CO) either indoors because of gas stoves or outdoors because of space-heating and water heating equipment. A recent study from the Harvard Chang School of Public Health and RMI shows that in Illinois in 2017, air pollution from burning fuels in buildings led to an estimated 1,123 early deaths and $12.574 billion in health impact costs.[2] These emissions can particularly affect children. In a meta-analysis analyzing the connections between gas stoves and childhood asthma, children in homes with gas stoves were 42% more likely to experience asthma symptoms, and 32% more likely to being diagnosed with asthma. [3]Therefore, ensuring all-electric appliances are installed is critical to reducing air pollution, protecting public health, reducing utility and construction costs, and meeting climate goals.NBI, ACEEE, and 2050

Partners on behalf of the California Investor Owned Utilities worked together to address many of the technical concerns raised when NBI's original proposal, CEPI-22, was discussed in June of 2022. The main revisions to this proposal include:

1. Separating the original CEPI-22 proposal into three pieces, an electric-ready proposal, an all-electric appendix, and a requirement for more energy efficiency credits in buildings that do not primarily use heat pumps for space and water heating. Each piece stands alone with its own independent support, so each proposal can be discussed and voted on separately.

2. Ensuring that jurisdictions encourage efficient electrification by only allowing the use of electric resistance heat for space and water heating in certain applications.

3. Additional requirements on appropriately sizing heat pumps for space heating and water heating are included so that electric resistance heat for supplementary heat is reduced. 2050 partners is conducting additional modeling to for a variety of building types in multiple climate zones to determine if additional requirements are needed. This modeling is not yet complete but will be complete before the commercial consensus committee considers this proposal.

4. A new section addressing the use of combustion equipment in existing buildings. This new section:

   a. Does not permit new combustion equipment in additions

   b. Requires buildings undergoing a substantial improvement, defined as work that exceeds 50% of the market value of the structure to both be all-electric and meet EUI targets outlined in ASHRAE Standard 100.

   c. Incentivizes heat pumps in new buildings by requiring buildings undergoing a substantial energy alteration to achieve additional energy efficiency credits.

   d. Requires new and replacement cooling equipment to be electric heat pump equipment configured to provide both space cooling and space heating and requires existing space heating systems that are not heat pump systems are required to provide supplementary heat.

   e. Requires new or replacement service hot water equipment to be electric.

   f. Requires new furnaces provided for space heating to only be permitted to be used as supplementary heat.

   g. Reduces the use of electric resistance and combustion equipment for supplementary heat through the use of improved controls.

Cost Impact: The code change proposal will decrease the cost of construction.
All-electric commercial buildings are less expensive to build than mixed fuel buildings because electric appliances and equipment are typically less expensive than combustion equipment and appliances. In additional developers avoid the cost of installing natural-gas lines and meters. Recent analysis by NBI and partners utilizing data from RS Means indicates that an all-electric 53,000 s.f. office building with a central heat pump water heater and minimum code compliant air source heat pump costs $0.07/s.f. to $0.24/s.f. less to build than a mixed-fuel office building of the same size. [4] Additional analyses from a recent CASE study indicate that all-electric high-rise multifamily buildings are also less expensive to build and operate than mixed-fuel buildings. HVAC costs, for example, are on the order of $2,504 to $7,131 lower per dwelling unit depending on the HVAC system installed. Installing electric space heating and water heating equipment instead of natural gas equipment in the majority of California's climate zones also yielded a positive benefit to cost ratio over the 15- year analysis period despite California's high electricity rates. This is perhaps why close to half of commercial buildings currently do not use natural gas. [5] Moving to all-electric construction also results in more stable utility bills because electricity prices are not as volatile as natural gas prices. [6]

Bibliography: [1] "U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." *Energy and the Environment Explained: Where Greenhouse Gases Come From*, U.S. Energy Information Administration (EIA), https://www.eia.gov/energyexplained/energy-and-the-environment/where-greenhouse-gases-come-from.php#:~:text=In%202021%2C%20petroleum%20accounted%20for,energy%2Drelated%20CO2%20emissions.
[2] *Health Air Quality Impacts of Buildings Emissions*. RMI, 5 May 2021, rmi.org/health-air-quality-impacts-of-buildings-emissions#MI.

[3] *Gas Stoves: Health and Air Quality Impacts and Solutions.* RMI, 1 Feb. 2021, rmi.org/insight/gas-stoves-pollution-health/.

[4]*Cost Study of the Building Decarbonization Code* , New Buildings Institute, Apr. 2022, https://newbuildings.org/wp-content/uploads/2022/04/BuildingDecarbCostStudy.pdf.

[5]“U.S. Energy Information Administration - EIA - Independent Statistics and Analysis.” *Commercial Buildings Energy Consumption Survey (CBECS)*, Energy Information Administration (EIA), 2018, https://www.eia.gov/consumption/commercial/data/2018/pdf/CBECS_2018_Building_Characteristics_Flipbook.pdf.

[6] Slanger, Dan. *Reality Check: The Myth of Stable and Affordable Natural Gas Prices*, RMI, 5 May 2022, https://rmi.org/the-myth-of-stable-and-affordable-natural-gas-prices/.

Attached Files

- **Commercial Electrification Sign On Letter 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/810/1704/files/download/384/

Workgroup Recommendation

Proposal # 810

CED1-16-22

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical distribution equipment.
15. Thermal bridges as identified in Section C402.6.
16. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable energy system to the point of interconnection with the electrical service and the ESS.
17. Location and layout of a designated area for ESS.
18. Rated energy capacity and rated power capacity of the installed or planned ESS.
19. Location of designated *EVSE spaces*, *EV Ready spaces*, and *EV Capable spaces* in parking facilities.

C405.14 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with electric vehicle power transfer infrastructure in ~~compliance~~ accordance with Sections C405.14.1 through C405.14.6.

C405.14.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section C405.14.1 shall comply with ~~all of~~ the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capacit~~i~~y in accordance with Section C405.14.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."
5. ~~Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each EV capable space.~~

C405.14.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with ~~all of~~ the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
2. Have a minimum electrical distribution system and circuit capacity in accordance with Section C405.14.5.

3. The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.14.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with ~~all of~~ the following:

1. Be served by an electrical distribution system ~~Have a minimum circuit capacity~~ in accordance with Section C405.14.5.
2. Have a minimum ~~charging rate in accordance with C405.14.4.1~~ nameplate charging capacity of 6.2 kVA (or 30A at 208/240V) per *EVSE space* served.
3. Be located within 3 feet (914 mm) of each *EVSE space* it serves.
4. Be installed in accordance with Section ~~C405.14.6~~ C405.14.4.1.

Delete and substitute as follows:

~~**C405.14.4.1 EVSE Minimum Charging Rate.** Each installed EVSE shall comply with one of the following:~~

1. ~~Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).~~
2. ~~When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously sharing each EVSE space at a minimum rate of no less than 3.3 kVA.~~
3. ~~When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.14.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 kVA.~~

C405.14.4.1 *EVSE* Installation. *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with *International Building Code* Section 1107.

Revise as follows:

C405.14.5 ~~Circuit~~ Electrical distribution system Capacity. The ~~capacity of electrical infrastructure~~ electrical distribution system serving each EV capable space, EV ready space, and EVSE space used to comply with Section C405.15.1 shall comply with one of the following:

1. ~~A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V)~~ Sized for a calculated *EV* charging load of not less than 6.2 kVA for each *EV ready space* or *EVSE space* and 3.3 kVA for each *EV capable space* it serves.
2. The requirements of Section C405.14.5.1.

C405.14.5.1 ~~Circuit~~ Capacity Management for *EV* loads. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. ~~Have a minimum capacity of 4.1~~ Be sized for a minimum calculated load of 3.3 kVA per *EVSE, EV ready* or *EV capable* space.
2. ~~Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE space for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces.~~
3. ~~Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.~~ Where all (100%) of the automobile spaces are *EVSE* or *EV ready spaces,* be sized for a minimum calculated load of 2.1 kVA per *EVSE* or *EV ready space.*

Where an energy management system is used to control *EV* charging loads for the purposes of this section, it shall not be configured to turn off electrical power to *EVSE* or *EV ready spaces* used to comply with Section C405.14.1.

Delete without substitution:

~~**C405.14.6 EVSE Installation.** EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with *International Building Code* Section 1107.~~

Reason: This public comment does not meaningfully change the stringency of any of the requirements, but is intended to improve the clarity, usability and enforceability of the EV charging section of the code. The edits do several things:

1. New requirements to note the location and layout of EVSE, EV Ready and EV Capable spaces on construction documents have been added.
2. There are several editorial changes to align the language with standard code language conventions. For example, "in compliance" has been replaced with "in accordance."
3. The capacity requirement has been removed from C405.14.2 and has been addressed more clearly in C405.14.5.
4. The language has been clarified that capacity requirements are not just for branch circuits, but for the whole electrical distribution system.
5. The minimum charging functionality requirements for EVSE (C405.14.4 #2 and C405.14.4.1) has been rewritten. C405.14.4.1 attempted to set requirements for minimum charging rates for EVSE controlled by an EMS. However, it created confusion. Energy management is not the only

reason that an EVSE will reduce the power delivery to an EV. EVSE will frequently reduce the power delivered to an EV based on the charging capacity and needs of the EV, or based on demand responsive controls. Therefore, it does not work to set a minimum charging rate for a load managed EVSE. To address this issue, the new language just sets a minimum nameplate charging capacity for the EVSE. Functional requirements for how EV power can be reduced by an EMS is addressed in the EMS section in C405.14.5. This allows C405.14.4.1 EVSE Minimum Charging Rate to be deleted completely. Additionally, the section uses language of the "nameplate charging capacity" rather than "be capable of charging" since this better aligns with how the functional capacity of equipment is generally discussed in the code.

6. C405.14.6 has been moved to C405.14.4.1 since that is a more logical location as those requirements are all specific to the EVSE.
7. C405.14.5, which addresses EV load management, has been significantly revised. The existing language creates some confusion since it includes requirements for both charging rate and available infrastructure capacity. The discussion by both the ELPR sub-committee and the full commercial committee revealed that there was some confusion about how to convert these requirements into electrical distribution system designs, particularly in regard to when the safety factor required by the electrical code was or was not included or how to address power factors. The new language includes a simplified approach.

- The section does not set direct requirements for circuit or system sizing at all. Distribution system sizing is really the purview of the electrical code. Since this section's real purpose is to ensure minimum available power for EV space, the edits focus C405.14.5 instead on the calculated EV loads that the electrical system must be sized to accommodate. This allows this code to set minimum functional requirements for how much power needs to be available for EV charging while leaving the sizing of the actual system to the requirements of the electrical code. Therefore, the 8.3 kVA branch circuit requirement (208/240V branch circuit with a 40A circuit breaker) in C405.14.5 Item #1 is expressed as a requirement for a 6.2 kVA calculate load (which is the load of a 30A charger on a 208/240V circuit). The 4.1 kVA requirement for the distribution system in C405.14.5.1 is expressed instead as a requirement 3.3 kVA calculated load (or a 2.1 kVA calculated load).
- During the development of the committee proposal that led to this language, it was important that EMSs not manage loads by simply turning power off to some EV spaces since that would have a significant impact on user satisfaction. As discussed above, dealing with this at the EVSE level does not quite work. This edit to C405.14.5.1addresses the issue of minimum simultaneous charging in a much simpler way by addressing the EMS rather than the EVSE. It simply states that the EMS cannot turn off power to the EV spaces as part of capacity management. This ensures that EVSE can reduce power to the EVs for other reasons, and leaves the door open for the EMS to cut power to the EVSE for other reasons beside capacity management such as demand response.
- Additionally, C405.14.5.1 item 2 has been removed since it is redundant with #3.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not change the cost of construction.

Workgroup Recommendation

Proposal # 777

CED1-17-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. Location of pathways for routing of raceways or cable from the on-site renewable electric energy system to the electrical distribution equipment.
15. Thermal bridges as identified in Section C402.6.
16. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable electric energy system to the point of interconnection with the electrical service and the ESS.
17. Location and layout of a designated area for ESS.
18. Rated energy capacity and rated power capacity of the installed or planned ESS.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first ("bottom-up inorganic recovery") case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second ("top-down inorganic recovery") case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third ("organic recovery") case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

CED1-18-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

~~**BIOMASS WASTE.** Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and biogases; but excludes wood and wood-derived fuels (including black liquor), biofuel feedstock, biodiesel, and fuel ethanol.~~

RENEWABLE ENERGY RESOURCES. Energy derived from solar radiation, wind, waves, tides, ~~*biomass waste*~~ *renewable fuels* or extracted from hot fluid or steam heated within the earth.

Add new definition as follows:

RENEWABLE FUEL. Fuels that achieve a 70 percent greenhouse gas emission reduction from a comparable fossil fuel calculated in accordance with California Air Resources Board's Low Carbon Fuel Standard or Annex V or Annex VI of the European Union Renewable Energy Directive 2018/2001.

Add new standard(s) as follows:

CARB California Air Resources Board. Low Carbon Fuel Standard: CA- GREET 3.0 model

EU European Parliament. Annex V and VI of the European Union Renewable Energy Directive 2018/2001 (RED II)

Reason: NBI submitted proposal CEPI-12 to revise the definition of renewable energy resource by removing the word "biomass" from the definition and substituting it with "biomass waste" to more accurately address the types of biomass that are likely to reduce and not increase pollutants and greenhouse gas emissions. Several conversations with industry stakeholders raised valid concerns with this approach namely, the revised definition approved in the draft 2024 IECC may be both difficult to enforce and could eliminate certain fuels that reduce greenhouse gas emissions not sourced from biomass waste products.

This proposal instead models the definition of a renewable fuel on existing policies used to reduce greenhouse gas emissions from fuels. This new proposed definition is based on current policies for transportation fuels in California, Washington and Oregon, Green-e's renewable fuel standard, and requirements for renewable fuels in Europe. Like the Green-e certified renewable fuel standard, the proposed definition relies on a method for calculating the greenhouse gas emission reduction from a renewable fuel product using California Air Resource Board's Low Carbon Fuel Standard. [1], [2] A similar calculation developed by the European Union for their Renewable Energy Directive II is also provided as an optional method for calculating emissions. Both methods include both direct greenhouse gas emission from the production and consumption of the fuel and indirect greenhouse gas emissions from land use changes. [3]

The required greenhouse gas emission reduction target of 70% when compared to fossil fuels is equivalent to the requirements for renewable building fuels in Europe as of 2021. Europe will increase the required percentage to 80% by 2026. [3] NBI believes the IECC should eventually follow Europe's lead and reduce the greenhouse gas emission requirement for renewable fuels as the US transitions to a more renewable grid.
This revised renewable fuel definition proposed is easier to enforce, technology neutral, and will ensure the renewable energy requirement proposed for inclusion in the 2024 IECC will prevent increased localized criteria air pollution while still reducing carbon emissions from the building.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not affect the cost of construction.

Bibliography: [1] California Air Resources Board. (2022, July 7). LCFS Pathway Certified Carbon Intensities. Retrieved from https://ww2.arb.ca.gov/resources/documents/lcfs-pathway-certified-carbon-intensities.
[2] Center for Resource Solutions. (2021, September 16). Green-e. Retrieved from Green-e Renewable Fuels Standard, Version 1.0: https://www.green-e.org/docs/rf/Green-e%20Renewable%20Fuels%20Standard.pdf

[3] European Commission. (2022, July 7). Renewable Energy – Recast to 2030 (RED II). Retrieved from EU Science Hub: https://joint-research-centre.ec.europa.eu/welcome-jec-website/reference-regulatory-framework/renewable-energy-recast-2030-red-ii_en

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/689/1672/files/download/360/

- **CELEX_32018L2001_EN_TXT.pdf**
  https://energy.cdpaccess.com/proposal/689/1672/files/download/342/

Workgroup Recommendation

Proposal # 689

CED1-19-22

Proponents: Jeff Bradley, representing American Wood Council (jbradley@awc.org); Matthew Hunter, representing American Wood Council (mhunter@awc.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

BIOMASS WASTE. Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, wood residuals, and biogases;but excludes ~~wood and wood-derived fuels (including black liquor),~~ biofuel feedstock, biodiesel, and fuel ethanol.

Reason: Federal and state laws and policies include wood waste – residuals - as renewable biomass energy. Wood residuals for biomass fuel is recognized as renewable by DOE, EPA, and the Energy Information Administration. The International Panel on Climate Change (IPCC) promotes biomass as a mitigation pathway to fighting climate change. CEPI-12-21 Part I is inconsistent with all of that.
Passing CEPI-12-21 Part I will even create an inconsistency within the IECC as Part II of the proposal has been withdrawn.

Excluding wood residuals as biomass would be an error that thwarts the proponent’s intention.

The end life of residuals has three fates: decay, building products, or burning.

Decaying residuals result in the same carbon release as burning; however, it is not under a controlled condition, so carbon monoxide, instead of the less harmful carbon dioxide, is released.

The second option, building, is the underlining assumption in the proposal. It assumes that if residuals are not burned, they will be used in another product with a longer carbon storage capacity. However, that assumption is false. If there were a large enough market for the residuals, they would not be used as fuel.

The market for residuals is increasing, and as it does, the more profitable use for building products will naturally occur. The proposal is intended to encourage building instead of burning, but instead it encourages forest residual decay – uncontrolled, released carbon - instead of controlled burning and attendant pollution controls.

Cost Impact: The code change proposal will decrease the cost of construction.
The revision of this definition will streamline the regulatory burden for end users of the code and authorities having jurisdiction over the code.

Workgroup Recommendation

Proposal # 827

CED1-20-22

Proponents: Robert OBrien, representing National Oilheat Research Alliance (robrien@noraweb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

RENEWABLE ENERGY RESOURCES. Energy derived from solar radiation, wind, waves, tides, *biomass* ~~*waste*~~ or extracted from hot fluid or steam heated within the earth.

Reason: The definition of renewable energy resources should align with that used by EPA (Environmental Protection Agency), USDA (United States Department of Agriculture), DOE (Department of Energy) and many other Federal and State Agencies. All of these recognize the use of liquid renewable fuels as crucial to decarbonization efforts and incentivize their use. The recently enacted Inflation Reduction Act of 2022 (IRA) has recognized renewable liquid fuels as a significant contributor towards decreasing GHG emissions. The IRA amends the 26 U.S. Code § 25C - Energy Efficient Home Improvement Credit to provide a $600.00 dollar tax credit for the installation of new renewable liquid fueled heating equipment that carries an US DOE Energy Star efficiency rating of 87 % or higher and is approved for use with 20% Biodiesel blends (B20). This compliments Federal and State programs that generate renewable credits utilizing renewable liquid fuels. Listed below are just a few of the current programs:
The EPA - Renewable Fuel Standard:

The Renewable Fuel Standard (RFS) program was created under *the Energy Policy Act of 2005* (EPAct), which amended the *Clean Air Act (CAA). The Energy Independence and Security Act of 2007 (EISA)* further amended the CAA by expanding the *Renewable Fuel Standard (RFS)* program.

The RFS program, which is implemented jointly by the U.S. Departments of Agriculture and Energy, is a national policy that requires a certain volume of renewable fuel to replace or reduce the quantity of petroleum-based transportation fuel, heating oil or jet fuel. The four renewable fuel categories under the RFS are:

- Biomass-based diesel
- Cellulosic biofuel
- Advanced biofuel
- Total renewable fuel

For a fuel to qualify as a renewable fuel under the RFS program, the US Department of Environmental Protection (EPA) must determine that the fuel qualifies under appropriate statutes and regulations. Among other requirements, fuels must achieve a reduction in greenhouse gas (GHG) emissions as compared to a 2005 petroleum baseline.

EPA has approved fuel pathways under the RFS program under all four categories of renewable fuel. Advanced pathways already approved include ethanol made from sugarcane, jet fuel made from camelina, cellulosic ethanol made from corn stover, compressed natural gas from municipal wastewater treatment facility digesters, and others.

- Biomass-based diesel must meet a 50% lifecycle GHG reduction
- Cellulosic biofuel must be produced from cellulose, hemicellulose, or lignin and must meet a 60% lifecycle GHG reduction
- Advanced biofuel can be produced from qualifying renewable biomass (except corn starch) and must meet a 50% GHG reduction
- Renewable (or conventional) fuel typically refers to ethanol derived from corn starch and must meet a 20% lifecycle GHG reduction threshold

Lifecycle GHG reduction comparisons are based on a 2005 petroleum baseline as mandated by EISA. Biofuel facilities (domestic and foreign) that were producing fuel prior to enactment of EISA in 2007 are “grandfathered” under the statute, meaning these facilities are not required to meet the GHG reductions.

EPA continues to review and approve new pathways including fuels made with advanced technologies or with new feedstocks. Certain biofuels are similar enough to existing fuels that they do not have to be blended and can be simply “dropped in” to existing petroleum-based fuels. These drop-in biofuels directly replace petroleum-based fuels and hold particular promise for the future.

The Massachusetts Alternative Portfolio Standard:

In Massachusetts, the *Alternative Energy Portfolio Standard (APS)* program authorized by the state legislature and regulated by the Commonwealth’s Department of Energy Resources (DOER) incentivizes blending of renewable “liquid biofuel” in heating oil.

Launched in January of 2018, the program provides Alternative Energy Certificates to retail heating oil companies who provide homeowners and businesses with heating oil blended with biofuel at a minimum of B10 – a 10% blend. According to DOER, the APS offers Massachusetts businesses, institutions and governments an incentive for installing eligible alternative energy systems, that “contribute to the Commonwealth's clean energy goals by increasing energy efficiency and reducing the need for conventional fossil fuel-based power generation.” Through calendar year 2021, more than 20 million gallons of B100 biofuel were incentivized by the APS.

Therefore, the IECC should redefine Renewable Energy Resources so that the energy code does not conflict with federal and state laws and policies.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This redefinition will have no impact on the cost of construction

Workgroup Recommendation

Proposal # 829

CED1-22-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

RENEWABLE ENERGY RESOURCES . Energy derived from solar radiation, wind, waves, tides, ~~biomass waste~~ landfill gas, biogas, renewable hydrocarbon sources, or extracted from hot fluid or steam heated within the earth.

Reason: This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].
In addition, there is much research being done to combine renewable dimethyl ether with propane, to hydrogenate vegetable oil to produce renewable propane, and any other number of innovative methods that may wind up producing hydrocarbon fuels with much reduced carbon intensity, which is the ultimate goal. Our point is, do not rule out any options as we strive to achieve zero carbon buildings. We cannot do it in a discrete manner as a step function; it will have to be achieved on a "glide path" and these renewable fuels will be needed until the electric grid is upgraded and improved.

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first ("bottom-up inorganic recovery") case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second ("top-down inorganic recovery") case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third ("organic recovery") case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into fuels”, https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

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Workgroup Recommendation

Proposal # 853

CED1-23-22

Proponents: Robert OBrien, representing National Oilheat Research Alliance (robrien@noraweb.org)

2024 International Energy Conservation Code [CE Project]

Delete and substitute as follows:

~~**BIOMASS WASTE.** Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and biogases; but excludes wood and wood-derived fuels (including black liquor), biofuel feedstock, biodiesel, and fuel ethanol.~~

BIOMASS. . Nonfossilized and biodegradable organic material originating from plants, animals and/or microorganisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the nonfossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material.

Reason: This definition was in the 2021 version of the IECC and needs to be re-inserted so that the IECC does not conflict with US federal law and policies, as well as the laws and policies of many states.
The United States Energy Information Administration (EIA) includes as biomass sources for energy: Biomass explained - U.S. Energy Information Administration (EIA)

- Wood and wood processing wastes—firewood, wood pellets, and wood chips, lumber and furniture mill sawdust and waste, and black liquor from pulp and paper mills
- Agricultural crops and waste materials—corn, soybeans, sugar cane, switchgrass, woody plants, and algae, and crop and food processing residues, mostly to produce biofuels
- Biogenic materials in municipal solid waste—paper, cotton, and wool products, and food, yard, and wood wastes
- Animal manure and human sewage for producing biogas/renewable natural gas

The Department of Energy(DOE) Office of Energy Efficiency& Renewable Energy (EERE) states: Bioenergy | Department of Energy
"Biomass is an organic renewable energy source that includes materials such as agriculture and forest residues, energy crops, and algae. Scientists and engineers at the Energy Department and National Laboratories are finding new, more efficient ways to convert biomass into biofuels that can take the place of conventional fuels like gasoline, diesel, and jet fuel."

The Environmental Protection Agency (EPA) describes biomass as: Biomass Heating and Cooling Technologies | US EPA
"Biomass is a term that covers different types of organic material that can be processed and burned to produce energy, including trees; construction, wood, and agricultural residues (such as corn husks, rice hulls, peanut shells, grass clippings, and leaves); crops; sewage sludge; and manure. Thermal applications use two main forms of biomass materials: woody biomass and gas or liquid biofuels"

States including New York, Connecticut and Rhode Island have mandates requiring the use of liquid renewable fuels in various blend levels currently and other states have it under consideration.

The IECC definition should align with Federal and State laws and policies. In addition, limiting the use of renewable fuels will impede rapid decarbonization and stifle development of new advanced biofuels and technology.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This will not impact construction cost

Workgroup Recommendation

Proposal # 858

CED1-24-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Add new definition as follows:

RENEWABLE HYDROCARBON SOURCES.. Hydrocarbon gases and liquids recovered from renewable biomass; or from reclamation of plastics, including polymer, monomer, or constituent chemical building blocks, in such a manner that they displace the primary or raw materials that are used as chemical building blocks in the production of plastics; or from the synthesis of clean hydrogen and associated chemical feedstocks.

Reason: This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].
The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first (“bottom-up inorganic recovery”) case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second (“top-down inorganic recovery”) case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third (“organic recovery”) case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

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Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
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Workgroup Recommendation

Proposal # 912

CED1-25-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Delete and substitute as follows:

~~**BIOMASS WASTE.** Organic non-fossil material of biological origin that is a byproduct or a discarded product. Biomass waste includes municipal solid waste from biogenic sources, landfill gas, sludge waste, agricultural crop byproducts, straw, and other biomass solids, liquids, and biogases; but excludes wood and wood-derived fuels (including black liquor), biofuel feedstock, biodiesel, and fuel ethanol.~~

RENEWABLE BIOMASS. Renewable Biomass includes the following (including any incidental minimal contaminants that are impractical to remove and are related to customary feedstock production and transport): (1) Planted crops and crop residue harvested from existing agricultural land cleared or cultivated prior to December 19, 2007 and that was nonforested and either actively managed or fallow on December 19, 2007. (2) Planted trees and tree residue from a tree plantation located on non-federal land (including land belonging to an Indian tribe or an Indian individual that is held in trust by the U.S. or subject to a restriction against alienation imposed by the U.S.) that was cleared at any time prior to December 19, 2007 and actively managed on December 19, 2007. (3) Animal waste material and animal byproducts. (4) Slash and pre-commercial thinnings from non-federal forestland (including forestland belonging to an Indian tribe or an Indian individual, that are held in trust by the United States or subject to a restriction against alienation imposed by the United States) that is not ecologically sensitive forestland. (5) Biomass (organic matter that is available on a renewable or recurring basis) obtained from within 200 feet of buildings and other areas regularly occupied by people, or of public infrastructure, in an area at risk of wildfire. (6) Algae. (7) Separated yard waste or food waste, including recycled cooking and trap grease.

Reason: This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].
The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first ("bottom-up inorganic recovery") case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second ("top-down inorganic recovery") case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third ("organic recovery") case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

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[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

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Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction.

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[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

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[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

Proposal # 913

CED1-26-22

Proponents: Glenn Heinmiller, representing IALD (glenn@lampartners.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.1 General. Electrical power and lighting systems and generation shall comply with this section. ~~*Sleeping units* shall comply with Section C405.2.5 and with Section C405.1.1 .~~ *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

Exception: *Dwelling units* and *sleeping units* that comply with **Section C405.2.10** and **Section C405.3.3**

C405.2.5 Specific application controls. Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:
   1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.
   1.2. Display and accent lighting, including lighting in display cases.
   1.3. Lighting in display cases.
   1.3 Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.
   1.4 Lighting equipment that is for sale or demonstration in lighting education.

~~2. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.~~

~~**Exceptions:**~~

~~1. Lighting and switched receptacles controlled by card key controls in buildings containing fewer than 50 sleeping units.~~

~~2. Spaces where patient care is directly provided.~~

~~3.~~ 2. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.

~~4.~~ 3. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Add new text as follows:

C405.2.10 Sleeping unit controls. *Sleeping units* shall have control devices or systems that are configured to automatically switch off all installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.

Exceptions:

1. Lighting and switched receptacles controlled by card key controls in buildings containing fewer than 50 sleeping units.
2. Spaces where patient care is directly provided.

Revise as follows:

C405.3.2.1 Building Area Method. For the Building Area Method, the interior lighting power allowance is calculated as follows:

1. For each building area type inside the building, determine the applicable building area type and the allowed lighting power density for that type from Table C405.3.2(1). For building area types not listed, select the building area type that most closely represents the use of that area. For the purposes of this method, an “area” shall be defined as all contiguous spaces that accommodate or are associated with a single building area type.
2. Determine the floor area for each building area type listed in Table C405.3.2(1) and multiply this area by the applicable value from Table C405.3.2(1) to determine the allowed lighting power (watts) for each building area type. Sleeping units and dwelling units are excluded from lighting power allowance calculations by application of Section ~~C405.1.1.~~ C405.3.3. The area of sleeping units and dwelling units is not included in the calculation.
3. The total interior lighting power allowance (watts) for the entire building is the sum of the lighting power from each building area type.

C405.3.2.2 Space-by-Space Method. Where a building has unfinished spaces, the lighting power allowance for the unfinished spaces shall be the total connected lighting power for those spaces, or 0.1 watts per square foot (1.08 w/m^2), whichever is less. For the Space-by-Space Method, the interior lighting power allowance is calculated as follows:

1. For each space enclosed by partitions that are not less than 80 percent of the ceiling height, determine the applicable space type from Table C405.3.2(2). For space types not listed, select the space type that most closely represents the proposed use of the space. Where a space has multiple functions, that space may be divided into separate spaces.
2. Determine the total floor area of all the spaces of each space type and multiply by the value for the space type in Table C405.3.2(2) to determine the allowed lighting power (watts) for each space type. Sleeping units and dwelling units are excluded from lighting power allowance calculations by application of Section ~~C405.1.1~~. C405.3.3. The area of sleeping units and dwelling units is not included in the calculation.
3. The total interior lighting power allowance (watts) shall be the sum of the lighting power allowances for all space types.

~~C405.1.1~~ C405.3.3 Lighting power for sleeping units and dwelling units. No less than 90 percent of the permanently installed lighting serving sleeping units and dwelling units, including lighting integrated into range hoods and exhaust fans, shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W.

Exceptions:

1. Lighting integral to a kitchen appliance ~~or exhaust hood~~.
2. Antimicrobial lighting used for the sole purpose of disinfecting.

Reason: Currently, the specific lighting requirements for sleeping units and dwelling units are presented in an awkward and confusing manner, and thus it is unclear exactly what the requirements are. This proposal solves that problem.

- C405.1 says that all “lighting systems” must comply with C405 and then goes on to list requirements specific to sleeping units and dwelling units. Read literally, sleeping units and dwelling units still must comply with everything else in C405! Obviously, that is not the intent – but that is what the code says!
- C405.1 says that sleeping units have to comply with C405.2.5 Specific application controls. So taken literally, that would mean if you had accent lighting or task lighting in a hotel room it would have to be controlled by an occupancy sensor or timeswitch. Obviously, that is not the intent – but that is what the code says!
- An exemption to C405.1 has been added to make it clear that sleeping units and dwelling units only must comply with C405.2.10 and C405.3.3, and nothing else.
- Currently, there are two types of requirements that apply to sleeping units and dwelling units – lighting power, and lighting controls – just like the rest of C405. This proposal rearranges these requirements and puts them where they belong – in C405.2 (lighting controls) and C405.3 (lighting power)
- C405.1.1 (lighting power requirements) has been moved to new section C405.3.3, intact and without major modification. “Power” and “sleeping units” were added to the title, and the language on range hoods and exhaust hoods added, following work of the PLR SC.
- Specific application controls requirements for range hoods and exhaust fans (following work of the PLR SC) has been added to C405.2.5.
- The lighting controls provision for sleeping units has been removed from C405.2.5 “Specific application controls” (where it doesn’t really belong) to a new section C405.2.10 which is specifically for sleeping unit controls.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
These minor revisions will have no significant effect on the cost of lighting equipment required.

Workgroup Recommendation

Proposal # 840

CED1-27-22

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.1 General. Electrical power and lighting systems and generation shall comply with this section. *Sleeping units* and *dwelling units* shall comply with Section ~~C405.2.5~~ C405.2.10 and with Section C405.1.1 . *General lighting* shall consist of all lighting included when calculating the total connected interior lighting power in accordance with Section C405.3.1 and which does not require specific application controls in accordance with Section C405.2.5.

C405.2.5 Specific application controls. Specific application controls shall be provided for the following:

1. The following lighting shall be controlled by an occupant sensor complying with Section C405.2.1.1 or a time-switch control complying with Section C405.2.2.1. In addition, a manual control shall be provided to control such lighting separately from the general lighting in the space:

   1.1. Luminaires for which additional lighting power is claimed in accordance with Section C405.3.2.2.1.

   1.2. Display and accent lighting, including lighting in display cases.

   1.3. Lighting in display cases.

   1.3 Supplemental task lighting, including permanently installed under-shelf or under-cabinet lighting.

   1.4 Lighting equipment that is for sale or demonstration in lighting education.

~~2.~~ ~~*Sleeping units* shall have control devices or systems that are configured to automatically switch off all installed luminaires and switched receptacles within 20 minutes after all occupants have left the unit.~~

   ~~**Exceptions:**~~

   ~~1. Lighting and switched receptacles controlled by card key controls in buildings containing fewer than 50 sleeping units.~~

   ~~2. Spaces where patient care is directly provided.~~

~~3.~~ 2. Lighting for nonvisual applications, such as plant growth and food warming, shall be controlled by a time switch control complying with Section C405.2.2.1 that is independent of the controls for other lighting within the room or space.

~~4.~~ 3. Task lighting for medical and dental purposes that is in addition to *general lighting* shall be provided with a *manual control*.

Add new text as follows:

C405.2.10 Sleeping unit and dwelling unit lighting and switched receptacle controls. *Sleeping units* and *dwelling units* shall be provided with lighting controls and switched receptacles as specified in C405.2.10.1 and C405.2.10.2.

C405.2.10.1 Sleeping units and dwelling units in hotels, motels, and vacation timeshare properties. *Sleeping units* and *dwelling units* in hotels motels and vacation timeshare properties shall be provided with the following:

1. At least two 125V, 15- and 20- amp switched receptacles per room, except for bathrooms, kitchens, foyers, hallways, and closets.
2. Lighting controls that automatically turn off all lighting and switched receptacles within 20 minutes after all occupants have left the unit

Exception: Automatic shutoff is not required where *captive key override* controls all lighting and switched receptacles in units with 6 or fewer permanently installed lights and switched receptacles.

C405.2.10.2 Sleeping units in congregate living facilities. *Sleeping units* in *congregate living facilities* shall be provided with the following controls:

1. Lighting in bathrooms shall be controlled by an *occupant sensor control* that automatically turns lights off within 20 minutes after all occupants have left the space.
2. Each unit shall have a *manual* control by the entrance that turns off all lighting and switched receptacles in the unit, except for lighting in bathrooms. The *manual* control shall be clearly labeled.

Reason: To improve usability, cost-effectiveness, energy efficiency, and functionality.

Usability

C405.2.5 "Specific Application Controls" includes requirements for special lighting applications which are found throughout many different space types on a project. When we have control requirements that are specific to a space type (like Parking Garages) this should be a separate subsection of C405.2, rather than being added to the list in C405.2.5.

The phrase "control devices or systems that are configured to automatically switch off..." is edited to "lighting controls that automatically switch off..."

The term "card key controls" is replaced with the defined term "*captive key override*" which has been in the code for the last couple of cycles.

Cost-Effectiveness

The exception that allows *captive key override* controls to be used instead of a more complicated and expensive occupancy-based control system is changed from hotels with 50 or fewer units to units with 6 or fewer lights and switched receptacles to control. This will allow basic guest rooms (two lights in the bathroom + a light at the door + a light on the ceiling + two switched receptacles) to continue to use *captive key override* controls, and will limit the requirement to use more expensive systems to larger units with more lighting to control. The number of units in the hotel is not related to how many lights are installed in each room.

Energy Efficiency

When a guest room in a hotel or motel has both a kitchen and a bathroom, it is a dwelling unit. Therefore the code currently has no requirement that lighting controls be provided in larger hotel suites, only in smaller guest rooms. This is backwards. By applying the controls requirements in hotels to include "dwelling units" we increase the stringency of the code.

"Vacation Timeshare Properties" is a classification in Group R-2 in the IBC. These properties are often indistinguishable from hotels and motels and share the characteristics of being pre-furnished and not having separately metered power for each unit. By adding "vacation timeshare properties" to the scope of these requirements we will improve energy efficiency.

Most lighting in hotel and motel guest rooms is plugged in. This lighting is not required to be shown when filing for permit, and is not subject to enforcement during inspections. In other words, the hotel owner is free to plug whatever they want into guest room receptacles when they furnish the room. This means that our energy code provisions related to guest room lighting controls are not terribly effective as they probably miss more than half of the lighting that actually goes into these rooms. This proposal would remedy that problem by requiring switched receptacles to be provided in bedrooms and living / sitting rooms. Two receptacles are required per room. These receptacles would be energized when the lighting system for the room is energized.

Functionality

The existing code language would require automatic control systems to be provided in all sleeping units except for I-2. This includes following space types: Alcohol and Drug Centers, Halfway Houses, Social Rehabilitation Facilities, Group Homes, and Prisons. People under custodial care in these facilities may not even have the ability to lock or unlock their own door. The code should not include specific lighting control requirements for these types of spaces - this should be determined exclusively by the functional requirements of the space.

"Congregate Living Facilities" is a defined term in Group R in the IBC. This includes Dormitories, Fraternities and Sororities, and similar occupancies. Living units in these occupancies are really more like dwelling units in their lighting control needs. Rather than requiring that these be controlled like hotel guest rooms, this proposal would require that they are provided with a master off switch by the door, similar to the requirement in L05 (Residential Light Control). For added efficiency, an occupant sensor is required in the bathroom.

Cost Impact: The code change proposal will decrease the cost of construction.
Provisions in this proposal will increase costs in some projects, and decrease costs in others. On the whole, the sensitivity to reducing costs in smaller, cheaper hotel rooms + the simplification of controls requirements in congregate living facilities will outweigh the additional cost in hotel suites and vacation timeshare properties and result in a net cost savings.

Workgroup Recommendation

Proposal # 842

CED1-28-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.1.1 Lighting for dwelling units. No less than 90 percent of the permanently installed lighting serving sleeping units and dwelling units shall be provided by lamps with an <u>initial</u> efficacy of not less than 65 lm/W or luminaires with an <u>initial</u> efficacy of not less than 45 lm/W.

Exceptions:

1. Lighting integral to a kitchen appliance or exhaust hood.
2. Antimicrobial lighting used for the sole purpose of disinfecting.

Reason: There is a significant difference between initial light output and the "mean" light output (at 40% of rated life for non-LED lamps) or the L70 light output for LED lamps (the time when the lumen output has declined by 30%).
To clarify this section, it is suggested that the word "initial" be added to provide clarity, since many lamp and luminaire spec sheets will provide information on initial and L70 or mean lumen output. As an alternative, the word "rated" could also be used.Here are web sites that may be of use for the consideration of this proposal:

https://linmoreled.com/blog/how-to-choose-the-right-lumen-output-when-replacing-conventional-light-fixtures/

https://www.ledsmagazine.com/manufacturing-services-testing/standards/article/16695700/understanding-the-difference-between-led-rated-life-and-lumenmaintenance-life-magazine

https://www.prolampsales.com/blogs/specialty-architectural-lighting/what-you-need-to-know-about-led-rated-life-and-lumen-depreciation

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change just clarifies a current section and has no impact on construction costs.

Workgroup Recommendation

Proposal # 688

CED1-29-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.1.1 Lighting for dwelling units. ~~No less than 90 percent of the p~~ Permanently installed lighting serving sleeping units and dwelling units shall be provided by lamps with an efficacy of not less than 65 lm/W or luminaires with an efficacy of not less than 45 lm/W.

Exceptions:

1. Lighting integral to a kitchen appliance or exhaust hood.
2. Antimicrobial lighting used for the sole purpose of disinfecting.

Reason: This proposal seeks to align the lighting requirements of multifamily dwelling units between the residential and commercial codes in order to ensure consistency between substantially similar multifamily buildings. Currently there are discrepancies in the lighting provisions between a three-story multifamily building and a four-story multifamily building. This leads to market confusion, enforcement inconsistencies, and large potential untapped energy savings. This revision seeks to close this gap by incorporating lighting requirements approved by the 2024 IECC residential consensus committee and create a common set of lighting requirements for multifamily buildings.
The 2022 version of Title 24 has created a new section to regulate multifamily buildings - similar to a more "omnibus" proposal submitted by NBI previously. Based on feedback from that submission, which advised not creating a new section, this proposal instead works to align the sections that currently exist.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
These changes match current market availability of products and should not change the cost of construction.

Bibliography: https://newbuildings.org/resource/multifamily-building-guide/
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/694/1674/files/download/364/

Workgroup Recommendation

Proposal # 694

CED1-30-22

Proponents: Anthony Floyd, representing Chair of SEHPCAC (sehpcac@iccsafe.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.13 Energy monitoring. New buildings ~~Buildings~~ with a gross conditioned floor area of not less than 10,000 square feet (929 m^2) shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.13.1 through C405.13.5. A plan for quantifying annual energy type and end-use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents.

Exceptions:

~~1.~~ ~~*Buildings* less than 10,000 square feet (929 m^2).~~

~~2.~~ ~~Existing buildings~~

~~3.~~ 1. R-2 occupancies ~~with less than 10,000 square feet (929 m^2) of *common area*~~.

~~4.~~ 2. Individual tenant spaces are not required to comply with this section provided that the space has its own utility services and meters and has less than 5,000 square feet (464.5 m^2) ~~with their own utility service and meter.~~ of conditioned floor area.

C405.13.2 End-use ~~electric~~ metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.13.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.13.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.13.3 is provided.

TABLE C405.13.2 ~~ELECTRICAL~~ ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.
Electric hot water heating for uses other than space conditioning	Electricity used to generate hot water. **Exception:** Electric water heating with design capacity that is less than 10 percent of building service rating

C405.13.3 ~~Electrical~~ Meters. Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.13.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can self-monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.13.4 and C405.13.5.Non-intrusive load monitoring (NILM) packages that extract energy consumption data from detailed electric waveform analysis ~~can~~ shall be permitted to substitute ~~substituted~~ for individual meters if the equivalent data ~~can be made~~ is available for collection in Section C405.13.4 and reporting in Section C405.13.5.

C405.13.4 Electrical energy data acquisition system. A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.13.2.The data acquisition system shall have the capability of providing building total peak electric demand and the time(s) of day and time(s) ~~of year~~ per month at which the peak occurs. Peak demand shall be integrated over the same time period as the underlying whole building meter reading rat~~e, which is typically 15 minutes but shall be no longer than one hour~~.

C405.13.5 Graphical energy report. A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the electrical energy consumption for each end-use category required by Section C405.13.2 ~~at least~~ not less than every hour, day, month and year for the previous 36 months. The graphical report shall ~~also~~ incorporate natural gas interval data or the ability to enter gas utility bills into the report.

C405.13.6 Non-electrical energy metering. Consumption of non-electrical fuel or energy sources including district heating or cooling,~~energy such as gas, district heating or cooling, unregulated fuel sources, or other non-renewable energy~~ shall be ~~automatically~~ metered in accordance with Section C405.13.2 and C405.12.3.~~or a method developed for usage calculation annually or more frequently from energy bills. Natural gas usage shall be monitored through on site interval metering or from utility interval data.~~

C405.13.7 Renewable energy. ~~The ability to measure the production of~~ on-site renewable energy sources shall be ~~provided~~ metered with ~~the same or greater~~ not less frequency ~~as~~ than non-renewable energy ~~metered~~ systems in accordance with Section C405.13.3..

C405.13.8 Plan for disclosure. The plan for annual energy use data gathering and disclosure shall include the following:

1. Property information including: ~~building type, total gross floor area, year built or year planned for construction completion, and occupancy type~~.

1.1 Address

1.2 Gross floor area

1.3 Year occupied

1.4 Occupancy classifications, with respective floor areas

2. Total annual building site energy use ~~per~~ by unit area ~~(square foot) of gross floor area~~ as collected or documented through Section C405.13.5 ~~(electrical)~~ and Section C405.13.6 ~~(non-electrical)~~ sources, separated by energy and fuel type ~~(electric, gas, district cooling or heating, unregulated fuel sources etc.). Electrical energy shall be further broken down by load type as identified in Table C405.13.2~~.

3. Annual site generated renewable energy ~~per~~ by unit area~~ (square foot) of gross floor area~~.

~~4. Peak electric demand per unit area (square foot) of gross floor area, with an estimate of relative building system contribution to that peak, and the time and date of the peak.~~

~~5. For projects using the Section C407 Simulated Building Performance approach to show compliance, include the following information from the building simulation:~~

~~5.1 Modeling software used.~~

~~5.2 Assumptions made that impact the simulated annual energy use per unit (square foot or square meter) of gross floor area (e.g. occupancy schedules, daylighting assumptions, climate file, plug loads, envelope performance including use of shading systems).~~

~~5.3 Simulated annual energy use per unit (square foot or square meter) of gross floor area.~~

~~5.4 Peak load, the time of date and time of peak and the hourly load profile on the day that experiences peak load.~~

Reason: The initial proposal under CEPI-203 altered the sub-metering requirements to focus solely on electrical and renewable systems with non-electric systems only requiring a utility meter. This is a substantial content change that regressed metering requirements for non-electric metering in way that does not support efficient building operation. The proposed revisions would reinstate the non-electric metering requirements present in the code today while refining the language proposed for the additional electric submetering added by CEPI-203. This revision also revised the original proposed language for the Plan for Disclosure section, recommending removal of language typically used for simulated measurement and verification that is out of place in a section dedicated to metering. An additional change was made to the exceptions as currently listed in the code that serves to clarify the intent of those exceptions.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is editorial in nature

Workgroup Recommendation

Proposal # 766

CED1-31-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.13 Energy monitoring. Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.13.1 through C405.13.5.A plan for quantifying annual energy type and use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents.

Exceptions:

1. *Buildings* less than 10,000 square feet (929 m^2).
2. Existing buildings
3. *Dwelling units* and *sleeping units*
4. ~~3.~~ 4. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area*.
5. ~~4.~~ 5. Individual tenant spaces less than 5,000 square feet (464.5 m^2) with their own utility service and meter.

COMMON AREA. All conditioned spaces within ~~portions of~~ Group R occupancy buildings ~~occupancies~~ that are not *dwelling units* or *sleeping units*.

Reason: Section C405.6 already requires a meter for each R-2 dwelling unit. We are not seriously considering benchmarking for dwelling units, are we? That's just another disincentive for code adoption.
The 'common area' definition is imprecise. Does it include pool equipment houses? Utility rooms? Parking garages? Given that each dwelling unit has its own meter, there is little reason to believe that metering 'common area' will save any energy; rather it will just add expense.

Cost Impact: The code change proposal will decrease the cost of construction.
A low value - from an energy savings perspective - dwelling unit monitoring and reporting system is not required, reducing construction costs.

Workgroup Recommendation

Proposal # 737

CED1-32-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.13 Energy monitoring. Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.13.1 through C405.13.5.A plan for quantifying annual energy type and use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents.

Exceptions:

1. *Buildings* less than ~~10,000~~ 25,000 square feet (~~929~~ 2323 m^2).
2. Existing buildings
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area*.
4. Individual tenant spaces less than ~~5,000~~ 10,000 square feet (~~464.5~~ 929 m^2) with their own utility service s and meter s.

Reason: These changes will align the minimum area thresholds for energy metering in the IECC with the thresholds in ASHRAE 90.1-2022. There is also an editorial suggestion, since tenant spaces may have multiple utility meters (e.g., gas and electric).

Cost Impact: The code change proposal will decrease the cost of construction.
This will reduce costs for buildings between 10,000 square feet and 25,000 square feet, as well as for individual tenant spaces between 5,000 square feet and 10,000 square feet.

Workgroup Recommendation

Proposal # 781

CED1-33-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.13 Energy monitoring. Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.13.1 through C405.13.5. ~~A plan for quantifying annual energy type and use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents.~~

Exceptions:

1. *Buildings* less than 10,000 square feet (929 m^2).
2. Existing buildings
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area*.
4. Individual tenant spaces less than 5,000 square feet (464.5 m^2) with their own utility service and meter.

~~**C405.13.8 Plan for disclosure.** The plan for annual energy use data gathering and disclosure shall include the following:~~

1. ~~Property information including building type, total gross floor area, year built or year planned for construction completion, and occupancy type.~~
2. ~~Total annual building site energy use per unit area (square foot) of gross floor area as collected or documented through Section C405.13.5 (electrical) and Section C405.13.6 (non-electrical) sources, separated by energy type (electric, gas, district cooling or heating, unregulated fuel sources etc.). Electrical energy shall be further broken down by load type as identified in Table C405.13.2.~~
3. ~~Annual site generated renewable energy per unit area (square foot) of gross floor area.~~
4. ~~Peak electric demand per unit area (square foot) of gross floor area, with an estimate of relative building system contribution to that peak, and the time and date of the peak.~~
5. ~~For projects using the Section C407 Simulated Building Performance approach to show compliance, include the following information from the building simulation:~~

   ~~5.1 Modeling software used.~~

   ~~5.2 Assumptions made that impact the simulated annual energy use per unit (square foot or square meter) of gross floor area (e.g. occupancy schedules, daylighting assumptions, climate file, plug loads, envelope performance including use of shading systems).~~

   ~~5.3 Simulated annual energy use per unit (square foot or square meter) of gross floor area.~~

   ~~5.4 Peak load, the time of date and time of peak and the hourly load profile on the day that experiences peak load.~~

Reason: The plan and multiple requirements for the plan should be deleted for the following reasons:
-Many jurisdictions do not have disclosure requirements.

-Disclosure programs do not ask for site energy use to be broken out by fuel type.

-Disclosure programs do not ask for further breakdowns of electric energy usage.

-Disclosure programs do not ask for annual site generated renewable energy information.

-Disclosure programs do not ask for monthly or annual peak electric demand data.

-Disclosure programs do not ask for estimates of building system or subsystem contributions to peak demand.

-Disclosure programs do not ask for the time or date of the peak demand (or estimated peak demand).

-Disclosure programs do not ask for simulated or modeled energy usage information.

Therefore, this requirement should be removed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
However, it will decrease the costs associated with creating such a plan.

Workgroup Recommendation

Proposal # 783

CED1-34-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.13 Energy monitoring. Buildings shall be equipped to measure, monitor, record and report <u>all types of</u> energy consumption data in compliance with Sections C405.13.1 through C405.13.5.A plan for quantifying annual energy type and use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents.

Exceptions:

1. *Buildings* less than 10,000 square feet (929 m^2).
2. Existing buildings
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area*.
4. Individual tenant spaces less than 5,000 square feet (464.5 m^2) with their own utility service and meter.

C405.13.1 ~~Electrical e~~ <u>E</u>nergy metering. For all ~~electrical~~ energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.13.2.

C405.13.2 End-use ~~electric~~ metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.13.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured <u>electric or fossil fuel or hydrogen</u> load for each of the end-use categories indicated in Table C405.13.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.13.3 is provided.

TABLE C405.13.2 ~~ELECTRICAL~~ ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, furnaces, heat pumps, boilers, and chillers ~~and water heating~~. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Gas or electric Lighting systems located within the building.
Exterior lighting	Gas or electric Lighting systems located on the building site but not within the building.
Plug and pipe loads	Devices, appliances and equipment connected to convenience receptacle outlets or gas piping networks.
Process load	Any single load that is not included in an HVAC, lighting or plug or pipe load category and that exceeds 5 percent of the peak connected electric or fossil fuel or hydrogen load of the whole building, including but not limited to data centers, laundry equipment, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads.
Building operations and other miscellaneous loads	The remaining electric or fossil fuel or hydrogen loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.
~~Electric hot w~~ Water heating	~~Electricity~~ **Energy** used to generate hot water. **Exception:** ~~Electric water heating with design capacity that is less than 10 percent of building service rating.~~ Water heaters serving individual dwelling units.

C405.13.3 ~~Electrical~~ Meters. Electric, fossil fuel, and hydrogen ~~M~~ meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.13.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can self-monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.13.4 and C405.13.5.Non-intrusive load monitoring (NILM) packages that extract energy consumption data from detailed electric waveform analysis can be substituted for individual meters if the equivalent data can be made available for collection in Section C405.13.4 and reporting in Section C405.13.5.

C405.13.4 ~~Electrical e~~ Energy data acquisition system. A data acquisition system shall have the capability to store the data from the required energy meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.13.2. ~~The data acquisition system shall have the capability of providing building total peak electric demand and the time(s) of day and time(s) of year at which the peak occurs. Peak demand shall be integrated over the same time period as the underlying meter reading rate, which is typically 15 minutes but shall be no longer than one hour.~~

C405.13.5 Graphical energy report. A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the ~~electrical~~ fossil fuel, hydrogen, and electric energy consumption for each end-use category required by Section C405.13.2 at least every hour, day, month and year for the previous 36 months. ~~The graphical report shall also incorporate natural gas interval data or the ability to enter gas utility bills into the report.~~

~~**C405.13.6 Non-electrical energy.** Consumption of non-electrical energy such as gas, district heating or cooling, unregulated fuel sources, or other non-renewable energy shall be automatically metered or a method developed for usage calculation annually or more frequently from energy bills. Natural gas usage shall be monitored through on site interval metering or from utility interval data.~~

C405.13.7 Renewable energy. The ability to measure the production of on-site renewable electric or fossil fuel or thermal energy shall be provided with the same or greater frequency as metered systems.

Reason: The current language requires extensive submetering of all uses of electricity while allowing an annual estimate or calculation of all other forms of energy. If you "can't manage what you can't measure", it makes no sense to measure one form of energy and basically ignore other forms of energy that may be the majority of energy consumption, costs, and emissions.
Therefore, the proposed changes require all forms of energy to be measured and monitored equally, to maximize the energy savings from on-site metering of end-uses.

Other changes are made to create more encompassing language or to remove unnecessary wording.

Cost Impact: The code change proposal will increase the cost of construction.

It will also increase energy savings for all non-electric forms of energy used at the building.

Workgroup Recommendation

Proposal # 789

CED1-35-22

Proponents: Helen Sanders, **Technoform North America** representing Facade Tectonics Institute (helen.sanders@technoform.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.13 Energy monitoring. Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.13.1 through C405.13.5.A plan for quantifying annual ~~energy~~ fuel type and end-use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents.

Exceptions:

1. *Buildings* less than 10,000 square feet (929 m^2).
2. Existing buildings
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area*.
4. Individual tenant spaces less than 5,000 square feet (464.5 m^2) with their own utility service and meter.

C405.13.1 Electrical energy metering. For all electrical energy supplied to the building and its associated site, including but not limited to site lighting, parking, recreational facilities and other areas that serve the building and its occupants, meters or other measurement devices shall be provided to collect energy consumption data for each end-use category required by Section C405.13.2.

Revise as follows:

C405.13.2 End-use ~~electric~~ metering categories. Meters or other approved measurement devices shall be provided to collect energy use data for each end-use category indicated in Table C405.13.2. Where multiple meters are used to measure any end-use category, the data acquisition system shall total all of the energy used by that category. Not more than 5 percent of the measured load for each of the end-use categories indicated in Table C405.13.2 shall be permitted to be from a load that is not within that category.

Exceptions:

1. HVAC and water heating equipment serving only an individual dwelling unit shall not require end-use metering.
2. End-use metering shall not be required for fire pumps, stairwell pressurization fans or any system that operates only during testing or emergency.
3. End-use metering shall not be required for an individual tenant space having a floor area not greater than 2,500 square feet (232 m^2) where a dedicated source meter complying with Section C405.13.3 is provided.

TABLE C405.13.2 ~~ELECTRICAL~~ ENERGY USE CATEGORIES

Portions of table not shown remain unchanged.

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads.
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.
Electric hot water heating for uses other than space conditioning	Electricity used to generate hot water. **Exception:** Electric water heating with design capacity that is less than 10 percent of estimated peak energy demand ~~building service rating~~

C405.13.3 Electrical Meters. Meters or other measurement devices required by this section shall be configured to automatically communicate energy consumption data to the data acquisition system required by Section C405.13.4. Source meters shall be allowed to be any digital-type meter. Lighting, HVAC or other building systems that can self-monitor their energy consumption shall be permitted instead of meters. Current sensors shall be permitted, provided that they have a tested accuracy of ±2 percent. Required metering systems and equipment shall have the capability to provide at least hourly data that is fully integrated into the data acquisition system and graphical energy report in accordance with Sections C405.13.4 and C405.13.5.Non-intrusive load monitoring (NILM) packages that extract energy consumption data from detailed electric waveform analysis ~~can~~ shall be permitted to substitute~~d~~ for individual meters if the equivalent data ~~can be~~ is made available for collection in Section C405.13.4 and reporting in Section C405.13.5.

C405.13.4 Electrical energy data acquisition system. A data acquisition system shall have the capability to store the data from the required meters and other sensing devices for a minimum of 36 months. The data acquisition system shall have the capability to store real-time energy consumption data and provide hourly, daily, monthly and yearly logged data for each end-use category required by Section C405.13.2.The data acquisition system shall have the capability of providing building total peak electric demand and the time(s) of day and time(s) ~~of year~~ per month at which the peak occurs. Peak demand shall be integrated over the same time period as the underlying whole building meter reading rate~~, which is typically 15 minutes but shall be no longer than one hour~~.

C405.13.5 Graphical energy report. A permanent and readily accessible reporting mechanism shall be provided in the building that is accessible by building operation and management personnel. The reporting mechanism shall have the capability to graphically provide the electrical energy consumption for each end-use category required by Section C405.13.2 ~~at least~~ not less than every hour, day, month and year for the previous 36 months. The graphical report shall ~~also~~ incorporate natural gas interval data or the ability to enter gas utility bills into the report. Data on use of other bulk energy sources such as fuel oil shall be reported on at least a monthly basis.

C405.13.6 Non-electrical energy metering. Consumption of non-electrical fuel or energy sources, ~~such as gas,~~ including district heating or cooling, ~~unregulated fuel sources, or other non-renewable energy~~ shall be ~~automatically~~ metered per sections C405.13.2 and C405.12.3. ~~or a method developed for usage calculation annually or more frequently from energy bills. Natural gas usage shall be monitored through on site interval metering or from utility interval data.~~

C405.13.7 Renewable energy. ~~The ability to measure the production of o~~ On-site renewable energy sources shall be ~~provided~~ metered with ~~the same or greater~~ not less frequency than non-renewable energy ~~as metered~~ systems in accordance with C405.13.3. Where renewable energy is generated on-site and exported for off-site use, it shall be metered in accordance with C405.13.3. Off-site generated non-electrical renewable energy used in the building shall be reported in accordance with C405.12.5

C405.13.8 Plan for disclosure. The plan for annual energy use data gathering and disclosure shall include the following:

1. Property information including ~~building type, total gross floor area, year built or year planned for construction completion, and occupancy type.~~.

   1.1 Address

   1.2 Gross conditioned floor area

   1.3 Year occupied

   1.4 Occupancy classifications with respective floor areas

2. Total annual building site energy use per unit gross floor area ~~(square foot) of gross floor area~~ as collected or documented through Section C405.13.~~5~~ 4 ~~(electrical)~~ and Section C405.13.6 ~~(non-electrical)~~ sources, separated by energy and fuel type ~~(electric, gas, district cooling or heating, unregulated fuel sources etc.). Electrical energy shall be further broken down by load type as identified in Table C405.13.2.~~

3. Annual site generated renewable energy per unit area ~~(square foot) of gross floor area.~~

~~4. Peak electric demand per unit area (square foot) of gross floor area, with an estimate of relative building system contribution to that peak, and the time and date of the peak.~~

~~5.~~ 4 For projects using the Section C407 Simulated Building Performance approach to show compliance, include the following information from the building simulation:

   5.1 Modeling software used.

   5.2 Assumptions made that impact the simulated annual energy use per unit ~~(square foot or square meter)~~ of gross floor area, including ~~(e.g.~~ occupancy schedules, daylighting assumptions, climate file, plug loads, lighting power densities and schedules, envelope performance including use of shading systems, where used~~)~~.

   5.3 Simulated annual energy use per unit (square foot or square meter) of gross floor area.

   5.4 Peak load, the ~~time of~~ date and time of peak and the hourly load profile on the day that experiences peak load.

Reason: This proposal is to clean up the new language in section C405.13 Energy Monitoring that FTI proposed previously. The intent of the additions in the first public comment was to provide building owners with the infrastructure and plan to monitor and manage building energy performance and prepare them for compliance with building performance standards which are being introduced around the U.S. Please see the reason statement in CEPI-203-21 for the full reason statement for the original language. These language changes in this public comment are meant to improve clarity and also address feedback received from the committee discussions and contain several edits received from CEHPCAC during the public comment period.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will neither increase nor decrease the cost of construction. Reporting data that is already available from utility bills, construction documents, and building simulations already submitted for code compliance and so will not change the cost of construction.

Workgroup Recommendation

Proposal # 905

CED1-36-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C405.13.2 ELECTRICAL ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
Electric vehicle charging	*Electric vehicle* charging loads **that are powered through the *building's* electrical service.**
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.
Electric hot water heating	Electricity used to generate hot water. **Exception:** Electric water heating with design capacity that is less than 10 percent of building service rating

Reason: At many commercial buildings, there will be EV charging provided by third parties, such as EV charging companies or cities or counties or utilities. These charging stations will be metered and billed separately from the building, and the building owner will have no say or control over their use of energy.
This provision is needed to avoid unnecessary wiring and metering of third party systems.

Cost Impact: The code change proposal will decrease the cost of construction.
This will reduce costs for buildings that are provided EV charging by third parties.

Workgroup Recommendation

Proposal # 778

CED1-37-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com); Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C405.13.2 ELECTRICAL ENERGY USE CATEGORIES

LOAD CATEGORY	DESCRIPTION OF ENERGY USE
Total HVAC system	Heating, cooling and ventilation, including but not limited to fans, pumps, boilers, chillers and water heating. Energy used by 120-volt equipment, or by 208/120-volt equipment that is located in a building where the main service is 480/277-volt power, is permitted to be excluded from total HVAC system energy use.
Interior lighting	Lighting systems located within the building.
Exterior lighting	Lighting systems located on the building site but not within the building.
Plug loads	Devices, appliances and equipment connected to convenience receptacle outlets.
Process load	Any single load that is not included in an HVAC, lighting or plug load category and that exceeds 5 percent of the peak connected load of the whole building, including but not limited to data centers, manufacturing equipment and commercial kitchens.
~~*Electric vehicle* charging~~	~~*Electric vehicle* charging loads.~~
Building operations and other miscellaneous loads	The remaining loads not included elsewhere in this table, including but not limited to vertical transportation systems, automatic doors, motorized shading systems, ornamental fountains, ornamental fireplaces, swimming pools, in-ground spas and snow-melt systems.
Electric hot water heating	Electricity used to generate hot water. **Exception:** Electric water heating with design capacity that is less than 10 percent of building service rating

Reason: According to the National Low Income Housing Coalition, the U.S. has a shortage of 7 million rental homes affordable and available to extremely low-income renters, whose household incomes are at or below the poverty guideline or 30% of their area median income. Only 36 affordable and available rental homes exist for every 100 extremely low-income renter households. Extremely low-income renters face a shortage in every state and major metropolitan area. Among states, the supply of affordable and available rental homes ranges from only 18 for every 100 extremely low-income renter households in Nevada to 61 in West Virginia. Among the 50 largest metropolitan areas in the U.S, the supply ranges from 13 affordable and available rental homes for every 100 extremely low-income renter households in Las Vegas, NV, to 50 in Providence, RI. Metering EV charging adds to the cost of construction without saving any building energy to justify the cost. The CEPI-140 reason statement - the proposal that brought these provisions into the code - says, *"As electric vehicles become more common place, even if not required by code, the electricity supplied to these chargers will increase the overall energy use when compared to the same building without EV charging."*

This is incorrect. The building's energy use, which is what is regulated by the IECC, does not change regardless of what external power transfers occur. The building uses the energy that the building does. It does not use the energy that is passed through to EV chargers.

The reason statement for CEPI-140 also said, *"It is far more cost-effective to sub-meter these loads during new construction than to try to isolate them and add additional sub-meters as part of a retrofit."* The logical fallacy in this statement is that it will be required in the future to submeter EV charging and there is no substantive reason to believe that is true. It's unlikely that all or even most of the jurisdictions adopting the IECC in the future will have benchmarking ordinances, particularly for buildings constructed to a current edition of the IECC. The CEPI-140 reason cites only a single jurisdiction that requires this information to be conditionally reported, without mentioning the 20,000 square foot trigger, below which R-2 buildings are not required to report any energy usage.

Finally, the CEPI-140-21 reason statement says that "*the incremental cost for submetering an additional system is nominal*" and cites an estimate applicable an office building; presumably with a single submeter for all vehicle charging. This cannot serve as a cost justification for the 100 percent EVSE installed, EV ready, or EV capable requirements applicable to R-2 uses where, potentially, each parking space might require a separate submeter. Even where an energy management system (EMS) is used to eliminate separate submeters, there is a cost for not just the equipment, but typically a cost for a leasing or maintenance contract for the EMS. That cost needs to be factored into a cost justification as well.

Cost justification for the addition of a submeter for each EV parking space needs to be provided to accurately capture the increased cost of construction for R-2 occupancies. It would be helpful if that analysis explained why the cost of housing should increase in a 2024 IECC compliant building to track energy usage that is not related to housing.

Cost Impact: The code change proposal will decrease the cost of construction.
Owners will not be forced to provide equipment that does not save building energy.

Bibliography: 1. https://nlihc.org/gap

Workgroup Recommendation

CED1-38-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com); Vladimir Kochkin, representing NAHB (vkochkin@nahb.org); Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [CE Project]

Delete and substitute as follows:

~~**C405.14 Electric Vehicle Power Transfer Infrastructure.** New parking facilities shall be provided with electric vehicle power transfer infrastructure in compliance with Sections C405.14.1 through C405.14.6.~~

Appendix CD Electric Vehicle Power Transfer Infrastructure. SECTION CD101 GENERAL

CD101.1 Purpose. The purpose of this appendix is to provide requirements for the installation of electric vehicle charging infrastructure.

CD101.2 Scope. Where adopted, this appendix applies to *commercial buildings* within the scope of the *International Energy Conservation Code.*

SECTION CD102

DEFINITIONS

AUTOMOBILE PARKING SPACE. A space within a building or private or public parking lot, exclusive of driveways, ramps, columns, office and work areas, for the parking of an automobile.

ELECTRIC VEHICLE (EV). An automotive-type vehicle for on-road use, such as passenger automobiles, buses, trucks, vans, neighborhood electric vehicles, and electric motorcycles, primarily powered by an electric motor that draws current from a building electrical service, EVSE, a rechargeable storage battery, a fuel cell, a photovoltaic array, or another source of electric current.

ELECTRIC VEHICLE SUPPLY EQUIPMENT (EVSE). Equipment for plug-in power transfer including the ungrounded, grounded and equipment grounding conductors, and the *electric vehicle* connectors, attachment plugs, personal protection system and all other fittings, devices, power outlets or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the *electric vehicle*.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE space). An *automobile parking space* provided with a dedicated *EVSE* connection.

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). A designated *automobile parking space* provided with electrical inf rastructure, such as, but not limited to, raceways, cables, electrical capacity, and panelboard or other electrical distribution equipment space, necessary for the future installation of an *EVSE.*

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An *automobile parking space* provided with a branch circuit and an outlet, junction box or receptacle, that will support an installed *EVSE* .

SECTION CD103

ELECTRIC VEHICLE POWER TRANSFER INFRASTRUCTURE

CD103.1 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with *electric vehicle (*EV)power transfer infrastructure i n accordance with Sections CD103.1 through CD103.1.6.

CD103.1.1 Quantity. The number of required *EV spaces*, *EV capable spaces* and *EV ready spaces* shall be determined in accordance with this section and Table CD103.1.1 based on the total number of *automobile parking spaces*and shall be rounded up to the nearest whole number. For R-2 buildings, the requirements of Table CD103.1.1 shall be based on the lesser of the total number of dwelling units or the total number of automobile parking spaces.

1. Where more than one parking facility is provided on a building site, the number of required *automobile parking spaces* required to have *EV* power transfer infrastructure shall be calculated separately for each parking facility.

2. For other than R-2 occupancies, where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.

3. Where the number of *EVSE* spaces provided is more than the required number of EVSE spaces, such additional EVSE spaces are permitted to be used to comply with the quantity requirements for *EV ready spaces* and *EV capable spaces*.

4. Where the number of *EV ready spaces* provided is more than the required number of EV *ready spaces*, such additional EV *ready spaces* are permitted to be used to comply with the quantity requirements for *EV capable spaces* .

5. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table CD103.1.1 shall be used.

Exceptions:

1. Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

2. Parking facilities serving R-2 occupancies where a continuous raceway or cable assembly can be installed after issuance of the certificate of occupancy without destruction of building finishes.

Table CD103.1.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

OCCUPANCY	EVSE SPACES	EV READY SPACES	EVCAPABLE SPACES
GROUP A	10%	0%	10%
GROUP B	15%	0%	30%
GROUP E	2%	0%	5%
GROUP F	2%	0%	5%
GROUP H	1%	0%	0%
GROUP I	2%	0%	5%
GROUP M	10%	0%	10%
GROUP R-1	20%	5%	75%
GROUP R-2	0%	0%	100%
GROUP R-3 AND R-4	2%	0%	5%
GROUP S exclusive of parking garages	1%	0%	0%
GROUP S-2 parking garages	1%	0%	0%

CD103.1.2 EV Capable Spaces. Each *EV capable space* shall comply with the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the *EV capable space* and a panelboard sized and rated to meet planned loads or other onsite electrical distribution equipment.

2. Installed raceways or cable assemblies shall be sized and rated to supply circuit capacity in accordance with CD103.1.2 (5).

3 The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.

4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future *electric vehicle supplyequipment* (EVSE)."

5. Reserved capacity shall be not less than 4.1 kVA (20A 208/240V) for each *EV capable space*.

CD103.1.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section CD103.1.1 shall comply with the following:

1. The branch circuit shall terminate at an outlet or enclosure, located within 3 feet (914 mm) of each *EV readyspace* it serves.

2. The branch circuit shall have a circuit capacity in accordance with CD103.1.5.

3. The panelboard or other electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

CD103.1.4 EVSE Spaces. An installed *EVSE* with multiple output connections shall be permitted to serve multiple *EVSE spaces*. Each *EVSE* installed to meet the requirements of Section CD103.1.1, serving either a single *EVSE space* or multiple *EVSE spaces*, shall comply with the following:

1. The EVSE shall have a circuit capacity in accordance with CD103.1.5.

2. The EVSE shall have a charging rate in accordance with CD103.14.1.

3. The EVSE shall be located within 3 feet (914 mm) of each *EVSE space* it serves.

4. The EVSE shall be installed in accordance with Section CD103.1.6.

CD103.14.1EVSE Minimum Charging Rate. Each installed EVSE shall comply with one of the following:

1. The EVSE shall be capable of charging at a rate of not less than 6.2 kVA (or 30A at 208/240V).

2. Where serving multiple *EVSE spaces* and controlled by an energy management system providing load management, the EVSE shall be capable of simultaneously charging each *EVSE space* at a rate of not less than 3.3 kVA.

3. Where serving *EVSE spaces* permitted to have a circuit capacity of 2.7 kVA in accordance with CD103.1.5.1, and where controlled by an energy management system providing load management, the EVSE shall be capable of simultaneously charging each *ESVE space* at a rate of not l ess than 2.1 kVA.

CD103.1.5CircuitCapacity. Electrical infrastructure serving *EV ready spaces* and *EVSE spaces* shall comply with one of the following :

1. Installed branch circuits shall have a rated capacity of not less than 8.3 kVA (or 40A at 208/240V) for each *EV ready space* or *EVSE space* they serve.

2. The requirements of CD103.1.5.1.

CD103.1.5.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. The branch circuit shall have a capacity of not less than 4.1 kVA per space.

2. The branch circuit shall have a capacity of not less than 2.7 kVA per space where serving *EV ready spaces* or *EVSE spaces* where all automobile parking spaces are designed to be *EV ready* or *EVSE spaces*.

CD103.1.6 EVSE Installation. *EVSE* shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594.*EVSE* shall be accessible in accordance with Section 1107 of the *International Building Code* .

Delete without substitution:

~~**C405.14.1 Quantity.** The number of required EV spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this Section and Table C405.14.1 based on the total number of automobile parking spaces and shall be rounded up to the near-est whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.~~

1. ~~Where more than one parking facility is provided on a building site, the number of required automobile parking spaces re-quired to have EV power transfer infrastructure shall be calculated separately for each parking facility.~~
2. ~~Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.~~
3. ~~Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.~~
4. ~~Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum require-ments for EV capable spaces.~~
5. ~~Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.~~
6. ~~Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.14.1 shall be used.~~

~~**Exception:** Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.~~

~~**TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE**~~

~~**C405.14.2 EV Capable Spaces.** Each EV capable space used to meet the requirements of Section C405.14.1 shall comply with all of the following:~~

1. ~~A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and a suitable panelboard or other onsite electrical distribution equipment.~~
2. ~~Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capactiy in accordance with C405.14.5~~
3. ~~The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.~~
4. ~~The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."~~
5. ~~Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each EV capable space.~~

~~**C405.14.3 EV Ready Spaces.** Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with all of the following:~~

1. ~~Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.~~
2. ~~Have a minimum circuit capacity in accordance with C405.14.5.~~
3. ~~The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."~~

~~**C405.14.4 EVSE Spaces.** An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with all of the following:~~

1. ~~Have a minimum circuit capacity in accordance with C405.14.5.~~
2. ~~Have a minimum charging rate in accordance with C405.14.4.1.~~
3. ~~Be located within 3 feet (914 mm) of each EVSE space it serves.~~
4. ~~Be installed in accordance with Section C405.14.6.~~

~~**C405.14.4.1 EVSE Minimum Charging Rate.** Each installed EVSE shall comply with one of the following:~~

1. ~~Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).~~
2. ~~When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously sharing each EVSE space at a minimum rate of no less than 3.3 kVA.~~
3. ~~When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.14.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 kVA.~~

~~**C405.14.5 Circuit Capacity.** The capacity of electrical infrastructure serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:~~

1. ~~A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each EV ready space or EVSE space it serves.~~
2. ~~The requirements of C405.14.5.1.~~

~~**C405.14.5.1 Circuit Capacity Management.** The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:~~

1. ~~Have a minimum capacity of 4.1 kVA per space.~~
2. ~~Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE space for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces.~~
3. ~~Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.~~

~~**C405.14.6 EVSE Installation.** EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with *International Building Code* Section 1107.~~

Reason: According to the National Low Income Housing Coalition the USA has a shortage of 7 million affordable rental homes.
The IECC-Commercial Consensus Committee’s response to this critical shortage is to inflate the cost (in both money and spent carbon) of housing by requiring mandatory installations of equipment that does not save building energy and that will likely never be used, such as EV charging

infrastructure at R-2 multifamily buildings, while ignoring[1]:

· New battery technologies are being regularly announced that bring charging times down to less than ten and in some cases less than five minutes range

· Advancing charging technologies (robot chargers, beamed charging, roadbed charging, mobile charging)

· Increased battery density and storage significantly extending the range of EVs and reducing needed charging times

· EV manufacturer business models where the EV owner does not own the battery – a huge cost savings - but leases it for a minimal subscription fee. In this case the battery is swapped out whole when needed in five minutes or less

· Commercial (business, mercantile, restaurant), market driven opportunities to invest in EV charging stations and networks

· Government funded EV charging infrastructure

· The relative ease of adding EV charging in structured parking in the future at R-2 occupancies

By the time the 2024 IECC-C is ready to be adopted – 2027 in many state jurisdictions - the EV charging infrastructure currently required is likely to be stranded technology. The money and carbon that was spent to provide EV charging infrastructure in R-2 occupancies will be wasted.

Finally, researchers at Stanford University make a compelling case that overnight EV charging will have deleterious effects on the grid. According to Eurasia Review:

"*In March, the Stanford research team published a paper on a model they created for charging demand that can be applied to an array of populations and other factors. In the new study, published in Nature Energy, they applied their model to the whole of the western United States and examined the stress the region's electric grid will come under by 2035 from growing EV ownership. In a little over a decade, they found, rapid EV growth alone could increase peak electricity demand by up to 25 percent, assuming a continued dominance of residential, nighttime charging.*

To limit the high costs of all that new capacity for generating and storing electricity, the researchers say, drivers should move to daytime charging at work or public charging stations, which would also reduce greenhouse gas emissions."

EV charging infrastructure belongs in an optional adoption appendix. In this way, if the relevant advances in technology do not occur, jurisdictions can adopt the appendix to meet local policy objectives.

If the predicted advances in technology do occur, and the EV charging infrastructure is in an optional adoption appendix, it will be ignored by the jurisdiction and a reason for building developers to oppose adoption of the code will go away.

An obstacle to creating more affordable housing will also go away.

[1] References to bulleted statements are provided in the bibliography

Cost Impact: The code change proposal will decrease the cost of construction.
Owners will not be forced to install equipment that may never be used or that may not be used for decades.

Bibliography: **1.** https://www.eurasiareview.com/23092022-charging-cars-at-home-at-night-is-not-the-way-to-go
2. https://electrek.co/2022/10/11/storedot-extreme-fast-charging-cycles/ **3.** https://electrek.co/2022/10/06/how-you-can-invest-in-ev-charging-stations-and-take-advantage-of-the-auto-transition/ **4**. https://electrek.co/2022/10/18/taco-bell-innovates-the-fast-food-experience-with-fast-ev-charging/ **5.** https://newatlas.com/energy/novel-electrode-ev-batteries-25-density-boost/ **6.** https://ca.news.yahoo.com/nasa-invents-incredible-battery-electric-112230038.html **7.** https://therealdeal.com/2022/05/24/more-multifamily-landlords-are-making-less-than-their-lenders/ **8.** https://www.newsweek.com/quantum-charging-electric-cars-could-fast-pumping-gas-1690630 **9.** https://newatlas.com/energy/natron-sodium-ion-battery-production/ **10.** https://www.vice.com/en/article/k7w5ma/phoenix-tent-city-homeless-encampment **11.** https://www.cnn.com/videos/business/2022/06/17/ziggy-ev-charging-robot-orig-ht.cnn-business
12. https://science.nasa.gov/technology/technology-highlights/cooling-technique-developed-for-space-use-makes-charging-electric-cars-on-earth-quicker-and-easier **13.** https://www.anthropocenemagazine.org/2022/10/could-this-fast-charging-energetic-battery-spark-the-ev-era/?utm_source=rss&utm_medium=rss&utm_campaign=could-this-fast-charging-energetic-battery-spark-the-ev-era&utm_source=rss&utm_medium=rss&utm_campaign=could-this-fast-charging-energetic-battery-spark-the-ev-era

Workgroup Recommendation

CED1-39-22

Proponents: Bryan Holland, representing National Electrical Manufacturers Association (NEMA) (bryan.holland@nema.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

ELECTRIC VEHICLE CAPABLE SPACE (EV CAPABLE SPACE). An ~~designated~~ automobile parking space ~~that is~~ provided with electrical infrastructure, such as, but not limited to, raceways, cables, enclosures, electrical capacity, and ~~panelboard or other~~ electrical distribution equipment space, necessary for ~~the future installation of an~~ connection to EVSE.

ELECTRIC VEHICLE READY SPACE (EV READY SPACE). An automobile parking space ~~that is~~ provided with a branch circuit and either an outlet or enclosure~~, junction box or receptacle, that will support an installed~~ for connection to EVSE.

ELECTRIC VEHICLE SUPPLY EQUIPMENT INSTALLED SPACE (EVSE SPACE). An automobile parking space ~~that is provided with a dedicated~~ where operational EVSE has been installed ~~connection~~.

C405.14 Electric Vehicle Power Transfer Infrastructure. ~~New~~ Parking facilities shall be provided with electric vehicle power transfer infrastructure in ~~compliance~~ accordance with Sections C405.14.1 through C405.14.6.

C405.14.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section C405.14.1 shall comply with ~~all of~~ the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and ~~a suitable panelboard or other onsite~~ electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capactiy in accordance with C405.14.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have ~~sufficient~~ dedicated overcurrent protection device space and ~~spare~~ electrical capacity to supply a calculated load in accordance with C405.14.5. ~~for a 2-pole circuit breaker or set of fuses.~~
4. The ~~electrical~~ enclosure or outlet and the electrical distribution equipment directory shall be marked: "For ~~future~~ electric vehicle supply equipment (EVSE)."
5. ~~Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each EV capable space.~~

C405.14.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with ~~all of~~ the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
2. Have a minimum system and circuit capacity in accordance with C405.14.5.
3. The ~~panelboard or other~~ electrical distribution equipment directory shall designate the branch circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.14.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with ~~all of~~ the following:

1. Have a minimum system and circuit capacity in accordance with C405.14.5.
2. ~~Have a minimum charging rate in accordance with C405.14.4.1.~~
3. Be located within 3 feet (914 mm) of each EVSE space it serves.
4. Be installed in accordance with Section C405.14.6.

~~**C405.14.4.1 EVSE Minimum Charging Rate.** Each installed EVSE shall comply with one of the following:~~

1. ~~Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).~~
2. ~~When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously sharing each EVSE space at a minimum rate of no less than 3.3 kVA.~~
3. ~~When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.14.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 kVA.~~

C405.14.5 System and Circuit Capacity. C405.14.5.1 System Capacity. The electrical distribution equipment supplying the branch circuit(s) serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

1. Have a calculated load of 7.2 kVA or the nameplate rating of the equipment, whichever is larger.
2. Meets the requirements of C405.14.5.3.1

C405.14.5.2 Circuit Capacity. The branch circuit ~~capacity of electrical infrastructure~~ serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

1. ~~A branch circuit shall~~ Have a rated capacity not less than ~~8.3 kVA (or 40A at 208/240V)~~ 50 amperes or the nameplate rating of the equipment, whichever is larger. ~~for each EV ready space or EVSE space it serves~~.
2. Meets the requirements of C405.14.5. .3.2.

C405.14.5.3 System and Circuit Capacity Management. C405.14.5.3.1 System Capacity Management. The maximum equipment load on the electrical distribution equipment supplying the branch circuits(s) serving EV capable spaces, EV ready spaces, and EVSE spaces controlled by an energy management system shall be the maximum load permitted by the energy management system, but not less than 3.3 kVA per space. **C405.14.5.3.2 Circuit Capacity Management.** ~~The capacity of~~ Each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces ~~designed to be~~ controlled by an energy management system ~~providing load management in accordance with NFPA 70,~~ shall comply with one of the following:

1. Have a minimum capacity of ~~4.1 kVA~~ 25 amperes per space.
2. Have a minimum capacity of ~~2.7 kVA~~ 20 amperes per space ~~when serving EV ready spaces or EVSE space~~ for R-2 occupancies when all ~~(100%) of the~~ automobile parking spaces ~~designated for R-2 occupancies~~ are ~~designed to be~~ EV ready spaces or EVSE spaces.

Reason: 1. Editorial revisions are made to the three definitions for added clarity and conciseness.
2. The term “new” is unnecessary in C405.14 for a Chapter 4 rule as requirements for existing buildings are located in Chapter 5.

3. List items 1-4 in C405.14.2 have been revised for conciseness and more technically correct terminology. List item 5 is no longer necessary as this is addressed in the revised list item 3.

4. C405.14.3 and C405.14.4 have been revised for clarity and conciseness.

5. C405.14.4.1 has been deleted as the EVSE “charging rate” is not the correct metric and better addressed in the revised C405.14.5 criteria.

6. C405.14.5 has been expanded into four sections covering system capacity and circuit capacity, with or without energy management. This aligns the criteria with the minimum requirements of the NEC while providing backstops to ensure effective system and circuit capacity is provided when the power rating of the EVSE is unknown or where an energy management system is utilized to reduce EVSE load demand.

7. C405.14.5.1 ensures the service or feeder that supplies EVSE branch circuits has the minimum required capacity as required by section 220.57 and 625.42 of the NEC.

8. C405.14.5.2 ensures the individual branch circuits that supply EVSE have the minimum required capacity as required by the 625.42 of the NEC.

9. C405.14.5.3.1 provides both a maximum and minimum calculated load for the service or feeder that supplies EVSE branch circuits controlled by an energy management system.

10. C405.14.5.3.2 ensures a minimum calculate load is provided for branch circuits controlled by and energy management system supplying more than EVSE as permitted in 625.40 of the NEC.

Here are examples of the calculations proposed in the public comment:

Example A: 10 EVSE spaces (kVA unknown)

C405.14.5.1 System Capacity: 10 x 7,200 VA = 72kVA capacity added to the service/feeder supplying EVSE branch circuits

C405.14.5.2 Circuit Capacity: 50A rated capacity for each of the 10 EVSE space branch circuits

Example B: 10 EVSE spaces, EMS installed having maximum EVSE capacity of 25kVA (kVA unknown)

C405.14.5.3.1 System Capacity Management: Maximum calculated load on the service/feeder supplying EVSE branch circuits is 25kVA with the minimum calculated load being 10 x 3,300 VA = 33 kVA.

C405.14.5.3.2 Circuit Capacity Management:

1. Each Branch Circuit, other than Group R-2, supplying 2 EVSE spaces each: 2 x 25A = 50A rated capacity for each of the 5 branch circuits

2. Each Branch Circuit, at Group R-2, supplying 2 EVSE spaces each: 2 x 20 A = 40A rated capacity for each for each of the 5 branch circuits.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will not increase nor decrease the cost of construction as it simply provides more compliance options to choose from.

Workgroup Recommendation

Proposal # 800

CED1-40-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.14 Electric Vehicle Power Transfer Infrastructure. Where included in building plans for n~~N~~ew parking facilities, ~~shall be provided with~~ electric vehicle power transfer infrastructure shall comply~~in compliance~~ with Sections C405.14.1 through C405.14.6.

~~**C405.14.1 Quantity.** The number of required EV spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this Section and Table C405.14.1 based on the total number of automobile parking spaces and shall be rounded up to the near-est whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.~~

1. ~~Where more than one parking facility is provided on a building site, the number of required automobile parking spaces re-quired to have EV power transfer infrastructure shall be calculated separately for each parking facility.~~
2. ~~Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.~~
3. ~~Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.~~
4. ~~Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum require-ments for EV capable spaces.~~
5. ~~Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.~~
6. ~~Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.14.1 shall be used.~~

~~**Exception:** Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.~~

~~**TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE**~~

~~Occupancy~~	~~EVSE Spaces~~	~~EV Ready Spaces~~	~~EV Capable Spaces~~
~~Group A~~	~~10%~~	~~0%~~	~~10%~~
~~Group B~~	~~15%~~	~~0%~~	~~30%~~
~~Group E~~	~~2%~~	~~0%~~	~~5%~~
~~Group F~~	~~2%~~	~~0%~~	~~5%~~
~~Group H~~	~~1%~~	~~0%~~	~~0%~~
~~Group I~~	~~2%~~	~~0%~~	~~5%~~
~~Group M~~	~~10%~~	~~0%~~	~~10%~~
~~Group R-1~~	~~20%~~	~~5%~~	~~75%~~
~~Group R-2~~	~~20%~~	~~5%~~	~~75%~~
~~Group R-3 and R-4~~	~~2%~~	~~0%~~	~~5%~~
~~Group S exclusive of parking garages~~	~~1%~~	~~0%~~	~~0%~~
~~Group S-2 parking garages~~	~~1%~~	~~0%~~	~~0%~~

C405.14.2 EV Capable Spaces. Where included in building plans for EV charging, e~~E~~ach EV capable space ~~used to meet the requirements of Section C405.14.1~~ shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capactiy in accordance with C405.14.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."
5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each EV capable space.

C405.14.3 EV Ready Spaces. Where included in building plans for EV charging, e~~E~~ach branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.
2. Have a minimum circuit capacity in accordance with C405.14.5.
3. The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.14.4 EVSE Spaces. Where included in building plans for EV charging, a~~A~~n installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.14.5.
2. Have a minimum charging rate in accordance with C405.14.4.1.
3. Be located within 3 feet (914 mm) of each EVSE space it serves.
4. Be installed in accordance with Section C405.14.6.

~~**C405.14.4.1 EVSE Minimum Charging Rate.**~~ ~~Each installed EVSE shall comply with one of the following:~~

1. ~~Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).~~
2. ~~When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously sharing each EVSE space at a minimum rate of no less than 3.3 kVA.~~
3. ~~When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.14.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 kVA.~~

~~**C405.14.5 Circuit Capacity.**~~ ~~The capacity of electrical infrastructure serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:~~

~~1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each EV ready space or EVSE space it serves.~~

~~2. The requirements of C405.14.5.1.~~

C405.14.5.1 Circuit Capacity Management. Where included in building plans for EV charging, ~~T~~ the capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE space for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces.
3. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.

C405.14.6 EVSE Installation. Where included in building plans for EV charging, EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with *International Building Code* Section 1107.

Reason: The proposals would increase building energy consumption if EV charging is implemented under the proposed requirements. While an interpretation of the revised IECC scope may permit the IECC Consensus Committee to consider EVs as a means for reducing full transportation fuel cycle energy consumption and climate emissions reductions, implementation of the EV charging under the provisions of these minimum code requirements would unquestionably increase metered building electricity consumption should EV charging be implemented.

The proposals unjustifiably presume that full transportation fuel cycle energy and emissions will decrease due to upstream primary energy changes. This presumption is not justified by the proponents of these changes and runs counter to current and the most likely electricity generation prospects based upon:

1.) Overall growth in generation capacity utilizing fossil fuels (specifically natural gas),
2.) Currently employed generation capacity,
3.) Dispatched generation capacity and time-of-use electricity demand devoted to EV charging,
4.) Electricity generation infrastructure capacity to meet increased demand and time-of-use demand imposed by vehicle recharging.

The proposals “pick winners” among renewable fuel sources by requiring building infrastructure to move toward EVs at the expense of alternative fuels directly employable as vehicle fuels, including renewable natural gas, responsibly sourced gas, hydrogen fuel cells, and renewable propane. The proposals take no account of these alternatives or their relative energy efficiency and climate performance.

The proposals discriminate among building owners and occupants by effectively subsidizing EV owners and operators. Economically disadvantaged building owners and occupants, who are unlikely to either afford or economically justify EV purchases, will be burdened with the costs associated with recharging infrastructure and potentially associated energy costs.

The requirements of these proposals, for these reasons, reach beyond prudent promulgation of minimum energy code requirements and, if ultimately justified by energy and transportation market transformation, would be better justified for voluntary implementation by building owners and occupants. These requirements do not belong in a minimum energy code and instead should be brought forward for consideration in “overlay” and “green codes.”

Costs versus benefits discussed by the Consensus Committee omitted the point that if no EVs are purchased or operated by building owners or occupants, the benefit-to-cost of the proposal would be “zero” (or mathematically undefined if analyzed as a cost-to-benefit ratio). This discussion presumed that EV owners and operators would be occupants of the covered buildings and would recharge EVs at the buildings, which is likely to be an outdated assumption by the time of code adoption and when, at best, a broad recharging infrastructure is implemented.

Limitations on the potential vehicle capacity for recharging at the building effectively rations the availability of recharging under even the most optimistic assumptions of EV adoption. As a minimum code, such rationing is not justified under the IECC.

Note that EV coverage that relates to safe design requirements and other minimum requirements related to safety and consistency with other cited codes is retained and applied as requirements where building plans include EV recharging infrastructure.

Cost Impact: The code change proposal will decrease the cost of construction.
By eliminating requirements for EV charging infrastructure, the deletion of the proposed requirements would reduce associated costs of EV infrastructure while facilitating safe building infrastructure where owner/occupants chose to install EV charging.

Workgroup Recommendation

Proposal # 911

CED1-41-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.14.1 Quantity. The number of required EV spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this Section and Table C405.14.1 based on the total number of automobile parking spaces and shall be rounded up to the near-est whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required automobile parking spaces re-quired to have EV power transfer infrastructure shall be calculated separately for each parking facility.
2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
3. Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.
4. Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum require-ments for EV capable spaces.
5. Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.
6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.14.1 shall be used.

~~Exception~~ Exceptions:

1. Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.
2. For R-2 occupancies, where the local electric distribution entity has certified in writing that it is not able to provide 100% of the necessary distribution capacity within 2 years after the estimated date of the certificate of occupancy. The required EV charging infrastructure shall be reduced based on the available existing electric distribution capacity.
3. For R-2 occupancies, where substantiation has been approved that meeting the requirements of Section R404.4.4.1 will alter the local utility infrastructure design requirements on the utility side of the meter so as to increase the utility side cost to the builder or developer by more than $400.00 per dwelling unit.

TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

Occupancy	EVSE Spaces	EV Ready Spaces	EV Capable Spaces
Group A	10%	0%	10%
Group B	15%	0%	30%
Group E	2%	0%	5%
Group F	2%	0%	5%
Group H	1%	0%	0%
Group I	2%	0%	5%
Group M	10%	0%	10%
Group R-1	~~20%~~ 10%	~~5%~~ 10%	~~75%~~ 20%
Group R-2[a]	~~20%~~ 0%	~~5%~~ 0%	~~75%~~ 40%
Group R-3 and R-4	2%	0%	5%
Group S exclusive of parking garages	1%	0%	0%
Group S-2 parking garages	1%	0%	0%

a. Where EVSE with a charging rate of not less than 48 kVA (or 100A at 480V) are available within 0.5 miles from the R-2 building, the total number of required EV spaces shall be permitted to be reduced by 5 spaces for each such EVSE. The total number of EV Capable spaces shall not be less than 20%.

Reason: The requirement for 100% compliance for R-1 and R-2 occupancies is an overreach and is likely to be amended by most jurisdictions. As a point of reference for local EV adoption decisions, on June 7 of 2022 the governor of Colorado vetoed bill HB22-1218 on EV charging: (https://www.documentcloud.org/documents/22056015-hb22-1218-veto-statement). IECC should either set a more reasonable fraction for EV charging or leave that decision completely to the jurisdiction. In structured parking facilities commonly used for MF buildings, future installation of EV infrastructure will not require removal of finishes (which is used as one of the key reasons for substantiating this proposal). More flexibility should be provided to accommodate the diversity of MF buildings and parking options across various types of communities around the country. The current proposal focuses on the most convenient method of charging – at the residence for use by a single vehicle. There are more cost-effective infrastructure models that can be centered around fast-charging stations used by many vehicles.

This proposal adds two exceptions for R-2 occupancies to address availability of electric distribution capacity. These exceptions are consistent with provisions approved for the residential IECC. The proposal also revises the quantity requirements for R-2 and R-1 occupancies. Lastly, the proposal adds an option to recognize Level 3 charging infrastructure available to the residents of the building and located within a short distance.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction for R-1 and R-2 occupancies.

Workgroup Recommendation

Proposal # 675

CED1-42-22

Proponents: Charles Eley, representing Architecture 2030 (charles@eley.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

Occupancy	EVSE Spaces	~~EV Ready Spaces~~	EV Capable Spaces
Group A	10%	~~0%~~	10%
Group B	15%	~~0%~~	30%
Group E	~~2%~~ 5%	~~0%~~	5%
Group F	~~2%~~ 5%	~~0%~~	5%
Group H	1%	~~0%~~	0%
Group I	~~2%~~ 5%	~~0%~~	5%
Group M	10%	~~0%~~	10%
Group R-1	~~20%~~ 25%	~~5%~~	75%
Group R-2	~~20%~~ 25%	~~5%~~	75%
Group R-3 and R-4	~~2%~~ 5%	~~0%~~	5%
Group S exclusive of parking garages	1%	~~0%~~	0%
Group S-2 parking garages	1%	~~0%~~	0%

Delete without substitution:

~~**ELECTRIC VEHICLE READY SPACE (EV READY SPACE).** An automobile parking space that is provided with a branch circuit and either an outlet, junction box or receptacle, that will support an installed EVSE.~~

~~**C405.14.3 EV Ready Spaces.** Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with all of the following:~~

1. ~~Terminate at an outlet or enclosure, located within 3 feet (914 mm) of each EV ready space it serves.~~
2. ~~Have a minimum circuit capacity in accordance with C405.14.5.~~
3. ~~The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."~~

Reason: Delete the category of EV Ready Spaces. EV Capable spaces include the conduit and space on the load center. This is enough to make it easy to upgrade to EVSE Spaces in the future. Having a third category adds unnecessary confusion.
Increase the EVSE Spaces to 25% in Groups R-1 and R-2 (move the 5% from EV ready to EVSE). These occupancy groups are critical to destination EV charging.

Increase the EVSE Spaces to 5% in Groups E, F, I and R-3/R-4. The 2% is too low. A 50 space parking lot (or smaller) would require only one EV space. The economics of running conduit and wiring push toward having at least of two EVSE spaces together.

Cost Impact: The code change proposal will increase the cost of construction.
Increasing EVSE spaces will increase initial construction cost, but save money in in long-run.

Bibliography: None

Workgroup Recommendation

Proposal # 704

CED1-43-22

Proponents: Amy Martino, representing Building Site Synergy (amartino@buildingsitesynergy.com)

2024 International Energy Conservation Code [CE Project]

C405.14 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with electric vehicle power transfer infrastructure in compliance with Sections C405.14.1 through C405.14.6.

Revise as follows:

C405.14.1 Quantity. The number of required EV spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this Section and Table C405.14.1 based on the total number of automobile parking spaces and shall be rounded up to the near-est whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

~~1.~~ ~~Where more than one parking facility is provided on a building site, the number of required automobile parking spaces re-quired to have EV power transfer infrastructure shall be calculated separately for each parking facility.~~

~~2.~~1. Where one ~~shared~~ parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.

Exceptions:

1.Where a building has multiple leased spaces and the occupancies have not been determined or may change with future leases and occupancies.

2. Where a jurisdiction permits shared parking in a mixed use development.

~~3.~~2. Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.

~~4.~~3. Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum require-ments for EV capable spaces.

~~5.~~ ~~Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.~~

~~6.~~4. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.14.1 shall be used.

Exception: Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

Occupancy	EVSE Spaces	EV Ready Spaces	EV Capable Spaces
Group A	10%	0%	10%
Group B	15%	0%	30%
Group E	~~2%~~ 10%	0%	~~5%~~ 10%
Group F	2%	0%	5%
Group H	1%	0%	0%
Group I	2%	0%	5%
Group M	10%	0%	10%
Group R-1	20%	~~5%~~ 0%	~~75%~~ 80%
Group R-2	20%	~~5%~~ 0%	~~75%~~ 80%
Group R-3 and R-4	2%	0%	5%
Group S exclusive of parking garages	1%	0%	0%
Group S-2 parking garages	~~1%~~ 10%	0%	0%10%

Note: For every twenty (20) EVSE, EV Ready, or EV Capable required parking spaces, one (1) EVSE which provides full charging from empty in one (1) hour or less may be substituted.

C405.14.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section C405.14.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within 3 feet (914 mm) of the EV capable space and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capactiy in accordance with C405.14.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE)."
5. Reserved capacity shall be no less than 4.1 kVA (20A 208/240V) for each EV capable space.

Revise as follows:

C405.14.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure~~, located within 3 feet (914 mm) of each EV ready space it serves.~~
2. Have a minimum circuit capacity in accordance with C405.14.5.
3. The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE)" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE)."

C405.14.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.14.5.
2. Have a minimum charging rate in accordance with C405.14.4.1.

~~3. Be located within 3 feet (914 mm) of each EVSE space it serves.~~

~~4.~~ 3. Be installed in accordance with Section C405.14.6.

C405.14.4.1 EVSE Minimum Charging Rate. Each installed EVSE shall comply with one of the following:

1. Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).
2. When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously sharing each EVSE space at a minimum rate of no less than 3.3 kVA.
3. When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.14.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 kVA.

C405.14.5 Circuit Capacity. The capacity of electrical infrastructure serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than 8.3 kVA (or 40A at 208/240V) for each EV ready space or EVSE space it serves.
2. The requirements of C405.14.5.1.

C405.14.5.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE space for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces.
3. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.

C405.14.6 EVSE Installation. EVSE shall be installed in accordance with NFPA 70 and shall be listed and labeled in accordance with UL 2202 or UL 2594. EVSE shall be accessible in accordance with *International Building Code* Section 1107.

Reason: <u>C405</u>
<u>REASONING:</u>

GENERAL

Ideally this section should be located in an appendix. The following public comments are at a minimum needed to address the discrepancies between actual potential implementation, conflicts in planning, design and zoning, different types of occupancies and what is conducive to level 2 charging. In its current form it is likely not enforceable, too complicated and the likelihood of its adoption by a municipality is questionable. I strongly suggest the IECC commercial consensus committee bring in a planning and zoning expert during its consideration including commercial and multifamily experts to address its implementation. In addition, I urge the review of what the IECC residential drafted through its working group which I participated in.

C405.14.1

DELETED

~~1.~~ This has been deleted for the reason of difficulty of enforcement and the multitude of parking situations encountered while in the planning and zoning phases of a project which is also unique and particular to many conditions including the site (topography, lot size, etc.), location (urban vs. suburban) design, affordability, cost, market influences, jurisdictional requirements, etc. This requirement is too complicated to address and needs further consideration.

1. Group R-2 Multifamily and other occupancies including Group B business can have multiple types of parking on site. This needs to be deleted or an exception for multifamily needs to occur. Many projects have different types of parking such as garages in the building, detached garages, surface parking (inc. visitors) and/or on street parking to meet the required local jurisdictional parking requirements. Site constraints play a major role in this.

2. On-street parking may be in the public Right of way serving adjacent buildings. Off street parking vs. on street parking should be addressed.

~~2~~1. Exceptions

1. Leased spaces will vary per tenant and their use. One year it may be 50% business and 50% Mercantile. Next year it could be all business with higher EV requirements. An owner typically does not limit their selection of tenants and may not know the combination of uses when the building is built. Group A (restaurants & art galleries, etc.) Group B (Business) Group M (mercantile) Group E (daycare) Group F (bakeries, dry cleaning laundries, etc.) can occur in the same building. In addition, any change in occupancy may triggers compliance with IECC. In strip centers, change of occupancy is continual.

a. Many mixed-use developments utilize shared parking (Where calculated parking is based on the use groups and “sharing” between daytime hours-(work) and night (residences) This reduces impervious parking and unused parking spaces and is quite effective to reduce our carbon footprint.

TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

MODIFIED:

Group E (Education) has been increased to be consistent with Group A (Assembly) and Group M (Mercantile) occupancies. Group E occupancies are conducive to Level 2 charging times due to parking for extended times such as a school day when in session. In addition, educators may be more likely to own electric vehicles.

Group S-2 (parking garages) has been increased to be consistent with Group A (Assembly) and Group M (Mercantile) occupancies. Group S-2 occupancies are conducive to Level 2 charging times due to parking for extended times in addition to being located within a structure rather than open surface parking. Parking structures typically have security and monitoring in addition to usually having the infrastructure to increase parking rates for EV charging within their system.

Group R-1 (ex. Hotels) & R-2 (ex. Residential apartments) typically will have surface parking. Providing EV Ready spaces only complicates how to protect the infrastructure from theft, weather realities such as snow requiring plowing, flooding, etc. Protection such as bollards would also be needed to ensure damage from vehicles.

ADDED :

Note: For every twenty (20) EVSE, EV Ready, or EV Capable required parking spaces, one (1) EVSE which provides full charging from empty in one (1) hour or less may be substituted.

1. This note has been added to allow flexibility for faster charging times for occupancies which do not permit or require extended parking times which would be required for Level 2 charging.

2. Parking is typically mandated by the jurisdiction (Township, city, etc.) through zoning and can be extremely complicated with many variations and considerations. Every jurisdiction's parking requirement will be unique including minimum parking spaces for each occupancy and even size of parking spaces. ICC codes do not mandate parking requirements. In addition, many required parking spaces may be increased due to industry standards such as mercantile/ retail which may exceed the local requirement. Many corporations require a minimum of 5 parking spaces per 1000 s.f when a jurisdiction may only require 4 parking spaces.

3. One complication of having only certain parking spaces designated for EV (both commercial and residential) and extended level 2 charging times is potential “fighting” over the service and space in particular someone “hogging” the charger even after fully charged. This could become a security and social problem difficult to monitor.

4. Most Group M (mercantile) uses provide parking utilized for only a short amount of time while someone does their shopping. Level 2 charging does not make sense in this instance.

5. Some examples of Group M (Mercantile/ retail) and Group B (business) with an average of 5 parking spaces per 1000 s.f. include the following. According to original proposed Table C405.13.1 the following Level 2 EV charging (minimum of 6 hours of charging time) would be required

   i. Small Strip center 10,000 s.f./ 10 stores (50 p.s. total): 5 EVSE and 5 EV capable

   ii. Large retail (grocery store) 40,000 s.f. (200 p.s . total): 20 EVSE & 20 EV capable

   iii. Large box store (Walmart Supercenter) 180,000 s.f. (900 p.s total): 90 EVSE & 90 EV capable

   iv. Business. Small office building 20,000 s.f. (100 p.s. total): 15 EVSE & 30 EV Capable

6. Motor fuel dispensing facilities (gas stations) are Group M Mercantile uses but based on their size do not require extensive parking. Level 2 charging does not make sense in this instance.

7. Group A (assembly) uses have a high parking count which in many instances remain vacant during the day. Level 2 charging does not make sense in this instance.

Cost Impact: The code change proposal will increase the cost of construction.
The cost impact should remain the same

Workgroup Recommendation

Proposal # 823

CED1-44-22

Proponents: Andrew Poliakoff, representing Electrify America, LLC (andrew.poliakoff@electrifyamerica.com); Genevieve Cullen, representing Electric Drive Transportation Association (gcullen@electricdrive.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.14.1 Quantity. The number of required EV spaces, EV capable spaces and EV ready spaces shall be determined in accordance with this Section and Table C405.14.1 based on the total number of automobile parking spaces and shall be rounded up to the near-est whole number. For R-2 buildings, the Table requirements shall be based on the total number of dwelling units or the total number of automobile parking spaces, whichever is less.

1. Where more than one parking facility is provided on a building site, the number of required automobile parking spaces re-quired to have EV power transfer infrastructure shall be calculated separately for each parking facility.
2. Where one shared parking facility serves multiple building occupancies, the required number of spaces shall be determined proportionally based on the floor area of each building occupancy.
3. Installed EVSE spaces that exceed the minimum requirements of this section may be used to meet minimum requirements for EV ready spaces and EV capable spaces.
4. Installed EV ready spaces that exceed the minimum requirements of this section may be used to meet minimum require-ments for EV capable spaces.
5. Where the number of EV ready spaces allocated for R-2 occupancies is equal to the number of dwelling units or to the number of automobile parking spaces allocated to R-2 occupancies, whichever is less, requirements for EVSE spaces for R-2 occupancies shall not apply.
6. Requirements for a Group S-2 parking garage shall be determined by the occupancies served by that parking garage. Where new automobile spaces do not serve specific occupancies, the values for Group S-2 parking garage in Table C405.14.1 shall be used.
7. For Group M, installed DC fast chargers may be used to satisfy the quantity requirements of Table C405.13.1 (EVSE Spaces, EV Ready Spaces and EV Capable Spaces), using a lesser number of chargers than the percentages listed in the table. The percentage of spaces to satisfy the requirement using DC fast chargers shall be equal to the nominal percentage times 9.6 kW divided by the average simultaneous kilowatt rating of the installed DC fast chargers.

Exception: Parking facilities, serving occupancies other than R2 with fewer than 10 automobile parking spaces.

Reason: In large retail locations, DC fast charging often provides an optimal experience for EV customers due to the ability to provide a full EV charge in 30-45 minutes. Rapid charging of this sort aligns well with typical retail shopping patterns as opposed to the eight to ten hours for AC Level 2 charging, more commonly seen at workplaces and hotels.
Indeed, Electrify America welcomes the code changes in CECPI-1-21 and recommends that they be placed into the main body of the code. EV charging code provisions are critical for broader ZEV adoption and CECPI-1-21 will play a necessary role in that process by shaping the parking space quantities and ratios at mercantile locations (Group M). In order to create a code that accounts for the full variety of charging types (DC fast charging and AC Level 2), Electrify America submits the following language to consider DC fast charging and recognize that use cases for DC fast charging should require a reduced amount of EV spaces, EV ready spaces and EV capable spaces at Group M locations.

Inclusion of the proposed language in ‘C405.13.1(7)’ will prevent jurisdictions from incurring unintended consequences and delay associated with infeasible attempts to use Table C405.13.1 as a measure of deploying high-powered DC fast charging at the same ratios as AC Level 2. To that point, using Table C405.13.1 as drafted would require an exorbitant number of fast chargers in large retail locations. Electrify America recently experienced a similar predicament wherein a large metropolitan city with pro-EVSE policies rightly interpreted an EV- charging parking provision as applicable to L2 charging and DCFC charging at the same ratios for a site designed to serve a nearby airport and TNC ridesharing. The issue was ultimately remedied but the ordeal needlessly delayed the city’s project by six months.

As an example, under the current language, permitting or planning entities would deem an 800 space mercantile lot as requiring 80 DCFC spaces. Such a number of DCFC spaces is notably infeasible from a power standpoint and would require a minimum 12 MW of electricity if 150kW dispensers were installed[1]. To put this in perspective, Electrify America’s typical site is a four dispenser site with 2x150 kW and 2 x 350 kW for a total of 1 MW. Luckily, the use case for DCFC in no way requires such a large number of chargers, as EV customers are able to charge rapidly while shopping and will then exit the space.

The amended proposal herein would instead use the following language to achieve a more appropriate result: *7. The percentage of spaces to satisfy the requirement using DC fast chargers shall be equal to the nominal percentage times 9.6 kW divided by the average simultaneous kilowatt rating of the installed DC fast chargers.*

Calculation for 150 kW chargers at 800 lot site

.20 x 9.6 = 1.92

1.92 ÷ 150 = .0128

.0128 x 800 = 10.24

10.24 = 11 spaces

Calculation for 350 kW chargers at 800 lot site

.20 x 9.6 = 1.92

1.92 ÷ 350 = .0054

.0054 x 800 = 4.32

4.32 = 5 spaces

Proponent:

Electrify America is the largest, open DC (Direct Current) fast charging network in the U.S., with 791 stations and 3,435 ultra-fast (150kW) and hyper-fast (350kW) chargers in 48 states and Washington, D.C. The company has installed an average four stations per week since its first charging station opened in May 2018. Through Electrify America's Boost Plan, the company will install 1,700 and 9,500 individual chargers across North America by the end of 2025.

Proponent:

The Electric Drive Transportation Association is a cross-industry trade association advancing the electrification of transportation. Our members represent the entire value chain of electric drive - including vehicle and component manufacturers, electric utilities, materials and infrastructure companies who are developing and deploying hybrid, plug-in and fuel cell technologies.

Cost Impact: The code change proposal will decrease the cost of construction.
This change would decrease the construction and utility costs for Group M locations by reducing the number of required DC fast chargers at Group M locations.

Bibliography: 1. West Coast Clean Transit Corridor Initiative, *Interstate 5 Corridor: California, Oregon, Washington, Final Report*, p. xi, June 2020, available at https://westcoastcleantransit.com/.

Workgroup Recommendation

Proposal # 890

CED1-45-22

Proponents: Sam Bauer, representing SWTCH (sam@theadhocgroup.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C405.14.1 REQUIRED EV POWER TRANSFER INFRASTRUCTURE

Occupancy	EVSE Spaces	EV Ready Spaces	EV Capable Spaces
Group A	10%	0%	10%
Group B	15%	0%	30%
Group E	~~2%~~ 15%	0%	~~5%~~ 30%
Group F	2%	0%	5%
Group H	1%	0%	0%
Group I	~~2%~~ 15%	0%	~~5%~~ 30%
Group M	~~10%~~ 15%	0%	~~10%~~ 30%
Group R-1	20%	5%	75%
Group R-2	20%	5%	75%
Group R-3 and R-4	2%	0%	5%
Group S exclusive of parking garages	1%	0%	0%
Group S-2 parking garages	~~1%~~15%	0%	~~0%~~ 30%

Reason: We recommend that all public-facing Commercial S-2 parking garages have the same EVSE and EV capable requirements, matching what has been proposed for garages associated with Business (B) occupancies. There are two reasons that we believe justify this change:

1. There is no reason for the distinction between a parking garage associated with a business (B), a school (E), or a parking garage which serves a commercial district (S-2). All are commercial facilities with public-facing uses. There is precedent for considering these commercial building types together: the Denver EV infrastructure requirements require the same levels of EV-installed, EV-ready, and EV-capable for A, B, E, I M, and S-2 building types.[1] The Southwest Energy Efficiency Project (SWEEP) also considers Commercial buildings (Groups A, B, E, I, M, S-2) collectively, recommending at least 20% of the total parking spaces as EV Capable.[2]
2. Retrofits are significantly more costly than EV-enabled or EV-capable spaces from new construction. For example, a study by Energy Solutions (2019) showed that retrofits can cost as much as $4,600 more per space than those installed during construction.[3] Recent estimates suggest that half of all vehicles sold by 2030 will be electric.[4] New garage construction should be future-proofed to meet the needs of EV owners over the next 10 years – 1% of parking spaces with EVSE will not suffice, and retrofitting to meet the coming demand would be unnecessarily costly.

Cost Impact: The code change proposal will increase the cost of construction.
This code change would increase the initial cost of construction. However, as we noted in our reason statement this code change would ultimately save building owners as much as $4,600 per space compared to retrofitting.

Bibliography:

1. Electric Vehicle Charging for Residential and Commercial Energy Codes, Technical Brief, 2021. ,https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EV_Charging_July2021.pdf>
2. EV Infrastructure Building Codes: Adoption Toolkit, SWEEP. <https://www.swenergy.org/transportation/electric-vehicles/building-codes#:~:text=Progressive%20Requirements%3A&text=Denver's%20new%20building%20codes%20require,installation%20of%20an%20EV%2
3. Electric Vehicle Infrastructure Cost Analysis Report for Peninsula Clean Energy (PCE) & Silicon Valley Clean Energy (SVCE), Energy Solutions, 2019. <https://www.peninsulacleanenergy.com/wp-content/uploads/2020/08/PCE_SCVE-EV-Infrastructure-Cost-Analysis-Report-2019.11.05.pdf>
4. "More Than Half of US Car Sales Will Be Electric by 2030," Bloomberg, September 20, 2022. <https://www.bloomberg.com/news/articles/2022-09-20/more-than-half-of-us-car-sales-will-be-electric-by-2030#xj4y7vzkg>

Workgroup Recommendation

Proposal # 888

CED1-46-22

Proponents: Don Chandler, representing self (don.chandler@aesengr.com)

2024 International Energy Conservation Code [CE Project]

C405.14 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with electric vehicle power transfer infrastructure in compliance with Sections C405.14.1 through C405.14.6.

Revise as follows:

C405.14.2 EV Capable Spaces. Each EV capable space used to meet the requirements of Section C405.14.1 shall comply with all of the following:

1. A continuous raceway or cable assembly shall be installed between an enclosure or outlet located within ~~3~~ 10 feet (~~914~~ 3046 mm) of the EV capable spaces and a suitable panelboard or other onsite electrical distribution equipment.
2. Installed raceway or cable assembly shall be sized and rated to supply an minimum circuit capactiy in accordance with C405.14.5
3. The electrical distribution equipment to which the raceway or cable assembly connects shall have sufficient dedicated space and spare electrical capacity for a 2-pole circuit breaker or set of fuses.
4. The electrical enclosure or outlet and the electrical distribution equipment directory shall be marked: "For future electric vehicle supply equipment (EVSE) in space #(s)."
5. Reserved capacity shall be no less than ~~4.1 kVA (~~20A 208/240V~~)~~ for each circuit serving EV capable spaces.

C405.14.3 EV Ready Spaces. Each branch circuit serving EV ready spaces used to meet the requirements of Section C405.14.1 shall comply with all of the following:

1. Terminate at an outlet or enclosure, located within ~~3~~ 10 feet (~~914~~ 3046 mm) of each EV ready space it serves.
2. Have a minimum circuit capacity in accordance with C405.14.5.
3. The panelboard or other electrical distribution equipment directory shall designate the brach circuit as "For electric vehicle supply equipment (EVSE) for space #s" and the outlet or enclosure shall be marked "For electric vehicle supply equipment (EVSE) on circuit #."

C405.14.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.14.5.
2. Have a minimum charging rate in accordance with C405.14.4.1.
3. Be located within ~~3~~ 10 feet (914 mm) of each EVSE space it serves.
4. Be installed in accordance with Section C405.14.6.

~~**C405.14.4.1 EVSE Minimum Charging Rate.** Each installed EVSE shall comply with one of the following:~~

1. ~~Be capable of charging at a minimum rate of 6.2 kVA (or 30A at 208/240V).~~
2. ~~When serving multiple EVSE spaces and controlled by an energy management system providing load management, be capable of simultaneously sharing each EVSE space at a minimum rate of no less than 3.3 kVA.~~
3. ~~When serving EVSE spaces allowed to have a minimum circuit capacity of 2.7 kVA in accordance with C405.14.5.1 and controlled by an energy management system providing load management, be capable of simultaneously charging each ESVE space at a minimum rate of no less than 2.1 1.66 kVA.~~

C405.14.5 Circuit Capacity. The capacity of electrical infrastructure serving each EV capable space, EV ready space, and EVSE space shall comply with one of the following:

1. A branch circuit shall have a rated capacity not less than ~~8.3.kVA~~ 20A at 208/240V) for each EV ready space or EVSE space it serves.
2. The requirements of C405.14.5.1.

C405.14.5.1 Circuit Capacity Management. The capacity of each branch circuit or panel serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of ~~4.1 kV~~ 20A per space.

2. Have a minimum capacity (kWatts)

~~of 2.7 kVA per space~~ when serving EV ready spaces or EVSE space or EV capable spaces for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces or EV capable spaces as determined by the formula

N x VKT x (1 + T) / (20 + 8 * ln(N)

where

· *N is the number of spaces with an EVSE of all automobile parking spaces to be sharing a circuit or panel.*

· *VKT is the anticipated average daily driving distance in kilometers, determined based on a local transportation survey (omitting trips that exceed the range of the battery) or an estimate based on the driving distance from the residential building to the major employment centre divided by 3 + 22 km (13.2 mi) or, in an existing building, on a survey of residents annual odometer readings.*

· T *is an adjustment for temperature of 1% for every degree Celsius difference (as used in climate zones) between 20.5 and the highest average monthly temperature difference for the location where*

*T = 0.01 * ABS(highest average monthly temperature difference from 20.5C)*

and shall have a maximum capacity of minimum capacity * 2.

3. Have a minimum capacity of ~~2.7 kV~~ 20A per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.

Reason: Reasons

1 In 405.14.2 1, 405.14.3 1, 405.14.4 3, the location of the outlet is revised from 3 feet to 10 feet to accommodate the situation where there is no wall or column to mount an EVSE or outlet on in a center space between structural pillars which tend to be 3 spaces apart. The EVSE for the center space can be mounted on a column and the 25 ft EV connector cord can be suspended over an adjacent space to reach the center space avoiding the need to add a pedestal and mechanical protection such as a wheel stop and bollard. A retractor can be used but is not necesary as the cord can simply hang between spaces and be more accessible and kept cleaner than dragging on the floor.

2 In 405.14.2 4, 405.14.3 3, marking must include the stall number on the directory and the circuit number by the outlet to prevent installation or moving of EVSEs on a non-commissioned circuit or space. Such errors are common and result in safety hazards as the ALMS will expect the EVSE to be on the wrong circuit if installed improperly or another uncontrolled appliances is connected. It is also useful for commissioning of the ALMS to have the unit # of the space owner / assignee on the directory.

3. In 405.14.4.1 ;This section is deleted as the charge rate is determined by the EV charger within the capacity of the EVSE nameplate rating and what is determined by an ALMS if used. There is no need or justification to specify a minimum rate as an ALMS will modulate the rate dynamically according to its priority and others charging, below the nameplate demand rating and zero if the ALMS determines the EVSE should pause the EV charging. If there is no ALMS, the EVSE will establish the maximum rate and be selected to meet the requirements of the building owners.

4. In 405.14.2 5, 405.14.5 1 and 405.14.5.1 3 ALMSs may operate by controlling sharing on a branch circuit, or a panel or multiple panels and distribution tiers. This is common in townhouses. The calculated load and demand rating allowed is determined by the NEC and the EVSE standard certification for safety and not required to be restated here.

Capacity limits to meet end user performance goals are managed by an ALMS but determined by calculating those performance needs for the system design and should not be restricted by policy. A minimum ensures the goals are met. A maximum limits overbuilding and excessive cost and grid impact. These performance needs vary from one building to the next primarily depending on location and temperature. Setting a one size fits all minimum is inappropriate but if set should be expressed in Amps due to conventional EVSE demand ratings in Amps not kVA as an EVSE can be connected to either 208V or 240V. The minimum should be consistent with J1772 minimum capacity for EVSEs.

5. 405.14.5.1 There is no rationale or justification to set an arbitrary minimum capacity that does not meet the needs of the building charging space owner without determining those needs first. These needs vary from building to building and one size does not fit all. An approach to such determination is suggested based on substantial modelling research in a calculation. This calculation is a simplified estimate derived from “The Power of Sharing”, published in Electricalline July-Aug 2019 to recognize the driving distance and temperature are major factors in estimating EV charging loads “See Practical Considerations for Load-Managed EV Charging in Multi-Unit Residential Settings”. The rationale for these calculations is explained in “Capacity to Charge” and the statistical modelling elaborated in “Statistical Modelling of Load-Managed Charging for Electric Vehicles in Multi-Unit Residential Parking” See references.

Minimums will not be adequate if both an ALMS is used when an alternate strategy to control grid loads is offered by a utility such as time of use billing or demand response signals as these strategies are incompatible with an demand side management ALMS without considering the capacity needs imposed by the conflict. The capacity determined may also be much too high if the minimum does not recognize all the factors that determine the need. This is analogous to specifying one simple wall insulation value for all climates and window sizes and ratings.

The maximum is also needed to accommodate both time of use or demand response and demand event driven strategies vs ALMSs demand managed strategies that compete to manage charging while avoiding over-building, with significant grid impacts. Using competing management strategies will increase the power requirements and decrease efficiency. The ALMS may have a soft quota cap that may dynamically reduce the rated demand of each circuit or feeder or building supply that may be set by an external entity such as a building management system using BACNet or a utility using OpenADR protocols or by an internal algorithm to minimize peak loads and demand charges in lower demand seasons.

Average energy requirements across buildings and locations may vary from 5 to 25 kWh per vehicle per day depending on building location, average temperatures and other factors.

Power requirements can range from 0.3 to 6.5 kW per vehicle with optimal sharing. The minimum in the existing draft conflicts with this wide range.

Cost reductions compared to dedicated circuits can be 55% for sharing 4 on a circuit, 65% for sharing 7 or 8 on a circuit, and 75% when sharing 10-12 on a circuit. (based on a variety of optional designs for over 30 buildings.) The minimum in the existing draft does not recognize the energy demand variance, the power demand variance on the building infrastructure, nor the cost variance impact.

Given this wide variation in requirements it is preferable to pre-determine the performance needs and management strategies, grid and building limitations and costs before setting minimums or maximums. The proposed formula can be used in the requirements phase to establish power requirements that are fit for purpose and drive an appropriate design.

This version of the IECC will reduce the other energy demands of a building to the extent that more spare capacity for charging is not needed for unspecified 'future loads'. As transportation evolves, specific use-cases for ride share vehicles or Uber drivers or robo-taxis should be identified in required commercial parking stalls and the appropriate power allocations be made for them.

Cost Impact: The code change proposal will decrease the cost of construction.
1. The code change proposal will decrease the cost of construction.

This code change proposal will decrease the cost of construction by about $1000 per center space as mounting pedestals, wheel stops, and bollards are removed.

2.The code change proposal will neither decrease nor increase the cost of construction.

The code change proposal will neither decrease nor increase the cost of construction as the information on a label has no impact on cost.

3. The code change proposal will neither decrease nor increase the cost of construction. The code change proposal will neither decrease nor increase the cost of construction as the minimum rate is controlled by the onboard charger or the ALMS and EVEMS, not a policy and removes these incorrect restrictions.

4.The code change proposal decreases and increases the cost of construction. The code change proposal will decrease the average cost of construction as higher utilization of the building infrastructure is the goal of better informed design, resulting in lower power demands. The code change proposal may increase the cost of construction in high demand areas where the current capacity minimums would be inadequate. There is a relationship between power and cost of about a dollar a Watt as a rule of thumb for charging infrastructure in residential buildings.

5. The code change proposal will decrease the cost of construction. Cost reductions compared to dedicated circuits can be 55% for sharing 4 on a circuit, 65% for sharing 7 or 8 on a circuit, and 75% when sharing 10-12 on a circuit. (based on a variety of optional designs for over 30 buildings.)

Bibliography: Chandler D. (Oct 2022) Practical Considerations for Load-Managed EV Charging in Multi-Unit Residential Settings https://www.researchgate.net/project/Simulation-model-for-EV-Charging

Chandler D. and Chandler D. (September 2020) Electrical Vehicle Charging -and the Power of Sharing, in Electrical Line Magazine at

https://digitalelectricalline.advanced-pub.com/?shareKey=lyCAZj

Chandler D. (May 2020). Statistical Modelling of Load-Managed Charging for Electric Vehicles in Multi-Unit Residential Parking

https://www.researchgate.net/publication/341763845_Statistical_Modelling_of_Load-Managed_Charging_for_Electric_Vehicles_in_Multi-Unit_Residential_Parking

Chandler D. (November 2020). Capacity to Charge. AES Engineering Ltd. Available at http://aesengr.com/publications/capacity-to-charge

Workgroup Recommendation

Proposal # 838

CED1-47-22

Proponents: Sam Bauer, representing SWTCH (sam@theadhocgroup.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.14.4 EVSE Spaces. An installed EVSE with multiple output connections shall be permitted to serve multiple EVSE spaces. Each EVSE installed to meet the requirements of Section C405.14.1, serving either a single EVSE space or multiple EVSE spaces, shall comply with all of the following:

1. Have a minimum circuit capacity in accordance with C405.14.5.
2. Have a minimum charging rate in accordance with C405.14.4.1.
3. Be located within 3 feet (914 mm) of each EVSE space it serves.
4. Be installed in accordance with Section C405.14.6.
5. Meet network and interopability standards in accordance with **C405.14.4.2**

Add new text as follows:

C405.14.4.2 EVSE Interoperability.

1. Chargers must communicate with a charging network via a secure communication method.
2. Chargers must be capable of using Open Charge Alliance (OCA) Open Charge Point Protocol (OCPP) to communicate with any Charging Network Provider.
3. Chargers must be designed to securely switch Charging Network Providers without any changes to hardware.

Add new standard(s) as follows:

Open Charge Alliance OCPP 2.0.1.

- Section A: Security
- Section B: Provisioning
- Section C: Authorization
- Section D: Local Authorization
- Section F: Remote Control
- Section G: Availability
- Section H: Reservation
- Section J: Meter Values
- Section L: Firmware Management
- Section N: Diagnostics
- Section 0: Display Message
- Section P: Data Transfer

Reason: We suggested adopting the language from the NEVI Formula program on interoperability, specifically to incorporate Open Charge Point Protocol (OCPP) standards. Such standards are critical to future-proof the nation's charging network and ensure maximum customer choice. OCPP has been developed to act as the intermediary between charging hardware and network management software, enabling station operators to leverage a single network provider to manage multiple hardware options. This level of flexibility is crucial to effectively deploy EV charging, particularly in multi-unit dwelling contexts. Building owners will install charging equipment sequentially over time as the charging needs of their residents change - OCPP can ensure interoperability across providers and over time to reduce the risk of stranded charging assets. And further, this open standard will increase competition as customers will not be locked into one hardware or software provider based on a prior purchasing decision.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change should not increase or decrease cost of construction. In the long-run, the increased competition from OCPP should drive down network costs as building owners will not be locked-in, increasing competition.

Bibliography: National Electric Vehicle Infrastructure Formula Program. A Proposed Rule by the Federal Highway Administration on 06/22/2022.
https://www.federalregister.gov/documents/2022/06/22/2022-12704/national-electric-vehicle-infrastructure-formula-program

Workgroup Recommendation

Proposal # 896

CED1-48-22

Proponents: Emily Kelly, representing ChargePoint (emily.kelly@chargepoint.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.14.5.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. ~~Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE space for R-2 occupancies when all (100%) of the automobile parking spaces designated for R-2 occupancies are designed to be EV ready spaces or EVSE spaces.~~
3. ~~3.~~ 2. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.

Reason: CECPI-1-21 C405.14.5.1 subsection 2 provides an option for R-2 occupancies to reduce the minimum required kVA when 100% of the automobile parking spaces are designated as EV ready or EVSE spaces. Subsection 2 should be removed as it is duplicative of subsection 3, which provides the same allowance for all occupancy types. Additionally, the proponents provide the below reasons in support of CECPI-1-21 C405.14.1 through C405.14.6 in the 2024 IECC.

Cost Impact: The code change proposal will decrease the cost of construction.
Numerous studies have been conducted regarding the cost difference between new construction vs. retrofit regarding EV infrastructure. In 2019, ChargePoint and Tesla engaged with the California Electric Transportation Coalition to publish the Plug-In Electric Vehicle Infrastructure Cost Analysis Report, which found that for 10% of spaces at a medium sized office/school parking lot the costs for new construction of EV-capable spaces were $901 vs $4,155 for retrofit construction. In addition to this, the City of Orlando highlighted a local EV-Ready building cost example prior to the passage of the City's EV-Ready Ordinance in 2021; finding 20% EV-capable and 2% EV-installed contributed to .0009% of total new construction project costs for a 116 unit Affordable Multi-family housing dwelling. ChargePoint supports CECPI-1-21 C405.14.1 through C405.14.6 and strongly recommends the inclusion in the 2024 IECC Commercial Code.

Attached Files

- **IECC_Commerical_Chargepoint.pdf**
  https://energy.cdpaccess.com/proposal/811/1520/files/download/356/

Workgroup Recommendation

Proposal # 811

CED1-49-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15 Renewable energy systems. *Buildings* in Climate Zones 0-7 shall comply with C405.15.1 through C405.15.4

Exceptions:

1. *Buildings* located in a jurisdiction with a Renewable Portfolio Standard of not less than 70 percent.
2. *Buildings* located in a jurisdiction where the amount of renewable or zero carbon electricity provided to the jurisdiction was not less than 70 percent of the total amount of electricity provided to the jurisdiction in the most recent previous calendar year.

Reason: Many jurisdictions in the US have renewable portfolio standards that have recently increased or will increase significantly over the next several years. For example, in California under SB 1020 that was signed into law in September 2022, the state electricity providers are required to achieve 90% renewable energy and zero-carbon electricity by the end of 2035. In Washington DC, the RPS requirement is 100% by 2032. In Oregon, the requirement is 100% by 2040. Several other states have similar requirements by 2045 or 2050, well within the lifetime of new buildings being built today or in the near future.
Other areas, like Seattle, already receive nearly all of their power from renewable and/or zero carbon resources. In 2020, Seattle received 86% of their power from hydroelectric facilities, 5% from wind farms, 5% from nuclear, 1% from biogas, and the other 3% from other sources. (source: https://www.seattle.gov/city-light/energy-and-environment).

In these areas, it does not make economic sense to force buildings to produce renewable energy when there are legal mandates for electricity (or other energy) providers to supply mostly or all renewable energy to buildings. Central station renewable energy has a much lower cost than rooftop residential and commercial (see Chapter 3 of the NREL report at https://www.nrel.gov/docs/fy22osti/82854.pdf).

These proposed exceptions account for current scenarios as well as mandated future scenarios for energy supply.

Cost Impact: The code change proposal will decrease the cost of construction.
In jurisdictions that meet the stringent exceptions.

Bibliography: *Spring 2022 Solar Industry Update*, National Renewable Energy Laboratory, April 2022, accessed at https://www.nrel.gov/docs/fy22osti/82854.pdf

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Workgroup Recommendation

Proposal # 790

CED1-50-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org); Rachael Dorothy, representing self (dorothy.2@osu.edu); Melissa Kops, representing CT Green Building Council (melissa@ctgbc.org); Andy Woommavovah, representing Healthcare (andy.woommavovah@trinity-health.org); Khaled Mansy, representing self (khaled.mansy@okstate.edu); Brad Smith, representing City of Fort Collins (brsmith@fcgov.com); Brad Hill, representing Honeywell International Inc. (brad.hill@honeywell.com); Emma Gonzalez-Laders, representing Dept. of State/DBSC (emma.gonzalez-laders@dos.ny.gov); David Goldstein, representing Natural Resources Defense Council (dgoldstein.nrdc@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15.1 On-site renewable energy systems. ~~*Buildings* shall install equipment for o~~ On-site renewable electricity generation systems shall be provided with a direct current (DC) nameplate power rating of not less than 0.75 W/ft^2 (8.1 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exceptions: The following buildings or building sites shall comply with Section C405.15.2:

1. A building site located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any building where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the buildng for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than 5,000 square feet (465 m^2).

C405.15.2 Off-site renewable energy. *Buildings* that qualify for one or more of the exceptions to Section 405.15.1 and do not meet the requirements of Section 405.15.1 ~~either in part or in full,~~ with an on-site renewable energy system, shall procure off-site renewable electrical energy, in accordance with C405.15.2.1 and C405.15.2.2, that shall not be less than the total off-site renewable electrical energy determined in accordance with Equation 4-14.

$$\text{TREoff} = (\text{RENoff} \times 0.75\ \text{W/ft}^2 \times \text{FLRA} - \text{IREon}) \times 15 \qquad \textbf{(Equation 4-14)}$$

TREoff = Total off-site renewable electrical energy in kilowatt-hours (kWh) to be procured in accordance with Table C405.15.2
RENoff = Annual off-site renewable electrical energy from Table C405.15.2, in units of kilowatt-hours per watt of array capacity
FLRA = the sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors
IREon = Annual on-site renewable electrical energy generation of a new on-site renewable energy system, to be installed as part of the building project, whose rated capacity is less than the rated capacity required in Section C405.15.1

C405.15.2.1 Off-site procurement. The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-14, with one or more of the following:

1. A *physical renewable energy power purchase agreement*
2. A *financial renewable energy power purchase agreement*
3. A *community renewable energy facility*
4. Off-site renewable energy system owned by the building property owner

The generation source shall be located where the energy can be delivered to the building *site* by any of the following:

1. Direct connection to the off-site renewable energy facility
2. The local utility or distribution entity
3. An interconnected electrical network where energy delivery capacity between the generator and the building *site* is available

C405.15.2.2 Off-site contract. The *renewable energy* shall be delivered or credited to the building site under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. ~~The total required off-site renewable electrical energy shall be procured in equal installments over the duration of the off-site contract.~~

C405.15.3 Renewable energy certificate documentation. The property owner or owner's authorized agent shall demon-strate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections C405.15.1 and C405.15.2 all of the following criteria for RECs and EACs shall be met:

1. The RECS and EACS ~~Are~~ are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the duration of the contract in C405.15.2.2 whichever is less;
2. The RECS and EACS ~~Are~~ are created within a 12-month period of the use of the REC; and
3. The RECS and EACS ~~Are~~ are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

C405.15.4 Renewable energy certificate purchase. A *building* that qualifies for one or more of the exceptions to Section C405.15.1 and where it can be demonstrated to the *code official* that the requirements of Section C405.15.2 cannot be met, the building owner shall contract for the purchase of renewable electricity products before the certificate of occupancy complying with the Green-e Energy National Standard for Renewable Electricity products equivalent to five times the amount of total off-site renewable energy calculated in accordance with Equation 4-14.

~~**COMMUNITY RENEWABLE ENERGY FACILITY.** A facility that produces energy from renewable energy systems and is qualified as a community energy facility under applicable jurisdictional statutes and rules.~~

~~**FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA).** A financial arrangement between a renewable electricity generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."~~

~~**PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA).** A contract for the purchase of renewable electricity from a specific renewable electricity generator to a purchaser of renewable electricity.~~

~~**RENEWABLE ENERGY CERTIFICATE (REC).** A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable electricity generation and could be sold separately from the underlying physical electricity associated with renewable energy systems; also known as an energy attribute and energy attribute certificate (EAC)~~.

RENEWABLE ENERGY INVESTMENT FUND (REIF). A fund established by a jurisdiction ~~the local government or other entity~~ to accept payment from ~~building~~ *building project* owners to construct or acquire interests in qualifying renewable energy systems, together with their associated RECS, ~~(along with RECs) on their~~ the *building project* owners' behalf.

Reason: NBI is proposing several suggested revisions to the off-site renewable energy requirements in the draft 2024 IECC. First, it is important that if a building installs off-site renewable energy to meet the on-site renewable energy requirement, those systems should be installed in a location where the off-site renewable energy can arguably contribute electricity to the building site. This can be done either with a direct connection from the off-site renewable energy system to the building site, or a direct connection to the local utility or distribution entity or in an interconnected electrical network. By requiring the off-site renewables are installed in one of these three locations, a state adopting the 2024 IECC can ensure that the renewable requirements whether installed on-site or off-site will reduce that building and state's carbon emissions and result in improved air quality and a grid that is less reliant on fossil fuels. This language is based on a similar requirement for off-site renewables in the 2021 IgCC.
NBI is also proposing changes to section C405.15.2 requiring that contracts procure renewable energy in equal installments over the duration of the off-site contract. The majority of contracts for off-site renewable energy will not be equal either in energy or in cost because renewable energy system generation varies slightly on an annual basis and because many contracts include small annual adjustments to the cost paid per kWh. NBI is also clarifying that building owners purchase renewable energy credits before the certificate of occupancy because unbundled RECS are typically purchased at one time.

Finally, NBI is proposing small tweaks to the language in Section C405.15.3 for readability and clarity, deleting unneeded definitions in Appendix CC and clarifying the definition for the renewable energy investment fund.

NBI strongly believes that the renewable energy requirements are a new critical addition to the 2024 IECC. In 2020, 21% of the electricity used in the United States was sourced from renewable energy, primarily wind, an intermittent source of energy. [1] The Inflation Reduction Act of 2022 (IRA), which provides reliable tax credits for renewable energy until at least 2032, is estimated to double the deployment of renewable energy technology by making it more cost effective than ever. [2] This proposal requires new commercial buildings to place renewables on the building site, which will support more reliable distributed energy generation and aligns with the incentives being provided in the IRA.

Requiring renewables on new commercial buildings with only certain exceptions will:1) Economically benefit individuals and communities as the country transitions towards a low-carbon economy;2) Increase the resilience of communities during disruptions to centrally supplied power;

3) Reduce the impact of utility-scale renewables on critical wildlife habitat; and

4) Reduce building carbon emissions and improve air quality by ensuring that approximately 10% of a building's energy use is from renewable energy sources.

In addition, this proposal will expand good paying jobs in one of the nation's fastest growing employment sectors. According to the Bureau of Labor Statistics, the two fastest growing occupations in the U.S. in 2019 were solar PV installers and wind turbine service technicians. [3] Because of the IRA, renewable energy manufacturers will be incentivized to locate their business in the U.S., and both renewable energy manufacturers and installers will be incentivized to provide good wages. This provision to require renewable energy on new commercial buildings will broaden and extend the IRA's positive impacts on the U.S. economy and positively impact our communities.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not affect the cost of construction.

Bibliography: [1] Renewables Became the Second-Most Prevalent U.S. Electricity Source in 2020 , U.S. Energy Information Administration, https://www.eia.gov/todayinenergy/detail.php?id=48896.
[2] Esposito, Daniel. "Inflation reduction act benefits: Clean Energy Tax Credits could double deployment." Forbes Magazine. 23 Aug. 2022, https://www.forbes.com/sites/energyinnovation/2022/08/23/inflation-reduction-act-benefits-clean-energy-tax-credits-could-double-deployment/?sh=6e7381c76727

[3] The National Solar Job Census 2020, Interstate Renewable Energy Council, May 2021,

Richardson, Jake. Solar and Wind Tech Are the Fastest Growing Jobs in US, Red, Green, and Blue, 28 Jan. 2019, http://redgreenandblue.org/2019/01/27/solar-wind-tech-fastest-growing-jobs-us/.

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/647/1706/files/download/359/

Workgroup Recommendation

Proposal # 647

CED1-51-22

Proponents: Charles Eley, representing Architecture 2030 (charles@eley.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15.1 On-site renewable energy systems. *Buildings* shall install equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than 0.75 W/ft^2 (8.1 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exceptions: The following buildings or building sites shall comply with Section C405.15.2:

1. A building site located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any building where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the buildng for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than ~~5,000~~ 2,000 square feet (~~465~~ 185 m^2).

Reason: On-site solar is cost effective for buildings smaller than 5,000 ft^2.

Cost Impact: The code change proposal will increase the cost of construction.
Initial construction cost will increase, but LCC cost for smaller buildings will be reduced.

Bibliography: None

Workgroup Recommendation

Proposal # 705

CED1-52-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15.1 On-site renewable energy systems. *Buildings* shall install equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than ~~0.75~~ 0.50 W/ft^2 (~~8.1~~ 5.4 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exceptions: The following buildings or building sites shall comply with Section C405.15.2:

1. A building site located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, elevator machine rooms, duct systems, parapets, planters, skylights, vegetated space, areas for access to equipment or other systems, pathways, or occupied roof terrace.
3. Any building where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the buildng for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than 5,000 square feet (465 m^2).
5. Any multifamily building served by a community renewable energy facility.
6. Any multifamily building with individual ownership of dwelling units.

TABLE C405.15.2 Annual Off-site Renewable Energy Requirement

Climate Zone	Annual Off-site Renewable Electrical Energy (kWh/W)
1A, 2B, 3B, 3C, 4B, and 5B	~~1.75 kWh/W~~ 1.35 kWh/W
0A, 0B, 1B, 2A, 3A, and 6B	~~1.55 kWh/W~~ 1.18 kWh/W
4A, 4C, 5A, 5C, 6A, and 7	~~1.35 kWh/W~~ 1.00 kWh/W

C405.15.4 Renewable energy certificate purchase. A *building* that qualifies for one or more of the exceptions to Section C405.15.1 and where it can be demonstrated to the *code official* that the requirements of Section C405.15.2 cannot be met, the building owner shall contract for renewable electricity products complying with the Green-e Energy National Standard for Renewable Electricity products equivalent to ~~five times~~ twice the amount of total off-site renewable energy calculated in accordance with Equation 4-14.

Reason: The proposed change revises the minimum unit power requirement from 0.75 W/ft^2 to 0.50 W/ft^2 to align with the provisions of ASHRAE 90.1 that will be published later in 2022.
Offsite renewable energy generation sources at community or utility scale should be treated on equal footing with onsite generation or be the preferred choice. We want to incentivize offsite renewables, not allocate it to a second tier. Offsite renewables offer a wide range of benefits to the building owner, the community, and society through the economy of scale. Offsite systems maximize the efficiency of renewable energy generation through better orientation at installation and maintenance over the life of the system. Commercial offsite systems will also allow for managed end-of-life disposal of the equipment. The proposed change maintains the tiered structure for the unit power requirement between the climate zones to recognize the greater solar resource available in southern climate zones, and it also provides better parity between onsite and offsite generation.

Additional clarifying language is added for determining the total area available for installation of solar systems. Two additional exceptions are provided for buildings served by community renewable energy and multifamily buildings with individual ownership.

The requirement to acquire RECs for 5 times the amount of total annual off-site renewable energy is unjustified and excessive, and would require the purchase of tens of thousands of dollars worth of RECs even for small buildings.

Cost Impact: The code change proposal will decrease the cost of construction.
This code change will reduce the minimum power requirements for renewable energy systems and accordingly decrease the cost of construction.

Workgroup Recommendation

Proposal # 739

CED1-53-22

Proponents: Bryan Holland, representing National Electrical Manufacturers Association (NEMA) (bryan.holland@nema.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15.1 On-site renewable energy systems. *Buildings* shall install equipment for on-site renewable electricity generation with a ~~direct current (DC)~~ nameplate output power rating of not less than 0.75 W/ft^2 (8.1 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exceptions: The following buildings or building sites shall comply with Section C405.15.2:

1. A building site located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any building where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the buildng for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than 5,000 square feet (465 m^2).

Reason: This code change proposal will permit all on-site renewable electricity generation with an output nameplate power rating not less .75 W/ft2 and not just direct current generating systems. This would include alternating current systems such as alternating current PV systems, flywheel generator systems, and wind electric systems.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will not increase nor decrease the cost of construction as it simply provides more compliance options to choose from.

Workgroup Recommendation

Proposal # 799

CED1-54-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

C405.15 Renewable energy systems. *Buildings* in Climate Zones 0-7 shall comply with C405.15.1 through C405.15.4

C405.15.1 On-site renewable energy systems. *Buildings* shall install equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than 0.75 W/ft^2 (8.1 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exceptions: The following buildings or building sites shall comply with Section C405.15.2:

1. A building site located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any building where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the buildng for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than 5,000 square feet (465 m^2).

Revise as follows:

C405.15.2 Off-site renewable energy. *Buildings* that qualify for one or more of the exceptions to Section 405.15.1 and do not meet the requirements of Section 405.15.1 either in part or in full, with an on-site renewable energy system, shall procure off-site renewable electrical energy, in accordance with C405.15.2.1 and C405.15.2.2, that shall not be less than the total off-site renewable ~~electrical~~ energy determined in accordance with Equation 4-14.

$$TREoff = (RENoff \times 0.75\ W/ft^2 \times FLRA - IREon) \times 15$$

(Equation 4-14)

TREoff = Total off-site renewable ~~electrical~~ energy in kilowatt-hours (kWh) <u>(r equivalent BTU energy content for renewable hydrocarbons (1 kWh = 3412 Btu)</u> to be procured in accordance with Table C405.15.2
RENoff = Annual off-site renewable electrical energy from Table C405.15.2, in units of kilowatt-hours per watt of array capacity
FLRA = the sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors
IREon = Annual on-site renewable electrical energy generation of a new on-site renewable energy system, to be installed as part of the building project, whose rated capacity is less than the rated capacity required in Section C405.15.1

TABLE C405.15.2 Annual Off-site Renewable Energy Requirement

Climate Zone	Annual Off-site Renewable ~~Electrical~~ Energy ~~(kWh/W)~~
1A, 2B, 3B, 3C, 4B, and 5B	1.75 kWh/W(5971 Btu/W)
0A, 0B, 1B, 2A, 3A, and 6B	1.55 kWh/W (5289 Btu/W)
4A, 4C, 5A, 5C, 6A, and 7	1.35 kWh/W (4606 Btu/W)

C405.15.2.1 Off-site procurement. The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable ~~electrical~~ energy, not less than required in accordance with Equation 4-14, with one or more of the following:

1. A *physical renewable energy ~~power~~ purchase agreement*
2. A *financial renewable energy ~~power~~ purchase agreement*
3. A *community renewable energy facility*
4. Off-site renewable energy system owned by the building property owner

C405.15.2.2 Off-site contract. The *renewable energy* shall be delivered or credited to the building site under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. The total required off-site renewable ~~electrical~~ energy shall be procured in equal installments over the duration of the off-site contract.

C405.15.3 Renewable energy certificate documentation. The property owner or owner's authorized agent shall demon-strate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections C405.15.1 and C405.15.2 all of the following criteria for RECs and EACs shall be met:

1. Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the duration of the contract in C405.15.2.2 whichever is less;
2. Are created within a 12-month period of the use of the REC; and
3. Are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

Revise as follows:

C405.15.4 Renewable energy certificate purchase. A *building* that qualifies for one or more of the exceptions to Section C405.15.1 and where it can be demonstrated to the *code official* that the requirements of Section C405.15.2 cannot be met, the building owner shall contract for renewable electricity products complying with the Green-e Energy National Standard for Renewable Electricity products equivalent to five times the amount of total off-site renewable energy calculated in accordance with Equation 4-14.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the hydrocarbon resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first ("bottom-up inorganic recovery") case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second ("top-down inorganic recovery") case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third ("organic recovery") case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will decrease the cost of construction.
This code change proposal can decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

Proposal # 927

CED1-55-22

Proponents: Charles Eley, representing Architecture 2030 (charles@eley.com)

2024 International Energy Conservation Code [CE Project]

Update standard(s) as follows:

C405.15.2.1 Off-site procurement. The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-14, with one or more of the following:

1. ~~A~~ *Physical renewable energy power purchase agreement*
2. ~~A~~*Financial renewable energy power purchase agreement*
3. ~~A~~ *Community renewable energy facility*
4. Off-site renewable energy system owned by the building property owner
5. *Green retail tariff*

Add new definition as follows:

C202 **Green retail tariff.** An electricity-rate structure qualified under applicable statutes or rules contracted by an electricity service provider to the *building project* owner to provide electricity generated with 100% *renewable energy resources.*

Reason: A green retail tariff is a special program offered by electric service providers (utilities) whereby they acquire 100% renewable energy to meet the electricity demands of a participating customer. The customer typically pays a premium in the range of one to two cents per kilowatt-hour (similar to participation in a community solar program). The delivered renewable energy is in addition to that required to meet applicable renewable portfolio standards and the RECs associated with the renewable energy are retired on behalf of the participating customer (as required by C405.15.3).
Section C405.15.2.2 would apply to green retail tariffs as it does to all off-site procurement options. A contract is required: (1) with a duration of at least 10 years, (2) that is structured to survive a transfer of ownership, and (3) and that acquires renewable energy in concert with energy consumption.

Retail green pricing is the most common method for procuring off-site renewable energy and the only option available to many building owners/managers. This is the option most widely used in Boston, San Francisco and other cities where the purchase of off-site renewable energy is already required for some building types and sizes.

Off-site renewable energy purchases are recognized in three places in the standard and this code change proposal strives to make the methods more consistent in section C405.15, Appendix CC and Appendix CD.

Not including this option will limit the ability of building owners to purchase off-site renewable energy and undermine the effectiveness of Section C405.15.

Cost Impact: The code change proposal will decrease the cost of construction.
The cost premium for 100% renewable energy through a green retail tariff is comparable to participation in a community renewables program. Providing more options for off-site procurement has the potential to reduce compliance costs.

Bibliography: ZERO Code 2.0, Off-Site Procurement of Renewable Energy, Technical Support Document, December 2020. Click here.
Clean Electricity, A practical path to zero-carbon buildings, Charles Eley, September 2022. Click here.

Workgroup Recommendation

Proposal # 686

CED1-56-22

Proponents: Charles Eley, representing Architecture 2030 (charles@eley.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15.2.1 Off-site procurement. The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-14, with one or more of the following:

1. ~~A P~~*hysical renewable energy power purchase agreement*
2. ~~A~~*Financial renewable energy power purchase agreement*
3. ~~A~~ *Community renewable energy facility*
4. Off-site renewable energy system owned by the building property owner
5. *Renewable energy investment fund*

Add new definition as follows:

RENEWABLE ENERGY INVESTMENT FUND. A fund established by the local government or other entity to accept payment from building owners to construct or acquire qualifying renewable energy (along with RECs) on their behalf.

Reason: A renewable energy investment fund is recognized in Appendix CC and Appendix CD. For consistency, it should be included in C405.15.2.1.

Cost Impact: The code change proposal will decrease the cost of construction.
Providing more options for acquiring off-site renewable energy will not increase the cost of compliance and could result in a reduction.

Workgroup Recommendation

Proposal # 768

CED1-57-22

Proponents: Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Michael Rosenberg, representing Pacific Northwest National Laboratory (michael.rosenberg@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.16 Electrical energy storage system. *Buildings* shall comply with either ~~the one of~~ C405.16.1 or C405.16.2.

C405.16.1 Electrical energy storage energy capacity. Each *building* shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 x Installed PV System Rated Power (kWDC)
2. ESS rated power capacity (kW)≥0.25 x Installed PV System Rated Power (kWDC).

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

Revise as follows:

C405.16.2 Electrical energy storage system ready. Each *building* shall have one or more reserved ESS-ready areas to accommodate future electrical storage in accordance ~~complying~~ with C405.16.2.1 through C405.16.2.4.~~the following:~~

1. ~~Energy storage system rated energy capacity (kWH) ≥ Conditioned floor area of the three largest stories (ft²) x 0.0008 kWh/ft²~~
2. ~~Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft²) x 0.0002 kWh/ft²~~

C405.16.2.1 ESS-ready location. Each ESS-ready area shall be located in accordance with Section 1207 of the *International Fire Code.*

Revise as follows:

C405.16.2.2 ESS-ready minimum area requirements. Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the *International Fire Code* and the UL9540 or UL9540A designated rating of the planned system. Where rated to UL9540A, the area shall be sized in accordance with the manufacturer's instructions.

C405.16.2.3 Electrical distribution equipment. The onsite electrical distribution equipment shall have sufficient capacity, rating, and space to allow installation of overcurrent devices and circuit wiring in accordance with NFPA 70 for future electrical ESS installation complying with the capacity criteria of Section C405.16.2 .4.

Add new text as follows:

C405.16.2.4 ESS-ready minimum system capacity. Compliance with ESS-ready requirements in C405.16.2.1 through C405.16.2.3 shall be based on a minimum total energy capacity and minimum rated power capacity as follows:

1. ESS rated energy capacity (kWh) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0008 kWh/ft^2
2. ESS rated power capacity (kWh) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0002 kWh/ft^2

Reason: This proposal is editorial and recommends language to reduce ambiguity.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is editorial and does not impact cost effectiveness of this requirement.

Workgroup Recommendation

Proposal # 649

CED1-58-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.16 Electrical energy storage system. *Buildings* shall comply with the one of C405.16.1 or C405.16.2.

Exception: Buildings without required onsite renewable energy systems.

C405.16.1 Electrical energy storage energy capacity. Each *building* shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 x Installed PV System Rated Power (kWDC)
2. ESS rated power capacity (kW)≥0.25 x Installed PV System Rated Power (kWDC).

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

Revise as follows:

C405.16.2 Electrical energy storage system ready. Each *building* shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

1. Energy storage system rated energy capacity (kWH) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0008 kWh/ft^2
2. Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft^2) x 0.0002 kWh/ft^2

Exception: Buildings that rely on offsite renewable energy for a significant amount of their energy demand.

C405.16.2.1 ESS-ready location. Each ESS-ready area shall be located in accordance with Section 1207 of the *International Fire Code.*

C405.16.2.2 ESS-ready minimum area requirements. Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the *International Fire Code* and the UL9540 or UL9540A designated rating of the planned system. Where rated to UL9540A, the shall be in accordance with the manufacturer's instructions.

C405.16.2.3 Electrical distribution equipment. The onsite electrical distribution equipment shall have sufficient capacity, rating, and space to allow installation of overcurrent devices and circuit wiring in accordance with NFPA 70 for future electrical ESS installation complying with the criteria of Section C405.16.2.

Reason: Energy storage does not serve a building energy conservation purpose at sites without on-site generation.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction for buildings without required onsite renewable energy systems.

Workgroup Recommendation

Proposal # 659

CED1-59-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com); Vladimir Kochkin, representing NAHB (vkochkin@nahb.org)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

Appendix CX
Energy Storage Systems

ENERGY STORAGE SYSTEM (ESS). One or more devices, assembled together, capable of storing energy in order to supply electrical energy at a future time.

Revise as follows:

CX101.1~~405.16~~ Electrical energy storage system. *Buildings* shall comply with the one of C X101.1.1~~405.16.1~~ or CX 101.1.2~~405.16.2~~.

CX101.1.1~~405.16.1~~ Electrical energy storage energy capacity. Each *building* shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 x Installed PV System Rated Power (kWDC)
2. ESS rated power capacity (kW)≥0.25 x Installed PV System Rated Power (kWDC).

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

CX101.2~~405.16.2~~ Electrical energy storage system ready. Each *building* shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

1. Energy storage system rated energy capacity (kWH) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0008 kWh/ft^2
2. Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft^2) x 0.0002 kWh/ft^2

CX101.2.1~~405.16.2.1~~ ESS-ready location. Each ESS-ready area shall be located in accordance with Section 1207 of the *International Fire Code.*

CX101.2.2~~405.16.2.2~~ ESS-ready minimum area requirements. Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the *International Fire Code* and the UL9540 or UL9540A designated rating of the planned system. Where rated to UL9540A, the shall be in accordance with the manufacturer's instructions.

CX101.3~~405.16.2.3~~ Electrical distribution equipment. The onsite electrical distribution equipment shall have sufficient capacity, rating, and space to allow installation of overcurrent devices and circuit wiring in accordance with NFPA 70 for future electrical ESS installation complying with the criteria of Section C405.16.2.

Reason: These provisions should be in an appendix. Requiring jurisdictions to individually consider the provisions in an adoption might give the city or county attorney time to evaluate the constitutional issues associated with the requirements. From the energy savings standpoint, onsite battery storage should be paired with onsite solar. Where onsite solar is not going to be installed, these requirements will not serve an energy saving function. This is going to be an issue for jurisdictions that will prioritize community-scale and utility-scale renewable energy over the more expensive and less practical onsite generation.
Additionally, highrise buildings, among others, typically have generators to provide emergency power. Requiring ESS in those buildings adds cost but not functionality.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction for jurisdictions that chose not to adopt the proposed Energy Storage Systems Appendix.

Workgroup Recommendation

Proposal # 747

CED1-60-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.16 Electrical energy storage system. *Buildings* shall comply with the one of C405.16.1 or C405.16.2.

Exceptions:

1. Buildings located in a jurisdiction with a Renewable Portfolio Standard of not less than 70 percent.
2. Buildings located in a jurisdiction where the amount of renewable or zero carbon electricity provided to the jurisdiction was not less than 70 percent of the total amount of electricity provided to the jurisdiction in the most recent previous calendar year.

Reason: Many jurisdictions in the US have renewable portfolio standards that have recently increased or will increase significantly over the next several years. For example, in California under SB 1020 that was signed into law in September 2022, the state electricity providers are required to achieve 90% renewable energy and zero-carbon electricity by the end of 2035. In Washington DC, the RPS requirement is 100% by 2032. In Oregon, the requirement is 100% by 2040. Several other states have similar requirements by 2045 or 2050, well within the lifetime of new buildings being built today or in the near future.
Other areas, like Seattle, already receive nearly all of their power from renewable and/or zero carbon resources. In 2020, Seattle received 86% of their power from hydroelectric facilities, 5% from wind farms, 5% from nuclear, 1% from biogas, and the other 3% from other sources. (source: https://www.seattle.gov/city-light/energy-and-environment).
In these areas, it does not make economic sense to force buildings to have on-site battery energy storage systems when there are legal mandates for electricity (or other energy) providers to supply mostly or all renewable energy to buildings. Central station renewable energy and battery energy storage systems have much lower costs than residential and commercial systems (see the NREL report at https://www.nrel.gov/docs/fy22osti/82854.pdf).

These proposed exceptions account for current scenarios as well as mandated future scenarios for energy supply.

Cost Impact: The code change proposal will decrease the cost of construction.
In jurisdictions with mandates for or an existing high percentage of grid-supplied renewable electricity.

Bibliography: *Spring 2022 Solar Industry Update*, National Renewable Energy Laboratory, April 2022, accessed at https://www.nrel.gov/docs/fy22osti/82854.pdf

Workgroup Recommendation

Proposal # 807

CED1-61-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

C405.16 Electrical energy storage system. *Buildings* shall comply with the one of C405.16.1 or C405.16.2.

Revise as follows:

C405.16.1 Electrical energy storage energy capacity. Each *building* shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 (kWh/kW) x Installed ~~PV System~~ On-site Renewable Energy System Rated Power (kW_{DC})
2. ESS rated power capacity (kW)≥0.25 x Installed ~~PV System~~ On-site Renewable Energy System Rated Power (kW_{DC}).

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

C405.16.2 Electrical energy storage system ready. Each *building* shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

1. Energy storage system rated energy capacity (kWH) ≥ ~~C~~ Gross conditioned floor area of the three largest floors~~stories~~ (ft^2) x 0.0008 kWh/ft^2
2. Energy storage system rated power capacity (kW) ≥ ~~C~~ Gross conditioned floor area of the three largest floors~~stories~~ (ft^2) x 0.0002 kW~~h~~/ft^2

Reason: The proposed amendment clarifies that the Energy Storage System rated energy and power capacity are related to the on-site renewable energy system's rated power. The changes also clarify that the size of the system is based on the gross conditioned floor area of the three largest floors. Additional changes were made to fix a typo in the units in Section C405.16.3 and clarify the units in Section C405.16.1. The changes were made to reflect the intent of the proposal to tie energy storage readiness provisions to renewable energy requirements in the 2024 IECC.
NBI believes that the energy storage-ready provisions proposed for the 2024 IECC which ensure that either an energy storage system is installed or that there is both sufficient physical space and electrical capacity for that energy storage system, are critical bolstering the economy, presenting a cost savings opportunity for building owners, increasing resilience to power outages, and aiding in the transition to a carbon-free grid. The Inflation Reduction Act of 2022 is estimated to double the deployment of renewable energy technology, ensuring that 67% of our energy will be carbon-free by 2035. As the U.S. rapidly deploys renewables, buildings must be prepared to aid in this transition by storing energy to match grid demands. That is why the Inflation Reduction Act includes tax credits which will reduce the capitol costs of energy storage systems by 30%. Ensuring buildings are energy storage-ready will allow more customers to take advantage of federal incentives, reduce their utility bills, make their buildings more resilient and aid in the transition to a carbon free economy. The proposed changes ensure that the energy storage-ready provisions fully align with the renewable energy provisions in the draft 2024 IECC.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal has no impact on the cost of construction.

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/706/1677/files/download/361/

Workgroup Recommendation

Proposal # 706

CED1-62-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.16.1 Electrical energy storage energy capacity. Each *building* shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 x Installed ~~PV~~ On-site Renewable Energy System Rated Power (kWDC)
2. ESS rated power capacity (kW)≥0.25 x Installed ~~PV~~ On-Site Renewable Energy System Rated Power (kWDC).

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

C405.16.2 Electrical energy storage system ready. Each *building* shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

1. Energy storage system rated energy capacity (~~kWH~~ kWh) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0008 kWh/ft^2
2. Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft^2) x 0.0002 ~~kWh~~ kW/ft^2

Reason: As currently written, battery energy storage systems are only required when PV systems are installed, so other renewable energy systems would be exempt. This revision would make the requirement applicable to all qualified on-site renewable energy systems that produce electricity.
The other part of the proposal makes technical corrections to the equations shown.

Cost Impact: The code change proposal will increase the cost of construction.
For buildings that install on-site renewable energy systems that are not PV systems.

Workgroup Recommendation

Proposal # 808

CED1-63-22

Proponents: Maureen Guttman, representing Energy Solutions

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.16.1 Electrical energy storage energy capacity. Each *building* shall have one or more ESS with a total rated energy capacity and rated power capacity as follows:

1. ESS rated energy capacity (kWh)≥1.0 (kWh/kWDC) x Installed PV System Rated Power (kWDC)
2. ESS rated power capacity (kW)≥0.25 (kWh/kWDC) x Installed PV System Rated Power (kWDC).

Where installed, DC coupled battery systems shall meet the requirements for rated energy capacity alone.

C405.16.2 Electrical energy storage system ready. Each *building* shall have one or more reserved ESS-ready areas to accommodate future electrical storage complying with the following:

1. Energy storage system rated energy capacity (kWh~~H~~) ≥ Conditioned floor area of the three largest stories (ft^2) x 0.0008 kWh/ft^2
2. Energy storage system rated power capacity (kW) ≥ Conditioned floor area of three largest stories (ft^2) x 0.0002 kWh/ft^2

C405.16.2.2 ESS-ready minimum area requirements. Each ESS-ready area shall be sized in accordance with the spacing requirements of Section 1207 of the *International Fire Code* and the UL9540 ~~or UL9540A~~ designated rating of the planned system. ~~Where rated to UL9540A, the shall be in accordance with the manufacturer's instructions.~~

Reason: The proposed revisions to the units in Section C405.16 are to provide clarity and consistency and are not substantive changes to the draft code.
The proposed revision to C405.16.2.2 removes the option to size an ESS-ready area based on UL9540A. UL9540 requires separations between ESS units of at least 3 feet, while UL9540A allows for deviations from this spacing requirement based on manufacturer’s instructions. Projects that follow C405.16.2 are not installing ESS units, only ensuring the building is ESS-ready. Therefore, there is no need to provide an option to size according to UL9540A, since this would be equipment specific.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Editorial change; no cost impact.

Workgroup Recommendation

Proposal # 859

CED1-64-22

Proponents: Jenny Hernandez, representing Las Cruces Sustainability

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

C405.17 **Additional electric infrastructure.** Buildings that contain combustion equipment shall be required to install electric infrastructure in accordance with this section.

Reason: The City of Las Cruces Sustainability Office is in support of New Building Institutes proposals to add an electric ready requirement. The inclusion of such language is critical for meeting the nations climate goals in greenhouse gas emissions. The City of Las Cruces is making it's own efforts to transition to clean energy however, cities across the nation including ourselves would have more success in passing such codes if it's adopted into the standardized codes that states adopt. This means that on a local level we can begin transitioning our infrastructure to be resilient and ready to meet the needs of our constantly changing climate. These codes ensure that our buildings can seamlessly transition when appropriate in a cost-effective way and gives autonomy to our community to decided what kind of energy they prefer to use for the places they live, work, and play. We believe that these revisions support the direction that the nation is heading. There is also a unique once in a lifetime opportunity for the all-electric appendix to be incentivized by the federal governments IRA. Parallel efforts for both of these can have tremendous outcomes in our nations success towards fighting climate change.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is a statement of support for New Buildings Institutes proposal to include electric ready standards.

Attached Files

- **City of Las Cruces Letter of Support NBI Codes.pdf**
  https://energy.cdpaccess.com/proposal/889/1666/files/download/390/

Workgroup Recommendation

Proposal # 889

CED1-65-22

Proponents: Bryan Holland, representing National Electrical Manufacturers Association (NEMA) (bryan.holland@nema.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2 Lighting controls. Lighting systems ~~powered through the energy service for the building~~ shall be provided with controls that comply with Sections C405.2.1 through C405.2.9 .

Exceptions: Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency lighting that is automatically off during normal operations.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2) of lighting in exit access components which are provided with fire alarm systems.

C405.5.1 Total connected ~~exterior building~~ exterior lighting power. The total exterior connected lighting power shall be the total maximum rated wattage of all exterior lighting ~~that is powered through the energy service for the building~~.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting that is automatically off during normal operations .
3. Exit signs.
4. Specialized signal, directional and marker lighting associated with transportation.
5. Advertising signage or directional signage.
6. Integral to equipment or instrumentation and installed by its manufacturer.
7. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.
8. Athletic playing areas.
9. Temporary lighting.
10. Industrial production, material handling, transportation sites and associated storage areas.
11. Theme elements in theme/amusement parks.
12. Used to highlight features of art, public monuments and the national flag.
13. Lighting for water features and swimming pools.
14. Lighting controlled from within sleeping units and dwelling units, .
15. Lighting of the exterior means of egress as required by the *International Building Code*.

Reason: This proposal establishes energy efficiency for exterior lighting on a buildings site regardless of where the power for the lighting is being sourced and closes an existing loophole that circumvents the energy code.
This provision will:

1. Increase energy efficiency
2. Close a loophole in the code
3. Establish consistency in code implementation
4. Simplifies compliance as does not require new or revised code provisions
5. Supports enforceability uniformly

The energy code currently limits the ability of the code to cover lighting on buildings sites where the electrical power distribution is separated from the building. Such applications, even though under the ownership and control of one entity, may have exterior lighting which should be under the code's governance. Some examples are parking lots on many retail, institutional, transportation and entertainment venue locations where the electrical distribution comes from a free-standing pedestal mounted electrical service. Additional applications are exterior lighting on plazas, walkways, outdoor amphitheaters, and similar that are part of a building site, but powered separately from the building.

Note that lighting controls are NOT required to follow energy code provisions per new language in the 2024 DRAFT section C405.2. Inserted into the draft (via a new proposal introduced as CEPI-150) is the following: "not powered through the electrical service of the building".

The intent of this proposal would remove or negate this new draft language.

From a technical perspective, exterior lighting located on building sites should be applied and be similarly just as efficient, no matter where the electrical power is served. This proposal would apply energy efficiency the same to all exterior lighting on a building site.

Exempting exterior lighting not powered through the electrical service of a building presents a loophole for enforcement. By choosing to set the electrical service separated from a building on a free-standing pedestal can be done simply to avoid energy efficiency compliance. This is a design practice in retail strip malls where a "house panel" will be set separate from the retail buildings, and power all lighting in mall parking areas.

As currently written and proposed by CEPI-150, exterior lighting on a building site powered separately from the building, may use any efficacy lighting and operate without the energy savings controls would provide. Essentially, this exterior lighting would be allowed to operate full on 24 hours a day, seven days a week without limits and without the code control provisions.

To resolve these inefficient situations, increase efficiency, reduce confusion and simplify enforcement, this proposal removes the language which limits controls and exterior lighting power. Approval of this proposal would support that all exterior lighting, regardless of electrical service location, would now comply and be as efficient as required for any building site.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The code change proposal will not increase or decrease the cost of construction

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Workgroup Recommendation

Proposal # 795

CED1-66-22

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2 Lighting controls. Lighting systems in interior parking areas shall be provided with controls that comply with C405.2.9. All other lighting systems powered through the energy service for the building shall be provided with controls that comply with Sections C405.2.1 through C405.2.8 ~~C405.2.9~~ .

Exceptions: Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency lighting that is automatically off during normal operations.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2) of lighting in exit access components which are provided with fire alarm systems.

~~C405.2.8~~ C405.2.9 Interior parking ~~garage~~ area lighting control. Interior parking ~~garage~~ area lighting shall be controlled by an *occupant sensor* complying with Section C405.2.1.1 or a *time-switch control* complying with Section C405.2.2.1. Additional lighting controls shall be provided as follows:

1. Lighting power of each luminaire shall be automatically reduced by not less than 30 percent when there is no activity detected within a lighting zone for 20 minutes. Lighting zones for this requirement shall be not larger than 3,600 square feet (334.5 m^2).

   Exception: Lighting zones provided with less than 1.5 footcandles of illumination on the floor at the darkest point with all lights on are not required to have automatic light-reduction controls.

2. Where lighting for eye adaptation is provided at covered vehicle entrances and exits from buildings and parking structures, such lighting shall be separately controlled by a device that automatically reduces lighting power by at least 50 percent from sunset to sunrise.
3. The power to luminaires within 20 feet (6096 mm) of perimeter wall openings shall automatically reduce in response to daylight by at least 50 percent.

   Exceptions:

   1. Where the opening-to-wall ratio is less than 40 percent as viewed from the interior and encompassing the vertical distance from the driving surface to the lowest structural element.
   2. Where the distance from the opening to any exterior daylight blocking obstruction is less than one-half the height from the bottom of the opening or fenestration to the top of the obstruction.
   3. Where openings are obstructed by permanent screens or architectural elements restricting daylight entering the interior space.

~~C405.2.9~~ C405.2.8 Demand responsive lighting controls. *Buildings* shall have controls that are capable of automatically reducing general lighting power not less than 15 percent in response to a demand response signal.

Exceptions:

1. Buildings with less than 4,000 watts of combined installed general lighting power in spaces that have more than 0.5 W/ft^2 (5.38 W/m^2) of general lighting power.
2. *Buildings* where demand response programs are not available.
3. I-2 and I-3 occupancies.

Reason: For clarity.
The parking garage lighting control requirements in Section C405.2.8 are clearly intended for interior parking areas only. It would be nonsensical to apply these control requirements to stairways, elevator lobbies, electrical closets, and other space types found within parking garages. By changing this section from "Parking garage" lighting controls to "Interior Parking Area" lighting controls, we are clarifying that this section is only meant to apply

to parking areas (a space type in Table C405.3.2(2)).

The revisions to C405.2 clarify that none of the other control sections apply to interior parking areas. There are no obvious conflicts, and no reduction in stringency, but it will be helpful to tell users of the code that they only need to refer to C405.2.8 when designing the controls for interior parking areas.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed change is editorial in nature and does not impact stringency.

Workgroup Recommendation

Proposal # 803

CED1-67-22

Proponents: Jonathan McHugh, representing McHugh Energy Consultants Inc. (jon@mchughenergy.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2 Lighting controls. Lighting systems ~~powered through the energy service~~ for the *building* or *building site* shall be provided with controls that comply with Sections C405.2.1 through C405.2.9 .

Exceptions: Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency lighting that is automatically off during normal operations.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2) of lighting in exit access components which are provided with fire alarm systems.

C405.2.7 Exterior lighting controls. Exterior lighting systems, serving the exterior lighting applications listed in Table C405.5.2(2) and Table C405.5.2(3), shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

C405.5.1 Total connected exterior building exterior lighting power. The total exterior connected lighting power shall be the total maximum rated wattage of all luminaires serving the exterior lighting applications listed in Table C405.5.2(2) and Table C405.5.2(3) ~~that is powered through the energy service for the building~~.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting that is automatically off during normal operations .
3. Exit signs.
4. Lighting for public streets, roadways, and highways, including lighting for driveway entrances occurring in the public right-of-way.

~~4~~ 5. Specialized signal, directional and marker lighting associated with transportation.

~~5~~ 6. Advertising signage or directional signage.

~~6~~ 7. Integral to equipment or instrumentation and installed by its manufacturer.

~~7~~ 8. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.

~~8~~ 9. Athletic playing areas.

~~9~~ 10. Temporary lighting.

~~10~~ 11. Industrial production, material handling, transportation sites and associated storage areas.

~~11~~ 12. Theme elements in theme/amusement parks.

~~12~~ 13. Used to highlight features of art, public monuments and the national flag.

~~13~~ 14. Lighting for water features and swimming pools.

~~14~~ 15. Lighting controlled from within sleeping units and dwelling units, .

~~15~~ 16. Lighting of the exterior means of egress as required by the *International Building Code*.

Reason: This proposal seeks to require that all outdoor lighting on a building's site be subject to the control requirements and the wattage limitations regardless of whether the outdoor lighting is circuited through the building's electrical service. The developers of the ANSI/IES/ASHRAE 90.1

standard recognized that limiting long standing outdoor efficiency measures only to lighting powered through the building service, limits the amount of national energy savings associated with these efficiency measures.
Addenda AM, BG and CB to 90.1 have updated title purpose and scope to include sites that do not have buildings on them as long as these sites have newly installed equipment covered by the standard. The most notable newly covered equipment is outdoor lighting as might be found in commercial parking lots without an associated building, or common site lighting for malls where the lot is also not associated with any one building.

Addendum CB updates the purpose of Std 90.1-2002 (Section 1.1) as follows: "*To establish the minimum energy efficiency requirements of buildings other than low-rise residential buildings, and sites…"* The scope of Std 90.1-2022 (Section 2.1 (a) item 3 includes, *"new systems and equipment specifically identified in this standard that are part of a site."* Section 4.1.1.6 and Section 4.2.1.4 of ASHRAE 90.1-2022 also make clear that outdoor lighting not connected to a building are also in scope. In the past covered outdoor lighting was served though the building's electrical service. With adoption of Std 90.1 addendum AM exterior lighting power allowances in table 9.4.2-2 are changed from *"building exteriors"* to *"exterior applications"* and in addendum, BG, the scope in Section 9.1.1.1 is expanded *to "New Sites Systems and Equipment"*.

This proposal is taking a minimalist approach to only reversing the narrowing of scope of outdoor lighting controls and power allowances to that which is served through the building service.

A companion proposal will more closely align the 2024 IECC with ASHRAE 90.1-2022.

To provide a rough estimate savings we calculated the reduced lighting power associated with the proposed outdoor lighting reduction for parking areas and drives by lighting zone and multiplied this by a nationwide estimate of parking and drives. The nationwide estimate of parking and drives was calculated from published statewide area estimates of hardscape areas in California by lighting zone from the 2019 Title 24 outdoor lighting code change proposal and then expanding this to a national estimate by multiplying by 8 (the ratio of US population to California population).

As shown in the following table, and assuming that 10% of outdoor hardscape lighting that previously was exempted from regulation due to the building service limitation was newly regulated, the additional energy savings would be 38 Million kWh/yr for each year's new construction and parking lot renovations.

			Fraction of Total Area by LZ			
			0.1%	9.9%	90.0%	0.0%
Description	**CA**	**US**	**US LZ 1**	**US LZ 2**	**US LZ 3**	**US LZ 4**
Hardscape Lighting NC (M ft^2)	136	1,088	1.1	108	979	0
Hardscape Lighting Alteration (Mft^2)	401	3,208	3.2	318	2,887	0
2021 IECC (W/ft^2)			0.030	0.040	0.060	0.080
2024 Proposed IECC (W/ft^2)			0.015	0.026	0.037	0.052
Hardscape Power Reduction (W/ft^2)			0.015	0.014	0.023	0.028
National Installed Wattage Reduction (MW)		**94.9**	0.1	6.0	88.9	0.0
Savings: Total National assume all areas @4,000 FLH (GWh/yr)		**379.8**	0.3	23.8	355.7	0.0
Savings: remove requirements for building service @10% (GWh/yr)		**38.0**	0.0	2.4	35.6	0.0
Savings: remove requirement for on building site @15% (GWh/yr)		**57.0**	0.0	3.6	53.4	0.0

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not increase the cost of outdoor lighting systems. The primary impact is lower lighting power allowances which reflect better LED performance without an increase in cost. This claim is in the original USDOE outdoor lighting power reduction proposal for 2024 IECC (CEPI-189-21) as follows:

This proposal is similar to an ANSI/ASHRAE/IES Standard 90.1 addendum. The 90.1 addendum met the Std. 90.1 scalar ratio. Exterior lighting fixture prices were surveyed. Prices were supplied by a third party and have remained relatively flat related over the last 5 years independent of the efficacy of the fixtures. Prices have remained flat while efficacy improved. Therefore, costs will not increase in response to this proposal.

This finding from DOE matched similar finding for the California lighting power reduction proposal. The California CASE team found that costs dropped slightly as the cost per Watt had stayed the same.:

For General Hardscape (Table 140.7-A), three different sites (large, medium, and small parking lot) were used to calculated realistic lighting layouts and determine an average watts per square foot that can be achieved per current design standards: IES RP-20-14 "Parking Lot," CALGreen, and

2016 Title 24, Part 6 Table 140.7-A. The proposed 2019 LPAs were the result of this analysis. The Statewide CASE Team then compared the 2016 4000K LED baseline effective area wattage allowance to the 3000K LEDs for the proposed measure. The unit cost per watt is the same for 2016 base case and the proposed 2019 Standards case. As explained in Section 4.3 above, the savings were achieved as a result of improved light loss factors, allowing a lower initial wattage to maintain the same light levels over time. To calculate first cost implications, the unit cost per watt for the LED luminaires in each lighting zone was multiplied by the total LPA in the base condition (2016), and in the proposed standards case. Since there is less wattage used in the 2019 LPA values, there is a lower cost of equipment.

Bibliography: ASHRAE 90.1-2019 Addenda:
Addendum AM:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_am_20220729.pdf

Addendum CB:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_cb_20220301.pdf

Addendum BG:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_bg_20220729.pdf

Codes and Standards Enhancement (CASE) Initiative 2019 California Building Energy Efficiency Standards: *Outdoor Lighting Power Allowances* – Final Report Addendum added in December 2017 https://title24stakeholders.com/wp-content/uploads/2018/01/2019-T24-CASE-Report_NR-Outdoor-Light-Sources_With-Addendum_December-2017.pdf

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Workgroup Recommendation

Proposal # 925

CED1-68-22

Proponents: Jonathan McHugh, representing McHugh Energy Consultants Inc. (jon@mchughenergy.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2 Lighting controls. Lighting systems ~~powered through the energy service~~ for the *building* or *building site* shall be provided with controls that comply with Sections C405.2.1 through C405.2.9 .

Exceptions: Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency lighting that is automatically off during normal operations.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2) of lighting in exit access components which are provided with fire alarm systems.

C405.2.7 Exterior lighting controls. Exterior lighting systems, serving the exterior lighting applications listed in Table C405.5.2(2) and Table C405.5.2(3), shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

C405.5.1 Total connected exterior building exterior lighting power. The total exterior connected lighting power shall be the total maximum rated wattage of all luminaires serving the exterior lighting applications listed in Table C405.5.2(2) and Table C405.5.2(3) ~~that is powered through the energy service for the building~~.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting that is automatically off during normal operations .
3. Exit signs.
4. Lighting for public streets, roadways, and highways, including lighting for driveway entrances occurring in the public right-of-way.

~~4~~ 5. Specialized signal, directional and marker lighting associated with transportation.

~~5~~ 6. Advertising signage or directional signage.

~~6~~ 7. Integral to equipment or instrumentation and installed by its manufacturer.

~~7~~ 8. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.

8 9. Athletic playing areas.

~~9~~ 10. Temporary lighting.

~~10~~ 11. Industrial production, material handling, transportation sites and associated storage areas.

~~11~~ 12. Theme elements in theme/amusement parks.

~~12~~ 13. Used to highlight features of art, public monuments and the national flag.

~~13~~ 14. Lighting for water features and swimming pools.

~~14~~ 15. Lighting controlled from within sleeping units and dwelling units, .

~~15~~ 16. Lighting of the exterior means of egress as required by the *International Building Code*.

C405.5.2 Exterior lighting power allowance. The exterior lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the building according to Table C405.5.2(1), unless otherwise specified by the code official.
2. For each exterior area that is to be illuminated by lighting ~~that is powered through the energy service for the building~~, determine the applicable area type from Table C405.5.2(2). For area types not listed and not exempted in Section C405.5.1, select the area type that most closely represents the proposed use of the area.
3. Determine the total area or length of each area type and multiply by the value for the area type in Table C405.5.2(2) to determine the lighting power (watts) allowed for each area type.
4. The total exterior lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.2(2), plus the watts from each area type.

Reason: This proposal seeks to require that all outdoor lighting on a building's site be subject to the control requirements and the wattage limitations regardless of whether the outdoor lighting is circuited through the building's electrical service. The developers of the ANSI/IES/ASHRAE 90.1 standard recognized that limiting long standing outdoor efficiency measures only to lighting powered through the building service, limits the amount of national energy savings associated with these efficiency measures.
Addenda AM, BG and CB to 90.1 have updated title purpose and scope to include sites that do not have buildings on them as long as these sites have newly installed equipment covered by the standard. The most notable newly covered equipment is outdoor lighting as might be found in commercial parking lots without an associated building, or common site lighting for malls where the lot is also not associated with any one building.

Addendum CB updates the purpose of Std 90.1-2002 (Section 1.1) as follows: "*To establish the minimum energy efficiency requirements of buildings other than low-rise residential buildings, and sites…"* The scope of Std 90.1-2022 (Section 2.1 (a) item 3 includes, *"new systems and equipment specifically identified in this standard that are part of a site."* Section 4.1.1.6 and Section 4.2.1.4 of ASHRAE 90.1-2022 also make clear that outdoor lighting not connected to a building are also in scope. In the past covered outdoor lighting was served though the building's electrical service. With adoption of Std 90.1 addendum AM exterior lighting power allowances in table 9.4.2-2 are changed from *"building exteriors"* to *"exterior applications"* and in addendum, BG, the scope in Section 9.1.1.1 is expanded *to "New Sites Systems and Equipment"*.

This proposal is taking a minimalist approach to only reversing the narrowing of scope of outdoor lighting controls and power allowances to that which is served through the building service.

A companion proposal will more closely align the 2024 IECC with ASHRAE 90.1-2022.

To provide a rough estimate savings we calculated the reduced lighting power associated with the proposed outdoor lighting reduction for parking areas and drives by lighting zone and multiplied this by a nationwide estimate of parking and drives. The nationwide estimate of parking and drives was calculated from published statewide area estimates of hardscape areas in California by lighting zone from the 2019 Title 24 outdoor lighting code change proposal and then expanding this to a national estimate by multiplying by 8 (the ratio of US population to California population).

As shown in the following table, and assuming that 10% of outdoor hardscape lighting that previously was exempted from regulation due to the building service limitation was newly regulated, the additional energy savings would be 38 Million kWh/yr for each year's new construction and parking lot renovations.

			Fraction of Total Area by LZ			
			0.1%	9.9%	90.0%	0.0%
Description	**CA**	**US**	**US LZ 1**	**US LZ 2**	**US LZ 3**	**US LZ 4**
Hardscape Lighting NC (M ft^2)	136	1,088	1.1	108	979	0
Hardscape Lighting Alteration (Mft^2)	401	3,208	3.2	318	2,887	0
2021 IECC (W/ft^2)			0.030	0.040	0.060	0.080
2024 Proposed IECC (W/ft^2)			0.015	0.026	0.037	0.052
Hardscape Power Reduction (W/ft^2)			0.015	0.014	0.023	0.028
National Installed Wattage Reduction (MW)		**94.9**	0.1	6.0	88.9	0.0
Savings: Total National assume all areas @4,000 FLH (GWh/yr)		**379.8**	0.3	23.8	355.7	0.0
Savings: remove requirements for building service @10% (GWh/yr)		**38.0**	0.0	2.4	35.6	0.0
Savings: remove requirement for on building site @15% (GWh/yr)		**57.0**	0.0	3.6	53.4	0.0

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not increase the cost of outdoor lighting systems. The primary impact is lower lighting power allowances which reflect better LED

performance without an increase in cost. This claim is in the original USDOE outdoor lighting power reduction proposal for 2024 IECC (CEPI-189-21) as follows:

This proposal is similar to an ANSI/ASHRAE/IES Standard 90.1 addendum. The 90.1 addendum met the Std. 90.1 scalar ratio. Exterior lighting fixture prices were surveyed. Prices were supplied by a third party and have remained relatively flat related over the last 5 years independent of the efficacy of the fixtures. Prices have remained flat while efficacy improved. Therefore, costs will not increase in response to this proposal.

This finding from DOE matched similar finding for the California lighting power reduction proposal. The California CASE team found that costs dropped slightly as the cost per Watt had stayed the same.:

For General Hardscape (Table 140.7-A), three different sites (large, medium, and small parking lot) were used to calculated realistic lighting layouts and determine an average watts per square foot that can be achieved per current design standards: IES RP-20-14 "Parking Lot," CALGreen, and 2016 Title 24, Part 6 Table 140.7-A. The proposed 2019 LPAs were the result of this analysis. The Statewide CASE Team then compared the 2016 4000K LED baseline effective area wattage allowance to the 3000K LEDs for the proposed measure. The unit cost per watt is the same for 2016 base case and the proposed 2019 Standards case. As explained in Section 4.3 above, the savings were achieved as a result of improved light loss factors, allowing a lower initial wattage to maintain the same light levels over time. To calculate first cost implications, the unit cost per watt for the LED luminaires in each lighting zone was multiplied by the total LPA in the base condition (2016), and in the proposed standards case. Since there is less wattage used in the 2019 LPA values, there is a lower cost of equipment.

Bibliography: ASHRAE 90.1-2019 Addenda:
Addendum AM:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_am_20220729.pdf

Addendum CB:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_cb_20220301.pdf

Addendum BG:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_bg_20220729.pdf

Codes and Standards Enhancement (CASE) Initiative 2019 California Building Energy Efficiency Standards: *Outdoor Lighting Power Allowances* – Final Report Addendum added in December 2017 https://title24stakeholders.com/wp-content/uploads/2018/01/2019-T24-CASE-Report_NR-Outdoor-Light-Sources_With-Addendum_December-2017.pdf

Workgroup Recommendation

Proposal # 935

CED1-69-22

Proponents: Jonathan McHugh, representing McHugh Energy Consultants Inc. (jon@mchughenergy.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2 Lighting controls. Lighting systems, ~~powered through the energy service for the building~~ shall be provided with controls that comply with Sections C405.2.1 through C405.2.9 .

Exceptions: Lighting controls are not required for the following:

1. Spaces where an automatic shutoff could endanger occupant safety or security.
2. Interior exit stairways, interior exit ramps and exit passageways.
3. Emergency lighting that is automatically off during normal operations.
4. Emergency lighting required by the *International Building Code* in exit access components which are not provided with fire alarm systems.
5. Up to 0.02 watts per square foot (0.06 W/m^2) of lighting in exit access components which are provided with fire alarm systems.

C405.2.7 ~~Exterior~~ Outdoor lighting controls. ~~Exterior lighting~~ Lighting systems , serving the outdoor lighting applications listed in Table C405.5.2(2) and Table C405.5.2(3), shall be provided with controls that comply with Sections C405.2.7.1 through C405.2.7.4.

Exceptions:

1. Lighting for covered vehicle entrances and exits from buildings and parking structures where required for eye adaptation.
2. Lighting controlled from within dwelling units.

C405.2.7.4 ~~Exterior~~ Outdoor lighting time-switch control function. Time-switch controls for ~~exterior~~ outdoor lighting shall comply with the following:

1. They shall have a clock capable of being programmed for not fewer than 7 days.
2. They shall be capable of being set for seven different day types per week.
3. They shall incorporate an automatic holiday setback feature.
4. They shall have program backup capabilities that prevent the loss of program and time settings for a period of not less than 10 hours in the event that power is interrupted.

C405.5.1 Total connected ~~exterior building exterior~~ outdoor lighting power. The total ~~exterior~~ connected outdoor lighting power shall be the total maximum rated wattage of all luminaires serving the outdoor lighting applications listed in Table C405.5.2(2) and Table C405.5.2(3) ~~lighting that is powered through the energy service for the building~~.

Exception: Lighting used for the following applications shall not be included.

1. Lighting *approved* because of safety considerations.
2. Emergency lighting that is automatically off during normal operations .
3. Exit signs.
4. Lighting for public streets, roadways, and highways, including lighting for driveway entrances occurring in the public right-of-way.

~~4~~ 5. Specialized signal, directional and marker lighting associated with transportation.

~~5~~ 6. Advertising signage or directional signage.

~~6~~ 7. Integral to equipment or instrumentation and installed by its manufacturer.

~~7~~ 8. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.

~~8~~ 9. Athletic playing areas.

~~9~~ 10. Temporary lighting.

~~10~~ 11. Industrial production, material handling, transportation sites and associated storage areas.

~~11~~ 12. Theme elements in theme/amusement parks.

~~12~~ 13. Used to highlight features of art, public monuments and the national flag.

~~13~~ 14. Lighting for water features and swimming pools.

~~14~~ 15. Lighting controlled from within sleeping units and dwelling units, .

~~15~~ 16. Lighting of the exterior means of egress as required by the *International Building Code*.

C405.5.2 ~~Exterior~~ Outdoor lighting power allowance. The ~~exterior~~ outdoor lighting power allowance (watts) is calculated as follows:

1. Determine the Lighting Zone (LZ) for the building according to Table C405.5.2(1), unless otherwise specified by the code official.
2. For each ~~exterior area that is to be illuminated by lighting that is powered through the energy service for the building~~, outdoor lighting application, determine the ~~applicable area~~ application type from Table C405.5.2(2). For ~~area~~ outdoor lighting applications ~~types~~ not listed in Table C405.5.2(2) and not exempted in Section C405.5.1, select the ~~area~~ application type that most closely represents the proposed use of the area.
3. Determine the total area or length of each ~~area~~ outdoor lighting application ~~type~~ and multiply by the value for the ~~area~~ application type in Table C405.5.2(2) to determine the lighting power (watts) allowed ~~for each area type.~~
4. The total ~~exterior~~ outdoor lighting power allowance (watts) is the sum of the base site allowance determined according to Table C405.5.2(2), plus the watts from each ~~area~~ application type.

C405.5.2.1 Additional ~~exterior~~ outdoor lighting power. Additional ~~exterior~~ outdoor lighting power allowances are available for the specific lighting applications listed in Table C405.5.2(3). These additional power allowances shall be used only for the luminaires serving these specific applications and shall not be used to increase any other lighting power allowance.

TABLE C405.5.2(2) LIGHTING POWER ALLOWANCES FOR ~~BUILDING EXTERIORS~~ OUTDOOR LIGHTING APPLICATIONS

1 foot = 304.8 mm, 1 watt per square foot = 10.76 watts per square meter. W = watts.

TABLE C405.5.2(3) INDIVIDUAL LIGHTING POWER ALLOWANCES FOR ~~BUILDING EXTERIORS~~ OUTDOOR LIGHTING APPLICATIONS

For SI: For SI: 1 watt per square foot = 10.76 watts per square meter.

W = watts.

Reason: This proposal seeks to harmonize IECC with scope of ASHRAE 90.1 which includes commercial construction not necessarily attached to any building. Examples include:

1. Commercial parking lots, some are on a site which used to have a building which was torn down and others are just stand-alone parking lots including municipal parking lots [C405.5, C405.2.7]

2. Common parking at retail malls. The common parking area is not associated with any one building and may not have the power supply being fed by any building as it is separately metered. [C405.5, C405.2.7]

3. Campus lighting served by a pedestal mounted meter and service: walkways, pedestrian tunnels, landscape lighting, etc. [Table C405.5.2(2)]

The developers of the ANSI/IES/ASHRAE 90.1 standard recognized that limiting long standing outdoor efficiency measures only to lighting powered through the building service, limits the amount of national energy savings associated with these efficiency measures.

Addenda AM, BG and CB to ASHRAE 90.1-2019 have updated title purpose and scope to include sites that do not have buildings on them as long as these sites have newly installed equipment covered by the standard. The most notable newly covered equipment is outdoor lighting as might be found in commercial parking lots without an associated building, or common site lighting for malls where the lot is also not associated with any one building.

Addendum CB updates the purpose of Std 90.1-2002 (Section 1.1) as follows: "*To establish the minimum energy efficiency requirements of buildings other than low-rise residential buildings, and sites…"* The scope of Std 90.1-2022 (Section 2.1 (a) item 3 includes, *"new systems and equipment specifically identified in this standard that are part of a site."* Section 4.1.1.6 and Section 4.2.1.4 of ASHRAE 90.1-2022 also make clear that outdoor lighting not connected to a building are also in scope. In the past covered outdoor lighting was served though the building's electrical service. With adoption of Std 90.1 addendum AM exterior lighting power allowances in table 9.4.2-2 are changed from *"building exteriors"* to *"exterior applications"* and in addendum, BG, the scope in Section 9.1.1.1 is expanded *to "New Sites Systems and Equipment"*.

This proposal contains the code language changes in Section C405 Electrical Power and Lighting Systems that would expand the scope of the outdoor lighting power and controls requirements so that jurisdiction could apply these energy savings measures to any commercial outdoor lighting system and not just outdoor lighting connected to or adjacent to buildings.

To provide a rough estimate savings we calculated the reduced lighting power associated with the proposed outdoor lighting reduction for parking areas and drives by lighting zone and multiplied this by a nationwide estimate of parking and drives. The nationwide estimate of parking and drives was calculated from published statewide area estimates of hardscape areas in California by lighting zone from the 2019 Title 24 outdoor lighting code change proposal and then expanding this to a national estimate by multiplying by 8 (the ratio of US population to California population).

As shown in the following table, and assuming that 10% of outdoor hardscape lighting that previously was exempted from regulation due to the building service limitation was newly regulated, the additional energy savings would be 38 Million kWh/yr. Assuming that an additional 15% of outdoor hardscape lighting is not on a building site, the additional nationwide energy savings is 57 Million kWh/yr. Thus the total impact of this proposal could be as high as 95 Million kWh/yr for each year's new construction and parking lot renovations.

			Fraction of Total Area by LZ			
			0.1%	9.9%	90.0%	0.0%
Description	**CA**	**US**	**US LZ 1**	**US LZ 2**	**US LZ 3**	**US LZ 4**
Hardscape Lighting NC (M ft^2)	136	1,088	1.1	108	979	0
Hardscape Lighting Alteration (Mft^2)	401	3,208	3.2	318	2,887	0
2021 IECC (W/ft^2)			0.030	0.040	0.060	0.080
2024 Proposed IECC (W/ft^2)			0.015	0.026	0.037	0.052
Hardscape Power Reduction (W/ft^2)			0.015	0.014	0.023	0.028
National Installed Wattage Reduction (MW)		**94.9**	0.1	6.0	88.9	0.0
Savings: Total National assume all areas @4,000 FLH (GWh/yr)		**379.8**	0.3	23.8	355.7	0.0
Savings: remove requirements for building service @10% (GWh/yr)		**38.0**	0.0	2.4	35.6	0.0
Savings: remove requirement for on building site @15% (GWh/yr)		**57.0**	0.0	3.6	53.4	0.0
Savings: remove both limitations @25% (GWh/yr)		**94.9**	0.1	6.0	88.9	0.0

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal will not increase the cost of outdoor lighting systems. The primary impact is lower lighting power allowances which reflect better LED performance without an increase in cost. This claim is in the original USDOE outdoor lighting power reduction proposal for 2024 IECC (CEPI-189-21) as follows:

This proposal is similar to an ANSI/ASHRAE/IES Standard 90.1 addendum. The 90.1 addendum met the Std. 90.1 scalar ratio. Exterior lighting fixture prices were surveyed. Prices were supplied by a third party and have remained relatively flat related over the last 5 years independent of the efficacy of the fixtures. Prices have remained flat while efficacy improved. Therefore, costs will not increase in response to this proposal.

This finding from DOE matched similar finding for the California lighting power reduction proposal. The California CASE team found that costs dropped slightly as the cost per Watt had stayed the same.:

For General Hardscape (Table 140.7-A), three different sites (large, medium, and small parking lot) were used to calculated realistic lighting layouts and determine an average watts per square foot that can be achieved per current design standards: IES RP-20-14 "Parking Lot," CALGreen, and 2016 Title 24, Part 6 Table 140.7-A. The proposed 2019 LPAs were the result of this analysis. The Statewide CASE Team then compared the 2016 4000K LED baseline effective area wattage allowance to the 3000K LEDs for the proposed measure. The unit cost per watt is the same for 2016 base case and the proposed 2019 Standards case. As explained in Section 4.3 above, the savings were achieved as a result of improved light loss factors, allowing a lower initial wattage to maintain the same light levels over time. To calculate first cost implications, the unit cost per watt for the LED luminaires in each lighting zone was multiplied by the total LPA in the base condition (2016), and in the proposed standards case. Since there is less wattage used in the 2019 LPA values, there is a lower cost of equipment.

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Addendum BG:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_bg_20220729.pdf

Codes and Standards Enhancement (CASE) Initiative 2019 California Building Energy Efficiency Standards: *Outdoor Lighting Power Allowances* – Final Report Addendum added in December 2017 https://title24stakeholders.com/wp-content/uploads/2018/01/2019-T24-CASE-Report_NR-Outdoor-Light-Sources_With-Addendum_December-2017.pdf

Workgroup Recommendation

CED1-70-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2.7.3 Lighting setback. Lighting that is not controlled in accordance with Section C405.2.7.2 shall comply with the following:

1. Be controlled so that the total wattage of such lighting is automatically reduced by not less than ~~50~~ 25 percent by selectively switching off or dimming luminaires at one of the following times:

   1.1. From not later than midnight to not earlier than 6 a.m.

   1.2. From not later than one hour after building or business closing to not earlier than one hour before building or business opening.

   1.3. During any time where activity has not been detected for 30 ~~15~~ minutes or more.

2. Luminaires serving outdoor parking areas and having a rated input wattage of greater than 40 watts and a mounting height of 24 feet (7315 mm) or less above the ground shall be controlled so that the total wattage of such lighting is automatically reduced by not less than ~~50~~ 25 percent during any time where activity has not been detected for 30 ~~15~~ minutes or more. Not more than 20 fixtures ~~1,500 watts of lighting power~~ shall be controlled together.

Reason: The current requirements need to be updated to account for lamp lumen depreciation, public safety in larger parking lots, and for periods of inclement weather.
In terms of safety, please see the following photo from https://www.ledsupply.com/blog/dimming-leds-guide-how-to-tell-if-your-lights-are-dimmable/

Please see how visibility is reduced at 25% and 50%. Add inclement weather (snow, rain, fog, etc). Then consider lumen depreciation (older fixtures at L80 or L70 with light outputs reduced by 20 to 30% at full power).

The proposed revisions will allow people more time to get from the building to a vehicle in a large parking lot in a safer manner while still saving energy.

In addition, under the previous version, where the rated input wattage threshold was greater than 75 Watts, that meant that no more than 19-20 fixtures could be controlled together (at 1,500 Watts). With the new threshold of 40 Watts, that means that 37 fixtures can be controlled together. This proposal takes out the 1500 Watts maximum and replaces it with a number of fixtures maximum.

Cost Impact: The code change proposal will increase the cost of construction.
Only for parking lots with 37 fixtures at 40.1 Watts each, for example, instead of controlling all fixtures with 1 control, an owner or designer will have to install two controls (for 18 fixtures and 19 fixtures to stay under the 20 maximum). Other very large parking lots may need to double the number of controls.

All other proposed changes only change the control parameters of the installed controls, with no effect on the costs.

Bibliography: https://www.energy.gov/sites/prod/files/2019/12/f69/ssl-connected-parking-lot-lighting_lda_dec2019.pdf

"The Rigors of Testing An unfiltered look at connected parking lot lighting systems",
LD+A Magazine, December 2019

Workgroup Recommendation

Proposal # 690

CED1-71-22

Proponents: Reid Hart, rep Pacific Northwest National Laboratory (reid.hart.pe@gmail.com); Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Ellen Franconi, representing Pacific Northwest National Laboratory (ellen.franconi@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2.9 Demand responsive lighting controls. *Buildings* shall have *demand responsive controls* complying with C405.2.9.1 for not less than 75 percent of the building area, excluding dwelling and sleeping units, to reduce lighting power during peak periods ~~that are capable of automatically reducing general lighting power not less than 15 percent in response to a demand response signal.~~

Exceptions:

1. Buildings with less than ~~4,000 watts of combined installed general lighting power in spaces that have more than 0.5 W/ft² (5.38 W/m²) of general lighting power.~~ 5000 square feet of floor area.
2. *Buildings* where a *demand response signal* is ~~programs are~~ not available from a controlling entity, such as a utility or service operator.
3. A-1, H, I-2 , ~~and~~ I-3 , and U occupancies and Parking Garages
4. Buildings that comply with Load Management measure G01 in Section C406.3.2

Add new text as follows:

C405.2.9.1 Demand responsive controls function. Demand responsive lighting controls shall function as follows:

1. When a peak period begins, all lights which are operating at 20 percent or more of full power shall be dimmed below the controlled level based on high end trim and daylight responsive controls.
2. Dimming shall be gradual and continuous over a period of not longer than 15 minutes until the lights are using no more than 80 percent of their initial power or light level at the beginning of the peak period
3. During the peak period, daylight responsive controls shall continue to function, with an illuminance setpoint that is reduced by at least 20 percent
4. When the peak period is over, all lights which were not overridden off by manual controls and occupant sensors shall gradually return to their initial power at the beginning of the peak period, and all daylight responsive controls shall return to their initial setpoint.

Exception: Warehouse and retail storage building areas shall be permitted to switch off at least 25 percent of lighting power rather than dimming.

Revise as follows:

C406.3.2 G01 Lighting Load Management. ~~Luminaires~~ The lighting system shall have dimming capability and automatic ~~load management~~ *demand responsive controls* that shall gradually reduce *general lighting* power during peak periods in compliance with Section C405.2.9.1~~. The load management controls shall reduce lighting power~~ in 75 percent of the building area . Achieved credits shall be determined as follows:

1. Where a *demand response signal* is not available from a controlling entity for the *building* or the building meets exceptions to requirements in Section C405.2.9, the full G01 credits in Section C406.3 shall be achieved.
2. Where a building does not qualify under item 1 above, 50 percent of the G01 credits in Section C406.3 shall be achieved.
3. Where less than 75 percent, but at least 50 percent of the project area ~~*general lighting*~~ is controlled, the G01 credits ~~from Tables C406.3~~ achieved in items 1 or 2 above shall be prorated as follows:

[building area with lighting load management, %] x [table credits for C406.3.2] / 75% **(Equation 4-29)**

Exception: Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25 percent of lighting power in 75 percent of the building area without dimming, or as adjusted by Equation 4-29.

Reason: Providing an exception to lighting demand response in Section C405.2.9 is appropriate where buildings comply with energy credit G01 in Section C406.3.3. Measure G01 is not restricted to only a demand responsive signal activation, but can work with local building demand monitoring or a scheduled peak approach in smaller buildings. Including an exception for C405.2.9 also avoids the perception that a building must comply with both (possibly conflicting) requirements, as measures in C406 are chosen by the building designer to meet a required credit level.

To coordinate with C405.2.9 requirements, where a demand response signal is available and the building is not exempt, the credits are reduced by half.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The measures in C406 are selected by the designer and not required for all buildings, so there is not a direct cost requirement.

Workgroup Recommendation

Proposal # 663

CED1-72-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2.9 Demand responsive lighting controls. *Buildings* shall have controls that are capable of automatically reducing general lighting power not less than 15 percent in response to a demand response signal.

Exceptions:

1. Buildings with less than 4,000 watts of combined installed general lighting power in spaces that have more than 0.5 W/ft^2 (5.38 W/m^2) of general lighting power.
2. *Buildings* where demand response programs are not available.
3. I-2 and I-3 occupancies.
4. *Buildings* with less than 5,000 square feet (464 m^2) of *conditioned floor area*.

Reason: As lighting power densities and allowances are lowered due to increased efficiency of LED lamp technology, the reductions achieved from reducing lighting power by 15% are decreasing.
A review of the proposed updates to the lighting power allowances in Table C405.3.2(1), in the building area method, shows that the range of maximum lighting power densities for buildings other than parking garages ranges from 0.43 to 0.83 W/ft^2.

For a 5,000 square foot building, the total connected lighting power ranges from 2,150 Watts to 4,150 Watts. With all of the requirements for lighting controls, it is very likely that the maximum operational lighting power will be 90% or less of the connected lighting power.

At 90%, the maximum operating lighting power ranges from 1,935 Watts to 3,735 Watts. Reducing this lighting by 15% will yield a maximum of 290 to 560 Watts. With utility demand response programs, there may be a minimum requirement for the amount of reductions needed to qualify for the demand response program (e.g., 5 kW, 5%of total building demand, etc.).

Adding this new exception will help to provide clarity and keep the requirement for larger buildings with larger potential for significant demand response.

Cost Impact: The code change proposal will decrease the cost of construction.
This will decrease the cost of construction for buildings that have less than 5,000 square feet of conditioned floor area. It will have no impact on construction costs for buildings that have 5,000 square feet or more conditioned floor area.

Workgroup Recommendation

Proposal # 748

CED1-73-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.2.9 Demand responsive lighting controls. *Buildings* shall have controls that are capable of automatically reducing general lighting power not less than 15 percent in response to a demand response signal.

Exceptions:

1. Buildings with less than 4,000 watts of combined installed general lighting power in spaces that have more than 0.5 W/ft^2 (5.38 W/m^2) of general lighting power.
2. *Buildings* where demand response programs are not available.
3. I-2 and I-3 occupancies.
4. <u>R-2 occupancies.</u>

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	13	7	11	6	8	9	6	1	24	8	9	30	15	5	32	28	31	36
E03	Envelope leak reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	7	7	9	65	16	1	73	43	52	26
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	1	7	7	6	8
E05	Add Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	1	14	12	13	13
E06	Improve Fenestration	C406.2.1.6	7	7	4	6	9	11	13	3	1	22	5	10	27	18	7	41	33	22	21
H01	HVAC Performance	C406.2.2.1	20	19	16	17	14	13	11	11	5	13	10	8	15	12	7	18	14	17	19
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	3	1	1	6	2	3	10	5	2	14	10	13	16
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	3	1	1	1	1	1	1	1	1	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	10	8	22	20	25	16	17	32	21	24	17	23	27	16	21	24	18	18
H05	DOAS/fan control	C406.2.2.5	32	31	27	28	23	23	28	21	12	42	24	24	56	36	19	73	54	70	79
W01	SHW preheat recovery	C406.2.3.1a	61	63	74	74	85	88	101	100	121	103	109	122	102	111	130	93	106	99	96
W02	Heat pump water heater	C406.2.3.1b	50	52	62	61	72	74	86	85	104	88	94	106	88	96	112	81	92	87	84
W03	Efficient gas water heater	C406.2.3.1c	38	39	46	46	53	55	63	62	76	64	68	76	64	69	81	58	66	62	60
W04	SHW pipe insulation	C406.2.3.2	7	7	8	7	8	8	8	9	10	8	9	9	7	8	9	6	7	6	6
W05	Point of use water heaters	C406.2.3.3a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3b	3	3	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	3	2
W07	SHW heat trace system	C406.2.3.3c	12	12	13	13	14	15	15	15	18	14	15	16	13	14	16	11	13	11	10
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	45	46	55	54	63	65	74	73	89	75	80	89	74	81	95	68	77	72	70
W10	Shower heat recovery	C406.2.3.6	15	16	19	19	22	23	26	26	32	27	29	32	27	29	34	25	28	27	26
P01	Energy monitoring	C406.2.4	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
X01	Demand Response Lighting Controls (R-2)	C406.2.X	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	4	4	4	4	3	4	3	2	3	2	1	1	2	1	1	1	1
L04	Increase daylight area	C406.2.5.4	5	5	5	5	5	5	4	4	4	4	4	3	3	4	3	2	3	3	2
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	4	6	8	3	5	4	3
L06	Light power reduction	C406.2.5.7	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	4	5	5	4	4	5	4	4	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	15	15	17	16	17	18	17	18	20	16	17	18	15	16	18	13	15	13	12
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	2	2	1	2	2	1	1	2	1	3	2	3	3

a. "x" indicates credit is not available for that measure.

Add new text as follows:

C406.2.X **Demand Responsive Lighting Controls for R-2 Occupancies.** R-2 occupancies shall have controls that are capable of automatically reducing general lighting power not less than 15 percent in response to a demand response signal.

Reason: This measure should be addressed through utility programs to ensure that the demand response controls are fully compatible with the programs' requirements at the time of program implementation. Demand response programs are not available universally and not all renters or owners will decide to opt in to participate where these programs are offered – in these cases the more expensive controls will become a "stranded asset." The proposed resolution – an exception for R-2 uses - acknowledges the variety of needs and desires of the residents of R-2 occupancies. This proposal also adds demand response controls as an optional practice in Section C406 for credit.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction for R-2 occupancies.

Workgroup Recommendation

Proposal # 779

CED1-74-22

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.3.1 Total connected interior lighting power. The total connected interior lighting power shall be determined in accordance with Equation 4-12.

$$TCLP = [LVL + BLL + LED + TRK + \text{Other}] \quad \textbf{(Equation 4-12)}$$

where:

TCLP = Total connected lighting power (watts).

LVL = For luminaires with lamps connected directly to building power, such as line voltage lamps, the rated wattage of the lamp.

BLL = For luminaires incorporating a ballast or transformer, the rated input wattage of the ballast or transformer when operating that lamp.

LED = For light-emitting diode luminaires with either integral or remote drivers, the rated wattage of the luminaire.

TRK = For lighting track, cable conductor, rail conductor, and plug-in busway systems that allow the addition and relocation of luminaires without rewiring, the wattage shall be one of the following:

1. The specified wattage of the luminaires, but not less than 8 W per linear foot (25 W/lin m).
2. The wattage limit of the permanent current-limiting devices protecting the system.
3. The wattage limit of the transformer supplying the system.

Other = The wattage of all other luminaires and lighting sources not covered previously and associated with interior lighting verified by data supplied by the manufacturer or other *approved* sources.

The connected power associated with the following lighting equipment and applications is not included in calculating total connected lighting power.

1. Emergency lighting that is automatically off during normal operations.
2. Lighting in spaces specifically designed for use by occupants with special lighting needs, including those with visual impairment and other medical and age-related issues.
3. Casino gaming areas.
4. Mirror lighting in makeup or dressing areas used for video broadcasting, video or film recording, or live theatrical and music performance.
5. Task lighting for medical and dental purposes that is in addition to general lighting.
6. Display lighting for exhibits in galleries, museums and monuments that is in addition to general lighting.
7. Lighting in any location that is specifically used for video broadcasting, video or film recording, or live theatrical and music performance.
8. Lighting for photographic processes.
9. Lighting integral to equipment or instrumentation and installed by the manufacturer.
10. Task lighting for plant growth or maintenance.
11. Advertising signage or directional signage.
12. Lighting for food warming.
13. Lighting equipment that is for sale.
14. Lighting demonstration equipment in lighting education facilities.
15. Lighting approved because of safety considerations.
16. Lighting in retail display windows, provided that the display area is enclosed by ceiling-height partitions.
17. Furniture-mounted supplemental task lighting that is controlled by automatic shutoff.
18. Exit signs.
19. Antimicrobial lighting used for the sole purpose of disinfecting a space.

20. Lighting in sleeping units and dwelling units.

21. Lighting for eye adaptation at vehicle entries in parking garages.

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Atrium	
Less than 40 feet in height	0.41
Greater than 40 feet in height	0.51
Audience seating area	
In an auditorium	0.57
In a gymnasium	0.23
In a motion picture theater	0.27
In a penitentiary	0.56
In a performing arts theater	1.09
In a religious building	0.72
In a sports arena	0.27
Otherwise	0.33
Banking activity area	0.56
Breakroom (See Lounge/breakroom)	
Classroom/lecture hall/training room	
In a penitentiary	0.74
Otherwise	0.72
Computer room, data center	0.75
Conference/meeting/multipurpose room	0.88
Copy/print room	0.56
Corridor	
In a facility for the visually impaired (and not used primarily by the staff)[b]	0.71
In a hospital	0.61
Otherwise	0.44
Courtroom	1.08
Dining area	
In bar/lounge or leisure dining	0.76
In cafeteria or fast food dining	0.36
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.22
In family dining	0.52
In a penitentiary	0.35
Otherwise	0.42
Electrical/mechanical room	0.71
Emergency vehicle garage	0.51
Food preparation area	1.19
Laboratory	
In or as a classroom	1.05
Otherwise	1.21
Laundry/washing area	0.51
Loading dock, interior	0.88
Lobby	
For an elevator	0.64
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.44
In a hotel	0.48
In a motion picture theater	0.20

In a performing arts theater	1.21
Otherwise	0.80
Locker room	0.43
Lounge/breakroom	
In a healthcare facility	0.77
Mother's Wellness Room	0.68
Otherwise	0.55
Office	
Enclosed	0.73
Open plan	0.56
~~Parking area daylight transition zone~~	~~1.06~~
Parking area, interior	0.11
Pharmacy area	1.59
Restroom	
In a facility for the visually impaired (and not used primarily by the staff[b]	0.96
Otherwise	0.74
Sales area	0.85
Seating area, general	0.21
Security screening general areas	0.64
Security screening in transportation facilities	0.93
Security screening transportation waiting area	0.56
Stairwell	0.47
Storage room	0.35
Vehicular maintenance area	0.59
Workshop	1.17
BUILDING TYPE SPECIFIC SPACE TYPES[a]	**LPD (watts/ft²)**
Automotive (see Vehicular maintenance area)	
Convention Center—exhibit space	0.50
Facility for the visually impaired[b]	
In a chapel (and not used primarily by the staff)	0.58
In a recreation room (and not used primarily by the staff)	1.20
Gaming establishments	
High limits game	1.68
Slots	0.54
Sportsbook	0.82
Table games	1.09
Gymnasium/fitness center	
In an exercise area	0.82
In a playing area	0.82
Healthcare facility	
In an exam/treatment room	1.33
In an imaging room	0.94
In a medical supply room	0.56
In a nursery	0.87
In a nurse's station	1.07
In an operating room	2.26
In a physical therapy room	0.82

In a recovery room	1.18
In a telemedicine room	1.44
Library	
In a reading area	0.86
In the stacks	1.18
Manufacturing facility	
In a detailed manufacturing area	0.75
In an equipment room	0.73
In an extra-high-bay area (greater than 50 feet floor-to-ceiling height)	1.36
In a high-bay area (25–50 feet floor-to-ceiling height)	1.24
In a low-bay area (less than 25 feet floor-to-ceiling height)	0.86
Museum	
In a general exhibition area	0.31
In a restoration room	1.24
Performing arts theater—dressing room	0.39
Post office—sorting area	0.71
Religious buildings	
In a fellowship hall	0.50
In a worship/pulpit/choir area	0.75
Retail facilities	
In a dressing/fitting room	0.45
Hair salon	0.65
Nail salon	0.75
In a mall concourse	0.57
Massage space	0.81
Sports arena—playing area	
For a Class I facility [c]	2.86
For a Class II facility[d]	1.98
For a Class III facility[e]	1.29
For a Class IV facility[f]	0.86
Sports arena-Pools	
For a Class I facility	2.20
For a Class II facility	1.47
For a Class III facility	0.99
For a Class IV facility	0.59
Transportation facility	
Airport hanger	1.36
At a terminal ticket counter	0.40
In a baggage/carousel area	0.28
Passenger loading area	0.71
In an airport concourse	0.49
Warehouse—storage area	
For medium to bulky, palletized items	0.33
For smaller, hand-carried items	0.69

For SI: 1 foot = 304.8 mm, 1 watt per square foot = 10.76 watts per square meter.

a. In cases where both a common space type and a building area specific space type are listed, the building area specific space type shall apply.

b. A ‘Facility for the Visually Impaired’ is a facility that is licensed or will be licensed by local or state authorities for senior long-term care, adult daycare, senior support or people with special visual needs.

c. Class I facilities consist of professional facilities; and semiprofessional, collegiate, or club facilities with seating for 5,000 or more spectators.

d. Class II facilities consist of collegiate and semiprofessional facilities with seating for fewer than 5,000 spectators; club facilities with seating for between 2,000 and 5,000 spectators; and amateur league and high school facilities with seating for more than 2,000 spectators.

e. Class III facilities consist of club, amateur league and high school facilities with seating for 2,000 or fewer spectators.

f. Class IV facilities consist of elementary school and recreational facilities; and amateur league and high school facilities without provision for spectators.

Reason: The proposed revision will save energy.
Daylight transition zones are critical for safety, by allowing drivers entering a parking garage in the middle of the day to see into the dark interior of the garage before they enter it, and avoid collisions with people or vehicles who may be in their way.

These daylight transition zones can be extremely energy intensive and extend quite far into the garage where there is no vehicular access control (e.g. parking access gate) and where there is a straight entry allowing cars to speed into the garage. On the other hand, daylight transition zones can also be non-existent where there is controlled access at the building perimeter.

The determination of how large the zone should be and how much light to provide is quite confusing even for experts. Under these circumstances, providing a tradable space type allowance amounts to a huge loophole for people who wish to exploit it. It would be extremely easy to expand the size of the zone to get a greater wattage allowance, and provide minimal additional lighting. This could potentially add thousands of watts of additional lighting allowance to each project.

Maintaining an exception (as under current code) allows garages which require large amounts of daylight transition zone lighting to meet this need, while preventing gaming. On the whole this will save energy, improve safety, and simplify compliance.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal would retain the exception that currently exists in the 2021 code.

Workgroup Recommendation

Proposal # 700

CED1-75-22

Proponents: Glenn Heinmiller, representing IALD (glenn@lampartners.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C405.3.2(2) INTERIOR LIGHTING POWER ALLOWANCES: SPACE-BY-SPACE METHOD

Portions of table not shown remain unchanged.

COMMON SPACE TYPES[a]	LPD (watts/ft²)
Lobby	
For an elevator	0.64
In a facility for the visually impaired (and not used primarily by the staff)[b]	1.44
~~In a hotel~~	~~0.48~~
In a motion picture theater	0.20
In a performing arts theater	1.21
Otherwise	0.80

Reason: The proposed lighting power allowance for Hotel Lobbies is insufficient. Hotel Lobby allowances, before 2018, tracked much more closely to the allowance for Lobby, Otherwise. Eliminating the space type for Hotel Lobbies will mean that designers will use the allowance from the Lobby, Otherwise space type for Hotel Lobbies. Hotel lobbies are no less complex a design than lobbies for corporate buildings or high-rise residential buildings. Often, hotel lobby designs are more complex, to support the hospitality setting.

ASHRAE/IES 90.1	Year				90.1 Add. ba
	2010	2013	2016	2019	2022
Hotel Lobby	0.90	1.06	1.06	0.51	0.48
Lobbies, Otherwise	0.90	0.90	1.00	0.84	0.80

IECC	Year				PC Draft#1
	* 2012	2015	2018	2021	2024
Hotel Lobby	2.10	1.06	1.06	0.51	0.48
Lobbies, Otherwise	1.10	0.90	1.00	0.84	0.80

* No decorative allowance

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This lighting power allowance adjustment does not require the use of more expensive lighting equipment

Workgroup Recommendation

Proposal # 734

CED1-76-22

Proponents: Jonathan McHugh, representing McHugh Energy Consultants Inc. (jon@mchughenergy.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.3.2.2.1 Additional interior lighting power. Where using the Space-by-Space Method, an increase in the interior lighting power allowance is permitted for specific lighting functions. Additional power shall be permitted only where the specified lighting is installed and controlled in accordance with Section C405.2.5. ~~This~~ These additional power allowances shall be used only for the ~~specified~~ luminaires serving the specific lighting function and shall not be used for any other purpose. An increase in the interior lighting power allowance is permitted in the following cases:

1. For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power allowance shall be the connected lighting power of the luminaires specifically highlighting merchandise, calculated in accordance with Equation 4-12, or the additional power allowance ~~determined~~ calculated in accordance with Equation 4-13, whichever is less.

$$\text{Additional lighting power allowance} = 750\text{ W} + (\text{Retail Area 1} \times 0.40\text{ W/ft}^2) + (\text{Retail Area 2} \times 0.40\text{ W/ft}^2) + (\text{Retail Area 3} \times 0.70\text{ W/ft}^2) + (\text{Retail Area 4} \times 1.00\text{ W/ft}^2)$$

For SI units:

$$\text{Additional lighting power allowance} = 750\text{ W} + (\text{Retail Area 1} \times 4.3\text{ W/m}^2) + (\text{Retail Area 2} \times 4.3\text{ W/m}^2) + (\text{Retail Area 3} \times 7.5\text{ W/m}^2) + (\text{Retail Area 4} \times 10.8\text{ W/m}^2)$$

where: **(Equation 4-13)**

Retail Area 1 = The floor area for all products not listed in Retail Area 2, 3 or 4.

Retail Area 2 = The floor area used for the sale of vehicles, sporting goods and small electronics.

Retail Area 3 = The floor area used for the sale of furniture, clothing, cosmetics and artwork.

Retail Area 4 = The floor area used for the sale of jewelry, crystal and china.

Exception: Other merchandise categories are permitted to be included in Retail Areas 2 through 4, provided that justification documenting the need for additional lighting power based on visual inspection, contrast or other critical display is approved by the code official.

2. For spaces in which lighting is specified to be installed in addition to the general lighting for the purpose of decorative appearance or for highlighting art or exhibits, ~~provided that~~ the additional lighting power allowance for that space shall be ~~not more than~~ the smallest wattage of the following:

2.1 0.66 W/ft^2 (7.1W/m^2) in lobbies, ~~and~~

2.2 ~~not more than~~ 0.55 W/ft^2 (5.9 W/m^2) in other spaces~~.~~ , or

2,3 the connected lighting power of the luminaires specifically for the purpose of decorative appearance or for highlighting art or exhibits, calculated according to Equation 4-12.

Reason: The purpose of this proposal is to clarify what is the lighting power allowance associated with additional lighting allowed for retail display lighting and decorative lighting. The maximum possible additional lighting allowances are very large; they are equivalent in magnitude to the general lighting allowances and approximately allow for doubling the installed lighting power when these additional allowances are fully utilized.
The current wording has this phrase: “This additional power shall be used only for the specified luminaires and shall not be used for any other purpose.” This means that one cannot install additional general lighting above what is allowed by the general lighting LPD and use the additional lighting power allowance.
The definition of what is the maximum allowed total lighting power allowance has become controversial with the lighting control credit for installing reduced lighting power below the allowed lighting power [see Section C406.2.5.6 L06 Reduced Lighting Power]. One can receive credits for up to a 20% in the base allowance. Common practice is to not install decorative lighting in many spaces. If it is not clear that decorative lighting is not able to claim the difference between the maximum allowed and what is installed, one could have a 50% reduction in LPD without actually changing common practice for many interior lighting designs. This is not the intent of the reduced lighting power credit.
The current draft of Section C406.2.5.6 L06 Reduced Lighting Power only compares the net lighting power and the net allowances not including the additional lighting power. In this situation the clarification is not very important. However there has been an interest in reverting the reduced lighting power credit to the format in the 2021 IECC Section C406.3. In the 2021 version of the IECC, the total lighting power is compared to the total lighting power allowances including the additional lighting power allowances.
The aim of this proposal is to make clear that the additional lighting power allowances is the lesser of what additional lighting is installed and the allowances which are a product of a lighting power density and the area for the allowance. As a result there is no reduction associated with using less additional lighting power only reductions allocated to installing less general lighting power than the general lighting power allowances.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal has no impact on the cost of the standard; it is only clarifying what is already intended for the calculation of additional lighting power allowances.

Workgroup Recommendation

Proposal # 851

CED1-77-22

Proponents: Bryan Holland, representing National Electrical Manufacturers Association (NEMA) (bryan.holland@nema.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.8 Electric motors. Electric motors shall meet the minimum efficiency requirements of Tables C405.8(1) through C405.8(4) when tested and rated in accordance with the DOE 10 CFR 431. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the motor manufacturer.

Exception: The standards in this section shall not apply to the following exempt electric motors:

1. Air-over electric motors.
2. Component sets of an electric motor.
3. Liquid-cooled electric motors.
4. Submersible electric motors.
5. Inverter-only electric motors.
6. Definite purpose machines covered in ANSI/NEMA MG 1-2021, Part 18.

NEMA

National Electrical Manufacturers Association
1300 North 17th Street, Suite 900
Rosslyn, VA 22209

MG1—~~2016~~ 2021: Motors and Generators

Reason: The coverage of motors in this section as written is still too broad. In accordance with the DoE Small Motor Rule, efficiency regulations apply only to open drip-proof single- and three-phase general purpose motors and exclude definite purpose motors such as jet pump, belted fan, submersible, sump pump motors, etc. The full complement of definite purpose machines can be found in ANSI/NEMA MG 1-2021, Part 18.

Cost Impact: The code change proposal will decrease the cost of construction.
The current requirements would potentially increase the cost of manufacturing of definite purpose machines to make them more efficient than what Federal regulations presently require, thus increasing the cost of construction. This new exception will prevent this increased cost of construction.

Bibliography: I. ANSI/NEMA MG 1-2021
II. 10 CFR Part 431

Workgroup Recommendation

Proposal # 796

CED1-78-22

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.9~~.1~~ Data Center<u>s and Computer Rooms</u> ~~Systems~~. ~~Transformers, uninterruptable power supplies, motors and electrical power processing equipment in data center systems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.~~

Add new text as follows:

<u>**C405.9.1** **Data centers.** Transformers, uninterruptable power supplies, motors and electrical power processing equipment in *data centers* shall comply with Section 8 of ASHRAE 90.4 in addition to this code.</u>

<u>**C405.9.2** **Computer Rooms.** Uninterruptable power supplies in *computer rooms* shall comply with the requirements in Tables 8.5 and 8.6 of ASHRAE 90.4 in addition to this code.</u>
<u>Exception: AC-output UPS that utilizes standardized NEMA 1-15P or NEMA 5-15P input plug, as specified in ANSI/NEMA WD-6-2016.</u>

Add new standard(s) as follows:

ANSI

American National Standards Institute
25 West 43rd Street, 4th Floor
New York, NY 10036

<u>WD-6-2016</u>	<u>Wiring Devices - Dimensional Specifications</u> <u>Section C405.9.2</u>

Reason: There are no standards for Uninterruptible Power Supply (UPS) systems in computer rooms like there are for Data Centers. This code proposal introduces minimum UPS efficiency aligned with efficient levels in ASHRAE 90.4. Therefore, the UPS requirements for computer rooms and data centers are equivalent. A UPS with a NEMA 1-15P or NEMA 5-15P plug are exempt from this requirement because minimum standards for these devices are already covered by DOE.
A similar code provision was adopted in both the 2022 Title 24 updates as well as the 2021 Washington State Energy Code (WSEC) and was found to be a cost-effective approach even though the proposal targeted ENERGY STAR efficiency thresholds.

Cost Impact: The code change proposal will increase the cost of construction.
This proposal is a compromise from an earlier proposal that required alignment with ENERGY STAR specifications. The cost data from that proposal can be used here as it was found to be a cost-effective approach.

Incremental costs were found to be $112/kW for high efficiency UPS systems, and were converted to $/sqft based on a 500sqft room (the threshold for which a computer room does not qualify as a data center). Costs were found to be estimated at $0.22/sqft and detailed cost information obtained through Final CASE report for 2022 Title 24 attached to this proposal and accessed publicly here:
https://title24stakeholders.com/wpcontent/uploads/2021/03/NR-Computer-Room-Efficiency-Final-CASE-Report_Statewide-CASETeam_updated.pdf

Bibliography: ENERGY STAR Program Requirements for Uninterruptible Power Supplies (UPSs) Test Method - Rev. Dec-2017

Workgroup Recommendation

Proposal # 698

CED1-79-22

Proponents: Bryan Holland, representing National Electrical Manufacturers Association (NEMA) (bryan.holland@nema.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.9 Data Centers ~~systems~~ and Computer Rooms. ~~Transformers, uninterruptible power supplies, motors and electrical power processing equipment in data centersystems shall comply with Section 8 of ASHRAE 90.4 in addition to this code.~~ Electrical equipment in data centers and computer rooms shall comply with this section.

Add new text as follows:

C405.9.1 Data Centers.. Transformers, uninterruptible power supplies, motors and electrical power processing equipment in data centers shall comply with Section 8 of ASHRAE 90.4 in addition to this code.

C405.9.2 Computer Rooms. Un interruptible power supplies in computer rooms shall comply with the requirements in Tables 8.5 and 8.6 of ASHRAE 90.4.

Reason: This code change proposal aligns the efficiency requirements for UPS installed in computer rooms with the efficiency requirements for this same equipment installed in data centers. This will reduce the energy consumption of UPS in computer rooms while improving the overall energy efficiency of the occupancy. Computer rooms and data centers are similarly aligned in the IECC-C in Table C405.3.2(2) when calculating interior lighting power allowance.

Cost Impact: The code change proposal will increase the cost of construction.
The code change proposal will increase the cost of construction for occupancies with computer rooms that include uninterruptible power supplies by requiring this equipment to comply with applicable criteria in Section 8 of ASHRAE 90.4 in addition to the IECC-C.

Workgroup Recommendation

Proposal # 797

CED1-80-22

Proponents: Jonathan McHugh, representing McHugh Energy Consultants Inc. (jon@mchughenergy.com); Reid Hart, representing Pacific Northwest National Laboratory (reid.hart@pnnl.gov); Michael Myer, representing Pacific Northwest National Laboratory (michael.myer@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																	
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting ~~dimming & tuning~~ _high end trim_	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

a. "x" indicates credit is not available for that measure.

TABLE 406.2(2) BASE ENERGY CREDITS FOR GROUP I-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	**Energy Credit Measure**	**Section**	**Climate Zone**																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting ~~dimming & tuning~~ *high-end trim*	C406.2.5.2	5	5	5	5	5	6	5	6	6	5	6	6	5	5	5	4	4	3	2

a. "x" indicates credit is not available for that measure.

TABLE 406.2(3) BASE ENERGY CREDITS FOR GROUP R-1 OCCUPANICES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting *high-end trim* ~~dimming & tuning~~	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1

a. "x" indicates credit is not available for that measure.

TABLE 406.2(4) BASE ENERGY CREDITS FOR GROUP B OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting *high-end trim* ~~dimming & tuning~~	C406.2.5.2	5	5	6	6	6	6	6	6	7	6	6	6	5	5	6	4	5	3	2

a. "x" indicates measure is not available for building occupancy in that climate zone.

TABLE 406.2(5) BASE ENERGY CREDITS FOR GROUP A-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting *high-end trim* ~~dimming & tuning~~	C406.2.5.2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	0

a. "x" indicates measure is not available for that measure.

TABLE 406.2(6) BASE ENERGY CREDITS FOR GROUP M OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting *high-end trim* ~~dimming & tuning~~	C406.2.5.2	9	9	11	10	12	13	11	13	15	9	12	11	7	9	10	5	7	5	3

a. "x" indicates credit is not available for that measure.

TABLE 406.2(7) BASE ENERGY CREDITS FOR GROUP E OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting *high-end trim* ~~dimming & tuning~~	C406.2.5.2	5	5	5	6	6	6	5	6	7	6	6	6	5	5	6	4	4	3	2

a. "x" indicates measure is not available for that measure.

TABLE 406.2(8) BASE ENERGY CREDITS FOR GROUP S-1 AND S-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	**Energy Credit Measure**	**Section**	**Climate Zone**																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting _high-end trim_ ~~dimming & tuning~~	C406.2.5.2	10	10	12	11	12	14	9	12	14	6	9	9	3	6	9	3	5	3	2

a. "x" indicates measure is not available for building occupancy in that climate zone.

TABLE 406.2(9) BASE ENERGY CREDITS FOR OTHER OCCUPANCIES[a,b]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
L02	Lighting *high-end trim* ~~dimming & tuning~~	C406.2.5.2	5	5	5	5	6	6	5	6	7	5	5	5	4	4	5	3	4	3	2

a. "x" indicates measure is not available for that measure.

b. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.2.5.2 L02 ~~Enhanced digital lighting controls~~ *High-end trim* lighting controls. Measure credits shall be achieved where general lighting in no less than 50 percent of the gross floor area within the project shall ~~comply~~ be controlled with the following *high-end trim* requirements of this section.

1. *High-end trim* shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by at least 15 percent from full output.
2. *High-end trim* controls are located for *ready access* only by authorized personnel.
3. The average maximum light output or power of the controlled lighting without *high-end trim* and with *high-end trim* shall be documented in accordance with Section C408.3.1.4 . to verify reduction of light output or power by at least 15 percent from *high-end trim*.

~~1. Lighting controls function. Interior general lighting shall be located, scheduled and operated in accordance with Section C405.2 and shall be configured with the following enhanced control functions:~~

~~1.1. Luminaires shall be configured for continuous dimming.~~

~~1.2. Each luminaire shall be individually addressed.~~

~~**Exceptions:**~~

~~1. Multiple luminaires mounted on no more than 12 linear feet (3.66 m) of a single lighting track and addressed as a single luminaire.~~

~~2. Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet (3.66 m).~~

~~1.3. No more than eight luminaires within a daylight zone are permitted to be controlled by a *single daylight responsive control*.~~

~~2 Luminaires shall be controlled by a digital control system configured with the following capabilities:~~

~~2.1. Sheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.~~

~~2.2. Load shedding.~~

~~2.3. Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.~~

~~3. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.~~

~~4. High-end trim. Luminaires shall be initially configured with the following:~~

~~4.1. High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by atleast 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.~~

~~4.2. Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.~~

~~4.3. High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.~~

For hotel and multifamily building use types, the gross lighted floor area is for common areas not including dwelling units or guest rooms. Where general lighting in more than 50 percent of the gross lighted floor area receives *high-end trim*, the base credits from Tables C406.1.2(1) through

C406.1.2(9) shall be prorated as follows:
[Tuned lighted floor area,%] × [Base energy credits for C406.2.5.2] / 50%

C408.3.1.4 *High-end trim.* Where lighting controls are configured for *high-end* trim ~~trims~~, verify the following:

1. ~~That high-end trim has been set.~~ The initial maximum setting for power or light output for each control group of luminaires shall be documented
2. The *high-end trim* setting for power or light output for each control group of luminaires shall be documented.
3. The *high-end trim* control documentation shall show the initial and *high end trim* settings and area for each control group and summarize the overall percentage of lighting output or power reduction from *high-end trim.*
4. ~~2~~ 4. ~~That the~~ The calibration adjustment equipment is located for *ready access* only by authorized personnel.
5. ~~3~~ 5. ~~That lighting~~ Lighting controls with *ready access* for users cannot increase the lighting power above the maximum level established by the *high-end trim* controls.

Reason: The proposed changes here are designed to more closely align the lighting control requirements for obtaining additional efficiency credits in Section 406.2.5.2 L02 Digital Lighting Controls with ASHRAE 90.1 Addendum AP Section 11.5.2.5.2 L02 Continuous Dimming and High-End Trim. Similarly, the proposal better aligns Section C408.3.1.4 Functional Testing of High-end trim with ASHRAE 90.1 Section 9.9.1 Verification and Testing (d) High-end trim controls.
Prior to these modifications Section 406.2.5.2, had requirements for digital controls that were reconfigurable, limited no more than 8 fixtures to daylight control zone and also had high-end trim controls. However, the calculated energy points were based solely on high-end trim and not all the other bells and whistles. Reconfigurability is great but it adds cost to the main control (high end trim) which is accounting for the savings. We believe that potentially more people would take this credit if the requirements for these points minimally required what was needed to save the energy predicted for this measure.

Additionally, by designing the control to more closely match that in ASHRAE 90.1, this might prevent “code shopping” and selecting ASHRAE 90.1 instead of the IECC because it had less extraneous requirements to its high end trim control credits.

The functional testing of high end trim controls in the original IECC proposal was short on the details required to confirm that the controls are set up on general lighting serving the desired faction of the building area. This has been ameliorated by matching more closely the the ASHRAE functional test.

In summary, these changes reduce the cost of minimally compliant controls and tuning activities to obtain the additional efficiency credits while assuring the primary energy savings measure is installed and adjusted.

More recent control efficacy studies with LED luminaires in 194 buildings have found that the average savings varies between 7% and 47% depending upon building type. See *Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC* at the following link:https://www.designlights.org/wp-content/uploads/2021/01/Energy-Savings-From-Networked-Lighting-Controls-with-and-without-LLLC_FINAL_09242020.pdf

Table 9. Summary of estimated control factors by building types.

Building Type	Total Buildings	Unique Manu-facturers	Control Factor (% Savings)				
			Average	25th–75th Percentile	High-End Trim Contributions	Other Control Strategies[1]	Other Control Strategies[2]
Assembly	6	2	0.28	0.11 - 0.45	0.07	0.21	0.23
Education	14	5	0.45	0.19 - 0.63	0.21	0.24	0.32
Healthcare	2	1	0.56	0.51 - 0.62	0.42	0.14	0.24
Manufacturing	73	4	0.40	0.20 - 0.55	0.16	0.24	0.29
Office	57	8	0.63	0.50 - 0.80	0.46	0.18	0.36
Restaurant	3	2	0.57	0.47 - 0.65	0.31	0.26	0.30
Retail	29	1	0.44	0.39 - 0.48	0.22	0.22	0.27
Warehouse	10	2	0.69	0.56 - 0.79	0.38	0.31	0.48
Overall	194	12	0.49	0.35 - 0.69	0.27	0.22	0.32

1. *Control factors were calculated with respect to the inferred baseline.*
2. *Control factors were calculated with respect to a baseline where influence and savings from high-end trim were removed.*

Cost Impact: The code change proposal will decrease the cost of construction.
This proposed change will reduce the cost of a minimally compliant control system. The system no longer is specifically required to be individually addressable or even networked but still retain the primary function responsible for energy savings -- the system has had the high end trim control adjusted so that the system at time of certificate of occupancy is drawing 15% less power than if the lighting system was operating at full light output.

Bibliography: ASHRAE 90.1-2019 Addendum AP (Energy Efficiency Credits) https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_ap_20220909.pdf
Northwest Energy Efficiency Alliance and the DesignLights Consortium. 2020 *Energy Savings from Networked Lighting Control (NLC) Systems with and without LLLC* https://www.designlights.org/wp-content/uploads/2021/01/Energy-Savings-From-Networked-Lighting-Controls-with-and-without-LLLC_FINAL_09242020.pdf

Workgroup Recommendation

Proposal # 685

CED1-81-22

Proponents: Glenn Heinmiller, representing IALD (glenn@lampartners.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.2.5 Energy Savings in Lighting Systems. Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of either:

1. C406.2.5.2 L02
2. C406.2.5.3 L03
3. C406.2.5.4 L04
4. C406.2.5.5 L05
5. C406.2.5.6 L06
6. Any combination of L03, L04, L05 and L06
7. Any combination of L02, L03 and L04

~~Where lighting energy credit measures include reductions in lighting power, the lighting shall achieve ANSI/IES recommended practice for minimum illuminance levels as referenced at “The Interactive Illuminance Selector,” which includes minimum recommended illuminance levels from various ANSI/IESRP-## standards.~~

Reason: The purpose of this requirement was to prevent low-quality lighting design solutions that might be incentivized by reduced lighting power density. Although well-intentioned, this requirement must be deleted because:

· Lighting designers must have the flexibility to design to whatever light levels are appropriate to provide quality lighting with minimal energy use. Sometimes this might mean illuminance levels that are below IES recommendations. In this case, the requirement would force the use of more energy than necessary.

· The purpose of the code is to regulate building energy use, not design quality. The IECC is not a design guide.

· This requirement would add a massive compliance and enforcement burden, for no energy savings benefit.

· C405.2.5.6 L06 provides no incentive for lighting power density lower than 80% of allowed lighting power. There is no incentive to have exceptionally low lighting power density that *might* lead to poor lighting quality.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Removing this requirement will have no effect on the cost of equipment used

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Workgroup Recommendation

Proposal # 735

CED1-82-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.2.5.6 L06 Reduced lighting power. Interior lighting within the whole building shall comply with all the requirements of this section.

1. The ~~net~~ connected interior lighting power (LPn) shall be 95 percent or less than the ~~net~~ interior lighting power allowance (LPAn) determined in accordance with Section C405.3.2~~.2~~ using the same method used to comply with Section C405.3.
2. In R-1 and R-2 occupancies the credit is calculated for all common areas other than dwelling units and sleeping units. ~~No less than 95 percent of t~~ The permanently installed light fixtures in dwelling units and sleeping units, excluding kitchen appliance lighting , antimicrobial lighting, and one decorative fixture per unit, shall be provided by ~~high efficacy~~ lamps with ~~a minimum~~ an efficacy of not less than 90 lumens per watt or ~~high efficacy~~ by luminaires that have ~~a minimum~~ an efficacy of not less than 65 ~~55~~ lumens per watt.

Energy credits shall not be greater than four times the L06 base credit from Section C406.2 and shall be determined using Equation 4-25:

(Equation 4-25)

$$EC_{LPA} = EC_5 \times 20 \times (LPA_n - LP_n)/LPA_n$$

where:

EC_{LPA}= additional energy credit for lighting power reduction

LP_n= ~~net~~ connected interior lighting power calculated in accordance with Section C405.3.1, watts~~, excluding any additional lighting power allowed in Section C405.3.2.2.1~~

LPA_n= interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2~~.2~~, watts~~, less any additional interior lighting power allowed in Section C405.3.2.2.1~~

EC_5 = L06 base credit from Section C406.2

Reason: This proposal is primarily designed to clarify and simplify calculation of the L06 energy credit. It has these components:

- The lighting power allowance used is whatever method is used to comply with Section C405.3, either the building area method or space by space method. This better aligns with a similar credit in ASHRAE Standard 90.1.
- The word "net" and exclusion of additional lighting from calculation of the reduction are removed. This allows the calculation of the lighting power allowance to match Section C405.3, eliminating the need for a differing calculation. There is a slight change in credits, with most credits achieved by those who minimize the use of additional lighting. The limitation of the allowance for additional lighting to lighting actually installed in the project is clear in Section C405.3.2.2, and further clarification is anticipated in a separate proposal.
- In dwelling and sleeping units, the allowance for 5% of the permanently installed fixtures to not meet the increased efficacy requirement is changed to an exception for one decorative fixture, as many units do not have 20 fixtures installed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Energy credits are selected by the designer, rather than required for all buildings, so there is no direct impact on the cost of construction.

Workgroup Recommendation

Proposal # 798

CED1-83-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C407.1 Scope. This section establishes criteria for compliance using simulated building performance. The following systems and loads shall be included in determining the simulated building performance: heating systems, cooling systems, service water heating, fan systems, lighting power, energy used to charge or fuel vehicles that are used for on-road and off-site transportation purposes, and receptacle loads and process loads.

~~**Exception:** Energy used to recharge or refuel vehicles that are used for on-road and off-site transportation purposes~~.

Reason: Since EV charging undoubtedly contributes to building energy consumption through metered electricity delivered to the building, charging loads must be included in building energy simulations

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The requirement for including EV charging electrical consumption in simulated building energy performance will not increase construction costs since this incremental consumption will be metered using conventional systems.

Workgroup Recommendation

Proposal # 916

CED1-84-22

Proponents: Michael Jouaneh, representing Lutron Electronics Co., Inc. (mjouaneh@lutron.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C408.3 Functional testing of lighting and receptacle controls. ~~Automatic lighting~~ Lighting and receptacle controls required by this code shall comply with this section.

C408.3.1 Functional testing. Prior to passing final inspection, the *registered design professional* or *approved agency* shall provide evidence that the lighting and receptacle control systems have been tested to ensure that control hardware and software are calibrated, adjusted, programmed and in proper working condition in accordance with the *construction documents* and manufacturer's instructions. Functional testing shall be in accordance with Sections C408.3.1.1 through C408.3.1.3 for the applicable control type.

C408.3.1.1 Occupant sensor controls. Where *occupant sensor controls* are provided, the following procedures shall be performed:

1. Certify that the *occupant sensor* has been located and aimed in accordance with manufacturer recommendations.
2. For projects with seven or fewer *occupant sensors*, each sensor shall be tested.
3. For projects with more than seven *occupant sensors,* testing shall be done for each unique combination of sensor type and space geometry. Where multiples of each unique combination of sensor type and space geometry are provided, not less than 10 percent and in no case fewer than one, of each combination shall be tested unless the *code official* or design professional requires a higher percentage to be tested. Where 30 percent or more of the tested controls fail, all remaining identical combinations shall be tested.

   For *occupant sensor controls* to be tested, verify the following:

   3.1. Where *occupant sensor controls* include status indicators, verify correct operation.

   3.2. The controlled lights and receptacles turn off or down to the permitted level within the required time.

   3.3. For auto-on *occupant sensor controls*, the controlled lights and receptacles turn on when an occupant enters the space.

   3.4. For manual-on *occupant sensor controls*, the controlled lights and receptacles turn on only when manually activated.

   3.5. The lights are not incorrectly turned on by movement in adjacent areas or by HVAC operation.

C408.3.1.2 Time-switch controls. Where *time-switch controls* are provided, the following procedures shall be performed:

1. Confirm that the *time-switch control* is programmed with accurate weekday, weekend and holiday schedules.
2. Provide documentation to the owner of *time-switch controls* programming including weekday, weekend, holiday schedules, and set-up and preference program settings.
3. Verify the correct time and date in the time switch.
4. Verify that any battery back-up is installed and energized.
5. Verify that the override time limit is set to not more than 2 hours.
6. Simulate occupied condition. Verify and document the following:

   6.1. All lights can be turned on and off by their respective area control switch.

   6.2. The switch only operates lighting in the enclosed space in which the switch is located.

7. Simulate unoccupied condition. Verify and document the following:

   7.1. Nonexempt lighting turns off.

   7.2. Manual override switch allows only the lights in the enclosed space where the override switch is located to turn on or remain on until the next scheduled shutoff occurs.

   7.3 Controlled receptacles turn off.

8. Additional testing as specified by the *registered design professional.*

Reason: The new requirement for hotel guestroom is for all lighting and switched receptacles to be off when room is vacant. This provision will help ensure that the code captures control of all lighting (permanent hardwired lighting as well as plugged-in lighting) by requiring verification that any switched or automatically controlled receptacles are also off when the room is vacant for more than 20 minutes. This provision also ensures energy savings from controlled receptacles by requiring the controlled receptacles are functioning as intended as well as the lighting.

Cost Impact: The code change proposal will increase the cost of construction.
Potential slight increase in cost. Functional testing of lighting controls is already required. This provision simply adds verification that the controlled receptacles are also working as intended.

Workgroup Recommendation

Proposal # 895

CED1-85-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

FINANCIAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (FPPA). A financial arrangement between a renewable ~~electricity~~ energy generator and a purchaser wherein the purchaser pays or guarantees a price to the generator for the project's renewable generation. Also known as a "financial power purchase agreement" and "virtual power purchase agreement."

PHYSICAL RENEWABLE ENERGY POWER PURCHASE AGREEMENT (PPPA). A contract for the purchase of renewable ~~electricity~~ energy from a specific renewable ~~electricity~~ energy generator to a purchaser of renewable ~~electricity~~ energy.

RENEWABLE ENERGY CERTIFICATE (REC). A market-based instrument that represents and conveys the environmental, social, and other non-power attributes of one megawatt hour of renewable ~~electricity~~ energy generation or 3,412,000 Btu of renewable thermal energy or bioenergy production and could be sold separately from the underlying physical ~~electricity~~ energy associated with renewable energy systems; also known as an energy attribute and energy attribute certificate (EAC).

Reason: The proposed changes remove the inconsistency in language between "renewable electricity" and "renewable energy". The term "renewable energy" is used throughout all other code language and should remain as the consistent definition.
Also aligns the definitions with ASRAHE 90.1 2022

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal could have no change on construction cost.

Workgroup Recommendation

Proposal # 774

CED1-86-22

Proponents: Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

CC103.1 Renewable energy. On-site renewable energy systems shall be installed, or off-site renewable energy shall be procured to offset the building energy as calculated in Equation CC-1. Where off-site renewable energy is procured to comply with Equation CC-1, the building thermal envelope shall be required to comply with the requirements of Section C402.

$$RE_{onsite} + RE_{offsite} \geq RE_{min}$$

where: **(Equation CC-1)**

RE_{onsite} = Annual site energy production from on-site renewable energy systems (see Section CC103.2), including installed on-site renewable energy systems for compliance with C405.13.1 and C406.5.

$RE_{offsite}$ = Adjusted annual energy production from off-site renewable energy systems that may be credited against (see Section CC103.3), including off-site renewable energy purchased for compliance with C405.13.2.

RE_{min} = Minimum renewable energy requirement B.

When Section C401.2.1(1) is used for compliance with the *International Energy Conservation Code*, the minimum renewable energy requirement shall be determined by multiplying the gross *conditioned floor area* plus the gross semiheated floor area of the proposed building by the prescriptive renewable energy requirement from Table CC103.1. An area weighted average shall be used for mixed-use buildings.
When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the *International Energy Conservation Code*, the minimum renewable energy requirement shall be equal to the building energy as determined from energy simulations.

Reason: This public comment would establish minimum envelope efficiency requirements for projects that use offsite renewable energy to comply with the zero-energy provisions of Appendix CC. The intent of Appendix CC, according to the “User note,” is to add renewable energy generation to new buildings “to avoid the additional emissions that would otherwise occur from conventional power generation.” Appendix CC permits code users to combine on-site and off-site renewable energy to achieve this but does not place any new limitations on which trade-offs are allowed in base code compliance. We are concerned that buildings constructed with under-performing thermal envelopes will drive an increase in the amount of energy that should be offset, and thus run counter to the intent of Appendix CC. This becomes an even bigger problem when inefficient buildings are using market-purchased renewable energy to compensate for increased energy use (and competing with others in the market for existing renewable energy rather than causing the installation of new renewable energy that otherwise would not have been available). Moreover, while the building thermal envelope components can be expected to last over the lifetime of the building, purchased offsite energy cannot provide the same long-term guarantees. This will frustrate the nation’s efforts to slow or reverse the growth of energy demand, and to convert generation to low- or zero-carbon sources. This public comment does not prohibit or limit the purchase of offsite renewable energy to satisfy the requirements of Appendix CC, but it does require that these buildings not consume excessive amounts of energy due to poor envelopes where offsite energy is purchased to offset energy use.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This public comment does not increase the baseline stringency of Appendix CC, but merely limits trade-offs between thermal envelope efficiency and offsite renewable energy, within an appendix that already requires compliance with base code requirements. As a result, whether costs of construction increase or decrease ultimately depends on choices made by the code user.

Cost-Effectiveness

This public comment does not increase the stringency of the code or result in increased costs, so a cost-effectiveness analysis does not apply. These backstops serve only as a consumer protection against excessive trade-offs between thermal envelope efficiency and offsite renewable energy purchases and do not require anything more than what would be required for base code prescriptive compliance, which values are already considered cost-effective. Thus, a cost-effectiveness analysis would be difficult to apply and would not be useful or informative.

Workgroup Recommendation

Proposal # 870

CED1-87-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C105.2.2 Building ~~T~~thermal envelope. Inspections shall verify the correct type of insulation, *R*-values, location of insulation, thermal bridge mitigation, fenestration, *U*-factor, SHGC and VT, and that air leakage controls are properly installed, as required by the code, *approved* plans and specifications.

Reason: Thermal bridging requirements were added in Section C402.7 of the draft standard. They should be included in the building thermal envelope items listed for inspection in Section C105.2.2. Thermal bridging details can be as important to building thermal envelope performance as the other items currently mentioned in C105.2.2 and, if not compliant, can severely impact performance. The proposal also uses the defined term "building thermal envelope" for the section title.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal just coordinates building thermal envelope inspections with provisions added to the IECC standard draft for thermal bridges.

Workgroup Recommendation

Proposal # 716

CED1-88-22

Proponents: Brian Trimble, representing International Masonry Institute (btrimble@imiweb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

EXTERIOR WALL ENVELOPE. A system or assembly of exterior wall components, including exterior wall finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the ~~detrimental~~ effects of the exterior environment.

Reason: Not all exterior effects are detrimental such solar for daylighting and thermal mass, so "detrimental" should be deleted from the definition.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Proposal # 849

CED1-89-22

Proponents: Glen Clapper, representing National Roof Contractors Association (gclapper@nrca.net)

2024 International Energy Conservation Code [CE Project]

Delete and substitute as follows:

~~**ROOF REPLACEMENT.** An *alteration* that includes the removal of all existing layers of roof assembly materials down to the roof deck and installing replacement materials above the existing roof deck.~~

ROOF REPLACEMENT. The process of removing the existing roof covering, repairing any damaged substrate and installing a new roof covering.

Reason: This proposal returns the definition to its 2021 form to align with the same definition in the ICC family of codes. A similar proposal, CEPI-17, Part II, for Section R202, was disapproved by the Residential Consensus Committee, as were similar proposals for the IBC, IRC and IEBC during the 2022 Group B Code Development Cycle.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Proposal # 886

CED1-90-22

Proponents: Helen Sanders, **Technoform North America** representing Facade Tectonics Institute (helen.sanders@technoform.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C303.1.3 Fenestration product rating. *U*-factors, *solar heat gain coefficient* (SHGC), and *visible transmittance* (VT) of fenestration products shall be determined as follows:

1. For windows, doors and skylights, *U*-factor, SHGC and VT ratings shall be determined in accordance with NFRC 100 and NFRC 200. For the Total Building Performance option in Section C407, the U-factor, SHGC, and VT modeled in the *proposed design* shall be based on either the proposed project specific size(s) and configuration(s) for all *fenestration* products representing 5% or more of the total *fenestration* area, or the NFRC 100 standard sizes and configurations for all *fenestration*. Physical testing of *fenestration* at the project size and configuration to verify U-factor is not required.
2. Where required for garage doors and rolling doors, *U*-factor ratings shall be determined in accordance with either NFRC 100 or ANSI/DASMA 105.

U-factors shall be determined by an accredited, independent laboratory, and *labeled* and certified by the manufacturer.

Products lacking such a *labeled U*-factor shall be assigned a default *U*-factor from Table C303.1.3(1) or Table C303.1.3(2). ~~The *solar heat gain coefficient* (SHGC) and *visible transmittance* (VT) of glazed fenestration products (windows, glazed doors and skylights) shall be determined in accordance with NFRC 200 by an accredited, independent laboratory, and *labeled* and certified by the manufacturer.~~ Products lacking such a *labeled* SHGC or VT shall be assigned a default SHGC or VT from Table C303.1.3(3). For Tubular Daylighting Devices, VT_{annual} shall be measured and rated in accordance with NFRC 203.

Reason: On larger projects using the performance path, where rigor is warranted, project-specific size and configuration yields more-accurate values for U-factor, SHGC and VT than NFRC 100 standard sizes. This helps ensure that HVAC equipment capacity sizing, energy consumption modeling and product comparisons are based on accurate values. This increased level of accuracy is becoming more important in order to meet energy efficiency targets and to ensure occupant comfort. The NFRC 100 and 200 standard size U-factor and SHGC values provide a simplified approach when employing the prescriptive path and do not deliver a robust output for HVAC sizing.
The new 2023 version of NFRC 100 and 200, which will be published next year (2023), introduces a new, easier to use, methodology (the Commercial Trendline Approach) for calculating commercial fenestration performance, and the accompanying NFRC certification process provides a project-size and configuration specific path for certifying commercial fenestration performance. The project specific size calculation methodology for U-factor (aspect ratio calculation) is described in Appendix A4 of NFRC 100-2023 which ensures consistency in size-specific calculation methodology. A pre-publication version of NFRC 100-2023 has been provided by NFRC for the purpose of supporting documentation for this proposal and is uploaded with this proposal. This standard has already been approved by the NFRC board and membership, and will be published once the new web tools and certification program are rolled out to accompany it in 2023. For ease of reference, the commercial trendline approach is detailed in section 5.12, starting on P121, and the size-specific U-factor determination is detailed in Appendix A4, page 135. In addition, the proposed language will help clarify the confusion among design teams on whether to consider NFRC sizes, or the project specific size and configurations, streamlining the design process. It also clarifies that the project size U-factor, SHGC and VT, shall be calculated according to the NFRC 100 and 200 standards and does not require separate physical testing.

The proposal does not change the fact that the NFRC 100 and 200 remains the standard by which performance is determined, and prescriptive U-factors and SHGC for fenestration remain based on the standard NFRC size.

Clause C402.4.3.4 Area-weighted U-factor listed below would still allow for using an area-weighted average of the different project size.

We have suggested this section of the code for this clarification to be inserted, but the committee may find a more appropriate place for it.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal aims to clarify and improve the way U-factor is defined in the total energy compliance path. There should be no impact in the cost of construction. Some project teams already simulate and submit both project size and NFRC size because of lack of clarity, so clarifying this point could actually reduce the cost of the design process.

Attached Files

- **ANSI NFRC 100-2023 ExAx_PrePublicationDRAFT.pdf**
  https://energy.cdpaccess.com/proposal/901/1719/files/download/400/

Workgroup Recommendation

Proposal # 901

CED1-91-22

Proponents: Brian Trimble, representing International Masonry Institute (btrimble@imiweb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C303.1.3(1) DEFAULT GLAZED WINDOW, GLASS DOOR AND SKYLIGHT U-FACTORS

FRAME TYPE	WINDOW AND GLASS DOOR		SKYLIGHT	
	Single	Double	Single	Double
Metal	1.20	0.80	2.00	1.30
Metal with Thermal Break	1.10	0.65	1.90	1.10
Nonmetal or Metal Clad	0.95	0.55	1.75	1.05
~~Glazed~~ Glass Block	0.60			

Reason: The proper term is glass block which is translucent. Glazed block is a different product. Glass Unit Masonry is more appropriate than Glass Block, but most designers know it as glass block.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Proposal # 847

CED1-92-22

Proponents: Aaron Phillips, representing Asphalt Roofing Manufacturers Association (aphillips@asphaltroofing.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C105.2.2 Building ~~Thermal~~ thermal envelope. Inspections shall verify the correct type of insulation, *R*-values, location of insulation, fenestration, *U*-factor, SHGC and VT, and that air leakage controls are properly installed, as required by the code, *approved* plans and specifications.

CONTINUOUS INSULATION (ci). Insulating material that is continuous across all structural members without thermal bridges other than fasteners and service openings. It is installed on the interior or exterior or is integral to any opaque surface of the *building thermal envelope*~~building envelope~~.

C401.3 Building ~~Thermal~~ thermal envelope certificate. A permanent *building thermal envelope*~~thermal envelope~~ certificate shall be completed by an *approved* party. Such certificate shall be posted on a wall in the space where the space conditioning equipment is located, a utility room or other *approved* location. If located on an electrical panel, the certificate shall not cover or obstruct the visibility of the circuit directory label, service disconnect label or other required labels. A copy of the certificate shall also be included in the construction files for the project. The certificate shall include the following:

1. *R*-values of insulation installed in or on ceilings, roofs, walls, foundations and slabs, *basement walls*, crawl space walls and floors and ducts outside *conditioned spaces*.
2. *U*-factors and *solar heat gain coefficients* (SHGC) of fenestrations.
3. Results from any *building thermal envelope* ~~envelope~~ air leakage testing performed on the *building*.

Where there is more than one value for any component of the *building thermal envelope*~~building envelope~~, the certificate shall indicate the area-weighted average value where available. If the area-weighted average is not available, the certificate shall list each value that applies to 10 percent or more of the total component area.

SECTION C402
BUILDING THERMAL ENVELOPE REQUIREMENTS

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor based method of Section C402.1.2; the R-value based method of C402.1.3; or the component performance alternative of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in *building thermal envelope*~~building envelope~~ assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with Section C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.
7. *Thermal bridges* in *above-grade walls* shall comply with Section C402.7.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

C402.1.1.2 Greenhouses. Greenhouse structures or areas that are mechanically heated or cooled and that comply with all of the following shall be exempt from the *building thermal envelope*~~building envelope~~ requirements of this code:

1. Exterior opaque envelope assemblies comply with Sections C402.2 and C402.5.5.

   Exception: Low energy greenhouses that comply with Section C402.1.1.

2. Interior partition *building thermal envelope* assemblies that separate the greenhouse from *conditioned space* comply with Sections C402.2, C402.5.3 and C402.5.5.

3. Fenestration assemblies that comply with the *building thermal envelope*~~thermal envelope~~ requirements in Table C402.1.1.2. The *U*-factor for a roof shall be for the roof assembly or a roof that includes the assembly and an *internal curtain system*.

   Exception: Unconditioned greenhouses.

TABLE C402.1.1.2 FENESTRATION BUILDING THERMAL ENVELOPE MAXIMUM REQUIREMENTS

TABLE C402.1.2 OPAQUE BUILDING THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

For SI: 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.

b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.

c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.

d. “Mass floors” shall be in accordance with Section C402.2.3.

e. These *C*-, *F*- and *U*-factors are based on assemblies that are not required to contain insulation.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. Swinging door *U*-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly *U*-factor less than or equal to 0.44 in Climate Zones 0 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

C402.1.2.2 U-factor thermal resistance of cold-formed steel assemblies. *U*-factors for *building thermal envelopes* ~~building envelopes~~ containing cold-formed steel framed ceilings and walls shall be permitted to be determined in accordance with~~with~~ AISI S250 as modified herein.

1. Where the steel-framed wall contains no cavity insulation, and uses continuous insulation to satisfy the U-factor maximum, the steel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing at 24 inches (610 mm) on center with a 23 percent framing factor or framing at 16 inches (400 mm) on-center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using AISI S250.
3. Where the steel-framed wall contains less than 23 percent framing factors the AISI S250 shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shape framing members the AISI S250 calculation option for other than standard C-shape framing is permitted to be used.

TABLE C402.1.3 OPAQUE BUILDING THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE ALTERNATIVES [a]

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.
b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.2.
c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted not less than 32 inches or less on center vertically and not less than 48 inches on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.
d. Where heated slabs are below grade, below-grade walls shall comply with the R-value requirements for above-grade mass walls .
e. “Mass floors” shall be in accordance with Section C402.2.3.
f. “Mass walls” shall be in accordance with Section C402.2.2.
g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation and full-slab insulation components shall be installed in accordance with Section C402.2.4.1 .
h. The first value is *cavity insulation*; the second value is *continuous insulation*. Therefore, “R-0+R-12ci” means R-12 *continuous insulation* and no *cavity insulation*; “R-13+R-3.8ci” means R-13 *cavity insulation* and R-3.8 *continuous insulation*; “R-20” means R-20 *cavity insulation* and no *continuous insulation*. R-13, R-20, and R-27 *cavity insulation* as used in this table apply to a nominal 4-inch (101 mm), 6-inch (152 mm), and 8-inch (203 mm) deep wood or cold-formed steel stud cavities, respectively.

C402.1.4 Component performance alternative. *Building thermal envelope*~~Building envelope~~ values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the *U*-, *F*-, psi-, chi-, and *C*-factors in Tables C402.1.2, C402.1.5, and C402.5 and the maximum allowable fenestration areas in Section C402.5.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.5.3.

$$\underline{A_P + B_P + C_P + T_P \leq A_T + B_T + C_T + T_T - V_F - V_S} \quad \textbf{(Equation 4-1)}$$

A_P = Sum of the (area x U-factor) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies
B_P = Sum of the (length x F-factor) for each proposed slab-on-grade edge condition
C_P = Sum of the (area x C-factor) for each proposed below-grade wall assembly
T_P = Sum of the (ψL_P) and (χN_p) values for each type of thermal bridge condition of the building thermal envelope as identified in Section C402.6 in the proposed building. For the purposes of this section, the (ψL_P) and (χN_P) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_P shall be assigned as zero.
ψL_P= psi-factor × length of the thermal bridge elements in the proposed building thermal envelope.
χN_P = chi-factor x number of the thermal bridge point elements other than fasteners, ties, or brackets in the proposed building thermal envelope.
A_T = Sum of the (area x U-factor permitted by Tables C402.1.2 and C402.5) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies
B_T = Sum of the (length x F-factor permitted by Table C402.1.2 for each proposed slab-on-grade edge condition
C_T = Sum of the (area x C-factor permitted by Table C402.1.2) for each proposed below-grade wall assembly
T_T = Sum of the (ψL_T) and (χN_T) values for each type of thermal bridge condition in the proposed building thermal envelope as identified in Section C402.6 with values specified as “compliant” in Table C402.1.4. For the purposes of this section, the (ψL_T) and (χNT) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_T shall be assigned as zero.
ψL_T= (psi-factor specified as “compliant” in Table C402.1.5) × length of the thermal bridge elements in the proposed building thermal envelope.
χN_T = (chi-factor specified as “compliant” in Table C402.1.5) x number of the thermal bridge point elements other than fasteners, ties, or brackets in the proposed building thermal envelope.
P_F = Maximum vertical fenestration area allowable by Section C402.5.1, C402.5.1.1, or C402.5.1.2
Q_F = Proposed vertical fenestration area
R_F = Q_F – P_F, but not less than zero (excess vertical fenestration area)
S_F = Area-weighted average U-factor permitted by Table C402.5 of all vertical fenestration assemblies
T_F = Area-weighted average U-factor permitted by Table C402.1.2 of all exterior opaque wall assemblies
U_F = S_F – T_F (excess U-factor for excess vertical fenestration area)
V_F = R_F x U_F (excess UxA due to excess vertical fenestration area)
P_S = Maximum skylight area allowable by Section C402.1.2
Q_S = Actual skylight area

$R_S = Q_S - P_S$, but not less than zero (excess skylight area)
S_S = Area-weighted average U-factor permitted by Table C402.5 of all skylights
T_S = Area-weighted average U-factor permitted by Table C402.1.2 of all opaque roof assemblies
$U_S = S_S - T_S$ (excess U-factor for excess skylight area)
$V_S = R_S \times U_S$ (excess UxA due to excess skylight area)
A proposed psi- or chi-factor for each thermal bridge shall comply with one of the following as applicable:

1. Where the proposed mitigation of a thermal bridge is compliant with the requirements of Section C402.6, the “compliant” values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
2. Where a thermal bridge is not mitigated in a manner at least equivalent to Section C402.6, the “non-compliant” values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
3. Where the proposed mitigation of a thermal bridge provides a psi- or chi-factor less than the “compliant” values in Table C402.1.4, the proposed psi- or chi-factor shall be determined by thermal analysis, testing, or other approved sources.

Staff note existing items removed

TABLE C402.5 BUILDING THERMAL ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

NR = No Requirement, PF = Projection Factor.

C402.6 Air leakage~~—~~building thermal envelope. The *building thermal envelope* shall comply with Sections C402.6.1 through C402.6.8.1.

C402.6.1.1 Air barrier design and documentation requirements . Design of the continuous air barrier shall be documented in the following manner:

1. Components comprising the continuous air barrier and their position within each *building thermal envelope* ~~building thermal envelope~~ assembly shall be identified.
2. Joints, interconnections, and penetrations of the continuous air barrier components shall be detailed.
3. The continuity of the air barrier building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space shall be identified.
4. Documentation of the continuous air barrier shall detail methods of sealing the air barrier such as wrapping, caulking, gasketing, taping or other approved methods at the following locations:

   4.1 Joints around fenestration and door frames.

   4.2 Joints between walls and floors, between walls at building corners, between walls and roofs including parapets and copings, where above-grade walls meet foundations, and similar intersections.

   4.3 Penetrations or attachments through the continuous air barrier in *building thermal envelope*~~building envelope~~ roofs, walls, and floors.

   4.4 Building assemblies used as ducts or plenums.

   4.5 Changes in continuous air barrier materials and assemblies.

5. Identify where testing will or will not be performed in accordance with Section C402.5.2 Where testing will not be performed, a plan for field inspections required by C402.5.2.3 shall be provided that includes the following:

   5.1 Schedule for periodic inspection,

   5.2 Continuous air barrier scope of work,

   5.3 List of critical inspection items,

   5.4 Inspection documentation requirements, and

   5.5 Provisions for corrective actions where needed.

C402.6.2.3 Building thermal envelope design and construction verification criteria. Where Section C402.6.2.1 and C402.6.2.2 are not appliable the installation of the continuous air barrier shall be verified by the *code official*, a *registered design professional* or *approved* agency in accordance with the following:

1. A review of the construction documents and other supporting data shall be conducted to assess compliance with the requirements in Section C402.6.1.
2. Inspection of continuous air barrier components and assemblies shall be conducted during construction to verify compliance with the requirements ofC402.6.2.3.1 or C502.6.2.3.2. The air barrier shall remain accessible for inspection and repair.
3. A final inspection report shall be provided for inspections completed by the *registered design professional* or *approved* agency. The inspection report shall be provided to the building owner or owner's authorized agent and the *code official.* The report shall identify deficiencies found during inspection and details of corrective measures taken.

C402.6.5 Air intakes, exhaust openings, stairways and shafts. Stairway enclosures, elevator shaft vents and other outdoor air intakes and exhaust openings integral to the *building thermal envelope*~~building envelope~~ shall be provided with dampers in accordance with Section C403.7.7.

C403.4.1 Thermostatic controls. The supply of heating and cooling energy to each *zone* shall be controlled by individual thermostatic controls capable of responding to temperature within the *zone*. Where humidification or dehumidification or both is provided, not fewer than one humidity control device shall be provided for each humidity control system.

> **Exception:** Independent perimeter systems that are designed to offset only *building thermal envelope*~~building envelope~~ heat losses, gains or both serving one or more perimeter *zones* also served by an interior system provided that both of the following conditions are met:
>
> 1. The perimeter system includes not fewer than one thermostatic control *zone* for each building exposure having exterior walls facing only one orientation (within ±45 degrees) (0.8 rad) for more than 50 contiguous feet (15 240 mm).
> 2. The perimeter system heating and cooling supply is controlled by thermostats located within the *zones* served by the system.

C403.13.1 Duct and plenum insulation and sealing. Supply and return air ducts and plenums shall be insulated with not less than R-6 insulation where located in unconditioned spaces and where located outside the building with not less than R-8 insulation in *Climate Zones* 0 through 4 and not less than R-12 insulation in *Climate Zones* 5 through 8. Ducts located underground beneath buildings shall be insulated as required in this section or have an equivalent thermal distribution efficiency. Underground ducts utilizing the thermal distribution efficiency method shall be *listed* and *labeled* to indicate the *R*-value equivalency. Where located within a *building thermal envelope*~~building envelope~~ assembly, the duct or plenum shall be separated from the building exterior or unconditioned or exempt spaces by not less than R-8 insulation in *Climate Zones* 0 through 4 and not less than R-12 insulation in *Climate Zones* 5 through 8.

Exceptions:

1. Where located within equipment.
2. Where the design temperature difference between the interior and exterior of the duct or plenum is not greater than 15°F (8°C).

Ducts, air handlers and filter boxes shall be sealed. Joints and seams shall comply with Section 603.9 of the International Mechanical Code.

C403.14 Mechanical systems located outside of the building thermal envelope. Mechanical systems providing heat outside of the *building thermal envelope*~~thermal envelope of a building~~ shall comply with Sections C403.14.1 through C403.14.4.

C406.1.3 Substantial Alterations to Existing Buildings. The *building* thermal *envelope*, *equipment*, and *systems* in *alterations* to *buildings* exceeding 5000 square feet (46.5 m^2) of *gross conditioned floor area* shall comply with the requirements of Section C406.1.1 and C406.1.2 where the alteration includes replacementof two or more of the following:

1. HVAC unitary systems or HVAC central heating or cooling equipment serving the alteration area, not including ductwork or *piping*.
2. 80% or more of the lighting fixtures in the *alteration* area.
3. *Building thermal envelope*~~Building envelope~~ components in the *alteration* area including new exterior cladding, fenestration, or insulation.

C406.2.1 More Efficient Building Thermal Envelope. A project shall achieve credits for improved envelope performance by complying with one of the following measures:

1. Section C406.2.1.1: E01
2. Section C406.2.1.2: E02
3. Section C406.2.1.3: E03
4. Both E02 and E03
5. Any combination of:
   - 5.1. Section C406.2.1.3: E03
   - 5.2. Section C406.2.1.4: E04
   - 5.3. Section C406.2.1.5: E05
   - 5.4. Section C406.2.1.6: E06

C406.2.1.1 EO1 Improved envelope performance 901 Appendix C. *Building thermal envelope*~~envelope~~ measures shall be installed to improve the energy performance ofthe project. The achieved energy credits shall be determined using Equation 4-15.

(Equation 4-15)

$$EC_{ENV} = 1000 \times (EPF_B - EPF_P)/EPF_B$$

EC_{ENV}= E01 measure energy credits
EPFB= base envelope performance factor calculated in accordance with ASHRAE 90.1-2019-Appendix C.
EPF_P= proposed envelope performance factor calculated in accordance with ASHRAE 90.1-2019-Appendix C.

C406.3.8 G07 Building Thermal Mass. The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:

1. Interior to the *building* thermal *envelope* insulation, provide 10 lb/ft(50 kg/m) of project conditioned floor area of passive thermal mass in the *building interior wall*, the inside of the *exterior wall*, or interior floor construction. Mass *construction* shall have mass surfaces directly contacting the air in *conditioned spaces* with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or *exterior wall* mass that is on the exterior of the insulation layer (e.g., the portion of CMU block on the exterior of insulation filled cell cavities) shall not be included toward the *building* mass required.
2. HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush *control* sequence.

3. Night flush controls shall be configured with the following sequence or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating, and is approved by the *authority having jurisdiction*.

   3.1. Summer mode shall be activated when outdoor air temperature exceeds 70ºF (21ºC) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45ºF (7ºC). During summer mode, the occupied cooling *set point* shall be set 1ºF (0.6ºC) higher than normal and the occupied heating *set point* shall be reset 2ºF (1.1ºC) lower than normal.

   3.2. When all the following conditions exist, night flush shall be activated:

      3.2.1. Summer mode is active in accordance with item 3.1.

      3.2.2. Outdoor air temperature is 5ºF (2.8ºC) or more below indoor average zone temperature.

      3.2.3. Indoor average zone temperature is greater than morning occupied heating *set point*.

      3.2.4. In climate zones 0A through 3A, outdoor dewpoint is below 50ºF (10ºC) or outdoor air enthalpy is less than indoor air enthalpy.

      3.2.5. Local time is between 10:00 pm and 6:00 am.

   3.3. When night flush is active,*automatic* night flush controls shall operate outdoor air *economizers* at low fan speed not exceeding 66 percent during the unoccupied period with *mechanical cooling* and heating locked out.

TABLE C407.2(1) REQUIREMENTS FOR TOTAL SIMULATED BUILDING PERFORMANCE

SECTION [a]	TITLE
Envelope	
C401.3	*Building thermal envelope* Thermal envelope certificate
C402.2.1.1	Joints staggered
C402.2.1.2	Skylight curbs
C402.2.6	Insulation of radiant heating system
C402.6	Air leakage—*building thermal envelope* ~~thermal envelope~~
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4	Thermostatic controls
C403.4.2	Off-hour controls
C403.4.7	HVAC system controls for operable openings to the outdoors
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.12, except C403.12.3	Refrigeration equipment performance
C403.13	Construction of HVAC system elements
C403.14	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C406.1.2	Additional renewable and load management credit requirements
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

C409.6.1.4 Building Thermal Envelope Components. *Building thermal envelope*~~Building envelope~~ components modeled in the standard reference design and the proposed design shall comply with the requirements of this Section.

C503.1 General. *Alterations* to any *building* or structure shall comply with the requirements of Section C503. *Alterations* shall be such that the existing *building* or structure is not less conforming to the provisions of this code than the existing *building* or structure was prior to the *alteration*. *Alterations* to an existing *building*, *building* system or portion thereof shall conform to the provisions of this code as those provisions relate to new construction without requiring the unaltered portions of the existing *building* or *building* system to comply with this code. *Alterations* shall not create an unsafe or hazardous condition or overload existing *building* systems.

Exception: The following *alterations* need not comply with the requirements for new construction, provided that the energy use of the building is not increased:

1. Storm windows installed over existing *fenestration*.
2. Surface-applied window film installed on existing single-pane *fenestration* assemblies reducing solar heat gain, provided that the code does not require the glazing or *fenestration* to be replaced.
3. *Roof recover*.
4. Roof replacement where roof assembly insulation is integral to or located below the structural roof deck.
5. *Air barriers* shall not be required for *roof recover* and roof replacement where the *alterations* or renovations to the building do not include *alterations*, renovations or *repairs* to the remainder of the *building thermal envelope*~~building envelope~~.
6. An existing building undergoing alterations that complies with Section C407.

C503.2 Building thermal envelope. Alterations of existing *building thermal envelope* assemblies shall comply with this section. New *building thermal envelope*~~building envelope~~ assemblies that are part of the *alteration* shall comply with Section C402 . An area-weighted average *U*-factor for new and altered portions of the *building thermal envelope* shall be permitted to satisfy the *U*-factor requirements in Table C402.1.4. The existing *R*-value of insulation shall not be reduced or the *U*-factor of a *building thermal envelope* assembly be increased as part of a *building thermal envelope* alteration except where complying with Section C407.

Exception: Where the existing building exceeds the fenestration area limitations of Section C402.5.1 prior to alteration, the building is exempt from Section C402.5.1 provided that there is no increase in fenestration area.

C503.6 Additional energy efficiency credits. *Alterations* shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone.* Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.

Exceptions:

1. *Alterations* that include replacement of no more than one of the following:

   1.1 HVAC unitary systems or HVAC central heating or cooling equipment serving the *work area* of the *alteration*.

   1.2 Water heating equipment serving the *work area* of the alteration.

   1.3 50 percent or more of the lighting fixtures in the *work area* of the alteration.

   1.4 50 percent or more of the area of interior surfaces of the *building thermal envelope*~~thermal envelope~~ in the *work area* of the alteration.

   1.5 50 percent or more of the building's *exterior wall envelope*, including fenestration.

2. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
3. *Alterations* that do not contain conditioned space.
4. Portions of *buildings* devoted to manufacturing or industrial use.
5. *Buildings* in Climate Zone 0A.
6. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.
7. *Alterations* that comply with Section C407.

C504.2 Application. For the purposes of this code, the following shall be considered to be repairs:

1. Glass-only replacements in an existing sash and frame.
2. *Roof repairs*.
3. Air barriers shall not be required for *roof repair* where the repairs to the building do not include *alterations*, renovations or *repairs* to the remainder of the *building thermal envelope*~~building envelope~~.
4. Replacement of existing doors that separate conditioned space from the exterior shall not require the installation of a vestibule or revolving door, provided that an existing vestibule that separates a conditioned space from the exterior shall not be removed.
5. *Repairs* where only the bulb, the ballast or both within the existing luminaires in a space are replaced, provided that the replacement does not increase the installed interior lighting power.

C505.2 Energy use intensities. *Building thermal envelope*~~Building envelope~~, space heating, cooling, ventilation, lighting and service water heating shall comply with Sec-tions C505.2.1 through C505.2.4.

Exceptions:

1. Where it is demonstrated by analysis approved by the *code official* that the change will not increase energy use intensity.
2. Where the occupancy or use change is less than 5,000 square feet (464 m^2) in area.

C505.2.1 Building thermal envelope. Where a *change of occupancy* or use is made to a whole building that the results in fenestration area greater than the maximum fenestration area allowed by Section C402.4.1, the *building* shall comply with Section C402.1.5, with a proposed UA that shall not be greater than 110 percent of the target UA.

Exception: Where the *change of occupancy* or use is made to a portion of the *building*, the new occupancy is exempt from Section C402.4.1 provided that there is not an increase in fenestration area.

Reason: "Building thermal envelope" is a defined term in the IECC, but "building envelope" and "thermal envelope" are not defined. This proposal attempts to standardize terminology throughout the commercial provisions by replacing all instances of "building envelope" and "thermal envelope" with the defined term "building thermal envelope." Within the commercial provisions of the First Public Comment Draft there are twenty-five uses of "building envelope" and twelve uses of "thermal envelope" that have been changed. If there are technically valid reasons to retain existing terminology in specific situations, please consider amending this proposal for those sections, as necessary.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal modifies terminology without intending to make technical changes. Therefore, there will be no impact on cost of construction.

Workgroup Recommendation

Proposal # 653

CED1-93-22

Proponents: Martha VanGeem, representing Masonry Alliance for Codes and Standards (martha.vangeem@gmail.com); Cortney Fried, representing Brick Industry Association (cfried@bia.org); Scott Campbell, representing NRMCA (scampbell@nrmca.org); Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org); Nicholas Lang, representing Masonry Alliance for Codes & Standards (nlang@ncma.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.
7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical distribution equipment.

~~15. Thermal bridges as identified in Section C402.6.~~

~~16.~~ 15. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable energy system to the point of interconnection with the electrical service and the ESS.

~~17.~~ 16. Location and layout of a designated area for ESS.

~~18.~~ 17. Rated energy capacity and rated power capacity of the installed or planned ESS.

~~**CHI-FACTOR (χ-FACTOR).** The heat loss factor for a single thermal bridge characterized as a point element of a building thermal envelope (Btu/h × °F)[W/K].~~

~~**PSI-FACTOR (ψ-FACTOR).** The heat loss factor per unit length of a thermal bridge characterized as a linear element of a building thermal envelope (Btu/h × ft × °F)[W/(m × K)].~~

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor based method of Section C402.1.2; the R-value based method of C402.1.3; or the component performance alternative of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.

~~7. *Thermal bridges* in *above-grade walls* shall comply with Section C402.7.~~

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

C402.1.4 Component performance alternative. Building envelope values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the *U*-, *F*-, ~~psi-, chi-~~, and *C*-factors in Tables C402.1.2, ~~C402.1.5,~~ and C402.5 and the maximum allowable fenestration areas in Section C402.5.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.5.3.

$$A_P + B_P + C_P + \cancel{T_P} \leq A_T + B_T + C_T + \cancel{T_T} - V_F - V_S$$

A_P = Sum of the (area x U-factor) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies **(Equation 4-1)**

B_P = Sum of the (length x F-factor) for each proposed slab-on-grade edge condition

C_P = Sum of the (area x C-factor) for each proposed below-grade wall assembly

~~T_P = Sum of the (ψL_P) and (χN_p) values for each type of thermal bridge condition of the building thermal envelope as identified in Section C402.6 in the proposed building. For the purposes of this section, the (ψL_P) and (χN_P) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_P shall be assigned as zero.~~

~~ψL_P= psi-factor × length of the thermal bridge elements in the proposed building thermal envelope.~~

~~χN_P = chi-factor x number of the thermal bridge point elements other than fasteners, ties, or brackets in the proposed building thermal envelope.~~

A_T = Sum of the (area x U-factor permitted by Tables C402.1.2 and C402.5) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies

B_T = Sum of the (length x F-factor permitted by Table C402.1.2 for each proposed slab-on-grade edge condition

C_T = Sum of the (area x C-factor permitted by Table C402.1.2) for each proposed below-grade wall assembly

~~T_T = Sum of the (ψL_T) and (χN_T) values for each type of thermal bridge condition in the proposed building thermal envelope as identified in Section C402.6 with values specified as “compliant” in Table C402.1.4. For the purposes of this section, the (ψL_T) and (χNT) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_T shall be assigned as zero.~~

~~ψL_T= (psi-factor specified as “compliant” in Table C402.1.5) × length of the thermal bridge elements in the proposed building thermal envelope.~~

~~χN_T = (chi-factor specified as “compliant” in Table C402.1.5) x number of the thermal bridge point elements other than fasteners, ties, or brackets in the proposed building thermal envelope.~~

P_F = Maximum vertical fenestration area allowable by Section C402.5.1, C402.5.1.1, or C402.5.1.2

Q_F = Proposed vertical fenestration area

$R_F = Q_F – P_F$, but not less than zero (excess vertical fenestration area)

S_F = Area-weighted average U-factor permitted by Table C402.5 of all vertical fenestration assemblies

T_F = Area-weighted average U-factor permitted by Table C402.1.2 of all exterior opaque wall assemblies

$U_F = S_F – T_F$ (excess U-factor for excess vertical fenestration area)

$V_F = R_F$ x U_F (excess UxA due to excess vertical fenestration area)

P_S = Maximum skylight area allowable by Section C402.1.2

Q_S = Actual skylight area

$R_S = Q_S – P_S$, but not less than zero (excess skylight area)

S_S = Area-weighted average U-factor permitted by Table C402.5 of all skylights

T_S = Area-weighted average U-factor permitted by Table C402.1.2 of all opaque roof assemblies

$U_S = S_S – T_S$ (excess U-factor for excess skylight area)

$V_S = R_S$ x U_S (excess UxA due to excess skylight area)

~~A proposed psi- or chi-factor for each thermal bridge shall comply with one of the following as applicable:~~

1. ~~Where the proposed mitigation of a thermal bridge is compliant with the requirements of Section C402.6, the “compliant” values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.~~
2. ~~Where a thermal bridge is not mitigated in a manner at least equivalent to Section C402.6, the “non-compliant” values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.~~
3. ~~Where the proposed mitigation of a thermal bridge provides a psi- or chi-factor less than the “compliant” values in Table C402.1.4, the proposed psi- or chi-factor shall be determined by thermal analysis, testing, or other approved sources.~~

Staff note existing items removed

~~TABLE C402.1.4 PSI- and CHI-FACTORS TO DETERMINE THERMAL BRIDGES FOR THE COMPONENT~~ PERFORMANCE ALTERNATIVE

~~Thermal Bridge per Section C402.6~~	~~Thermal Bridge Compliant with Section C402.6~~		~~Thermal Bridge Non-Compliant with Section C402.6~~	
	~~psi-factor (Btu/h-ft-°F)~~	~~chi-factor (Btu/h-ft-°F)~~	~~psi-factor (Btu/h-ft-°F)~~	~~chi-factor (Btu/h-ft-°F)~~
~~C402.6.1 Balconies, slabs, and decks~~	~~0.2~~	~~n/a~~	~~0.5~~	~~n/a~~
~~C402.6.2 Cladding supports~~	~~0.2~~	~~n/a~~	~~0.3~~	~~n/a~~
~~C402.6.3 Structural beams and columns~~	~~n/a~~	~~1.0-carbon steel~~ ~~0.3-concrete~~	~~n/a~~	~~2.0-carbon steel~~ ~~1.0-concrete~~
~~C402.6.4 Vertical fenestration~~	~~0.15~~	~~n/a~~	~~0.3~~	~~n/a~~
~~C402.6.5 Parapets~~	~~0.2~~	~~n/a~~	~~0.4~~	~~n/a~~

~~For SI: W/m-K = 0.578 Btu/h-ft-°F; 1 W/K = 1.90 Btu/h-°F~~
~~n/a = not applicable~~

~~C402.7~~ ~~Thermal bridges in above-grade walls.~~ ~~Thermal bridges in above-grade walls shall comply with the section or an approved design.~~

Exceptions:

1. ~~*Buildings* and structures located in Climate Zones 0 through 3.~~
2. ~~Any *thermal bridge* with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.~~
3. ~~Blocking, coping, flashing, and other similar materials for attachment of roof coverings.~~
4. ~~*Thermal bridges* accounted for in the *U*-factor or *C*-factor for a *building thermal envelope.*~~

~~C402.7.1 Balconies and floor decks.~~ ~~Balconies and concrete floor decks shall not penetrate the building thermal envelope. Such assemblies shall be separately sup-ported or shall be supported by structural attachments or elements that minimize thermal bridging through the building thermal envelope.~~

~~Exceptions:~~ ~~Balconies and concrete floor decks shall be permitted to penetrate the *building thermal envelope* where:~~

1. ~~an area-weighted *U*-factor is used for *above-grade wall* compliance which includes a *U*-factor of 0.8 Btu/h-°F-ft^2 for the area of the *above-grade wall* penetrated by the concrete floor deck, or~~
2. ~~an approved thermal break device of not less than R-10 is installed in accordance with the manufacturer's instructions.~~

~~C402.7.2 Cladding supports~~. ~~Linear elements supporting opaque cladding shall be off-set from the structure with attachments that allow the continuous insulation, where present, to pass behind the cladding support element.~~

~~Exceptions:~~

1. ~~An *approved* design where the above-grade wall *U*-factor used for compliance accounts for the cladding support element *thermal bridge.*~~
2. ~~Anchoring for curtain wall and window wall systems.~~

~~C402.7.3 Structural beams and columns.~~ ~~Structural steel and concrete beams and columns that project through the *building thermal envelope* shall be covered with not less than R-5 insulation for not less than 2 feet (610 mm) beyond the interior or exterior surface of an insulation component within the *building thermal envelope.*~~

Exceptions:

1. ~~Where an approved thermal break device is installed in accordance with the manufacturer's instructions.~~
2. ~~An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or col-umn thermal bridge.~~

~~C402.7.4 Vertical fenestration.~~ ~~Vertical fenestration intersections with above grade walls shall comply with one or more of the following:~~

1. ~~Where above-grade walls include continuous insulation, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within 2 inches (610 mm) of the interior or exterior surface of the continuous insulation.~~

2. ~~An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column thermal bridge.~~
3. ~~The surface of the rough opening, not coved by the fenestration frame, shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inches (457 mm) thick.~~
4. ~~For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel *U*-factor shall account for *thermal bridges*.~~

Exceptions:

1. ~~Where an approved design for the above-grade wall *U*-factor used for compliance accounts for *thermal bridges* at the intersection with the vertical fenestration.~~
2. ~~Doors~~

~~**C402.7.5 Parapets.** Parapets shall comply with one or more of the following as applicable:~~

1. ~~Where continuous insulation is installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the continuous insulation shall extend up both sides of the parapet not less than 2 feet (610 mm) above the roof covering or to the top of the parapet, whichever is less. Parapets that are an integral part of a fire-resistance rated wall, and the exterior continuous insulation applied to the parapet, shall comply with the fire resistance ratings of the building code.~~
2. ~~Where continuous insulation is installed on the exterior side of the above-grade wall and the roof insulation is below the roof deck, the continuous insulation shall extend up the exterior side of the parapet to not less than the height of the top surface of the roof assembly.~~
3. ~~Where continuous insulation is not installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the wall cavity or integral insulation shall extend into the parapet up to the exterior face of the roof insulation or equivalent R-value insulation shall be installed not less than 2 feet (610 mm) horizontally inward on the underside of the roof deck.~~
4. ~~Where continuous insulation is not installed on the exterior side of the *above-grade wall* and the roof insulation is below the roof deck, the wall and roof insulation components shall be adjacent to each other at the roof-ceiling-wall intersection.~~

~~**Exception:** An *approved* design where the *above-grade wall U*-factor used for compliance accounts for the parapet *thermal bridge*.~~

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

<table>
<tr><th>BUILDING COMPONENT CHARACTERISTICS</th><th>STANDARD REFERENCE DESIGN</th><th>PROPOSED DESIGN</th></tr>
<tr><td>Space use classification</td><td>Same as proposed</td><td>The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.</td></tr>
<tr><td rowspan="5">Roofs</td><td>Type: insulation entirely above deck</td><td>As proposed</td></tr>
<tr><td>Gross area: same as proposed</td><td>As proposed</td></tr>
<tr><td>U-factor: as specified in Table C402.1.2</td><td>As proposed</td></tr>
<tr><td>Solar absorptance: 0.75, except as specified in Section C402.4 and Table C402.4 for Climate Zones 0, 1, 2, and 3</td><td>As proposed</td></tr>
<tr><td>Emittance: 0.90, except as specified in Section C402.4 and Table C402.4 for Climate Zones 0, 1, 2, and 3</td><td>As proposed</td></tr>
<tr><td rowspan="5">Walls, above-grade</td><td>Type: same as proposed</td><td>As proposed</td></tr>
<tr><td>Gross area: same as proposed</td><td>As proposed</td></tr>
<tr><td>U-factor: as specified in Table C402.1.2</td><td>As proposed</td></tr>
<tr><td><s>Thermal bridges: Account for heat transfer consistent with compliant psi- and chi-factors from Table C402.1.4 for thermal bridges as identifiedin Section C402.7 that are present in the proposed design.</s></td><td><s>As proposed; psi and chi-f actors for proposed thermal bridges shall be determined in accordance with requirements in Section C402.1.4.</s></td></tr>
<tr><td>Solar absorptance: 0.75</td><td>As proposed</td></tr>
<tr><td></td><td>Emittance: 0.90</td><td>As proposed</td></tr>
<tr><td rowspan="3">Walls, below-grade</td><td>Type: mass wall</td><td>As proposed</td></tr>
<tr><td>Gross area: same as proposed</td><td>As proposed</td></tr>
<tr><td>U-Factor: as specified in Table C402.1.2 with insulation layer on interior side of walls</td><td>As proposed</td></tr>
<tr><td rowspan="3">Floors, above-grade</td><td>Type: joist/framed floor</td><td>As proposed</td></tr>
<tr><td>Gross area: same as proposed</td><td>As proposed</td></tr>
<tr><td>U-factor: as specified in Table C402.1.2</td><td>As proposed</td></tr>
<tr><td rowspan="2">Floors, slab-on-grade</td><td>Type: unheated</td><td>As proposed</td></tr>
<tr><td>F-factor: as specified in Table C402.1.2</td><td>As proposed</td></tr>
<tr><td rowspan="3">Opaque doors</td><td>Type: swinging</td><td>As proposed</td></tr>
<tr><td>Area: Same as proposed</td><td>As proposed</td></tr>
<tr><td>U-factor: as specified in Table C402.1.2</td><td>As proposed</td></tr>
<tr><td rowspan="3">Vertical fenestration other than opaque doors</td><td>Area<table><tr><td>1.</td><td>The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area.</td></tr><tr><td>2.</td><td>40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.</td></tr></table></td><td>As proposed</td></tr>
<tr><td>U-factor: as specified in Table C402.5</td><td>As proposed</td></tr>
<tr><td>SHGC: as specified in Table C402.5 except</td><td></td></tr>
</table>

	that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 **–** (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 **–** (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 **–** (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

Reason: We are asking that the thermal bridge mitigation portion of the draft that was added by the committee be deleted throughout the draft.
The thermal bridge mitigation proposal in the draft was a committee-developed document, CECPI-4-21, and was developed in the last month or so before the committee action. It was developed primarily by the proponents of conflicting proposals CEPI 33-21, CEPI 40-21, and CEPI 45-21. It was not developed with input from other important stakeholders such as structural engineers who would need to comply with this or the industries who assist designers with design.

We are asking that it be **deleted** or made a non mandatory appendix for the following reasons:

- **This hasn't been tried anywhere for any building.**

- **It hasn't been modeled as a whole building to see if it actually saves energy** under actual weather conditions. Cooling energy costs are now on par with heating energy costs in mild to cold climates through Climate Zone 5. This means that the thermal mass effects of thermal bridges have the potential to reduce peak loads and reduce cooling costs. This proposal focuses on steady-state effects. There is no indication that all these years of modeling buildings without thermal bridges has any impact on predicted loads or sizing calculations.

- **ASHRAE has developed addendum av**, likely to soon be published as part of 90.1-2022. This IECC draft is a severely truncated version of 90.1 addendum av. While this draft content is shorter than addendum av, many assume it is simpler, but it is challenging for compliance for many types of typical construction.

- **ASHRAE addendum av was developed over 8 years**, with significant input from many professionals. This draft in the IECC is oversimplified to the point of not allowing common construction methods.

- **Constructability was not considered and costs were not provided.** Cost effectiveness was not provided as required by ICC in the original proposal. The cost statement indicated it provides "*practical mitigation which does not require significant changes to current practices, setting a relatively low performance bar*." While certain types of construction can easily comply, **typical construction cannot easily comply, which means the draft is not practical**.

- The 20 to 70% savings in the reason statement of the original proposal for the current draft is not related to this proposal (it is an often repeated myth). Just because thermal bridges in some buildings in some climates can result in significant energy loss doesn't mean that this proposal saves that amount of energy**.** California wanted to verify this and did a detailed analysis available online and showed 1% savings; they decided it was not worth the effort in training and compliance because it was so complex. Granted, California is generally warmer and uses different criteria but at least they did an analysis and considered compliance and enforcement. **This proposal will cost the commercial building industry huge design and construction costs with little or no energy saving value.** Just because a concept sounds good doesn't mean a proposal on the topic saves energy.

- **This IECC draft will result in some very forward-thinking jurisdictions attempting to require it** and the rest of the jurisdictions not knowing how to construct buildings or enforce it. It will require education on the new requirements for the design and regulatory communities. Every structural and envelope designer and every plan reviewer and building inspector will need education on these provisions and it takes a long time for the various professional associations to develop and deliver that new content. Big new concepts in a code trigger big new needs for education development and administration.

- **There is no analysis by climate zone.** As we tighten the envelope, more air conditioning and less heating is needed. This changes what saves energy in mixed climate zones.

- As an example of the simple flaws in the document, compliance is required for all fasteners, no matter how small, unless the performance alternative is used.

- Designers are not familiar with **psi and chi factors**. They cannot be calculated except as part of an expensive research project and they are variable depending on the type of thermal bridge and amount of insulation in the adjacent assembly. Values are not available for most assemblies. We do not support the default psi and chi factors in the table because they do not take into account these complexities. The performance alternative of this draft truncates the number of psi and chi factors resulting in significant inaccuracies. **Since users will not be familiar with these, they will think they are accurate when they are not.** They can be off by many multiples.

- **The performance alternative C402.1.4 does not allow the use of actual psi and chi factors for actual thermal bridges.**

- **In Section C402.7.1, Balconies and floor decks, exception 2, an approved thermal break of R-10 is allowed but is much more than what is necessary for a thermal break.** Consider that wood blocking, which is allowed as an exception, has an R-value of about R-1 or less. Even smaller thermal breaks in windows are effective.

- **In Section C402.7.2, Cladding supports, the language is flawed** as it does not allow for structural attachments for cladding systems, as allowed for anchoring in exception 2 for curtain walls. It is not clear how brick cladding on off-set shelf angles can be supported.

- **C402.7 allows exceptions for flashing on the roof but not around windows or dissimilar wall materials.** This proposal does not have input from the construction industry.

- **ACI/TMS 122.1,** “Thermal Bridge Mitigation for Buildings Having Concrete and Masonry Walls and Masonry Veneer— Code Requirements,” is the code for mitigating thermal bridges developed by concrete and masonry professionals. This should be considered an alternate path. ASHRAE 90.1-2022 or ASHRAE 90.1-2019, addendum av (both have the same criteria), are also an acceptable, stakeholder developed method.

- **The biggest thermal bridge in a building is the fenestration.** To put this in perspective, a slab edge has the same steady state heat transfer as a strip of fenestration one foot high. Granted a slab edge has thermal mass and glass has other benefits, but this is an example of the oversimplification of this proposal.

- The thermal bridge mitigation requirements in the current draft is applicable for walls with board insulation on the outside of the building, but this is not the way many buildings are constructed. Many buildings have a hard exterior surface for security, durability, resilience, or local reasons. ACI/TMS 122.1 provides an alternative for these types of construction and cladding attachments.

- The proposal does not provide industry time to adapt to radical changes in the way buildings are constructed.

Cost Impact: The code change proposal will decrease the cost of construction.
This removes the thermal bridge mitigation requirements that were added with no cost and energy savings justification. It will reduce the cost of construction.

Workgroup Recommendation

Proposal # 691

CED1-94-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor ~~based~~ method of Section C402.1.2; the R-value ~~based~~ method of C402.1.3; or the component performance method ~~alternative~~ of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with C402.6.

~~6.~~ 7. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.

~~7.~~ 6. *Thermal bridges* in *above-grade walls* shall comply with Section C402.7.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

C402.1.2 Assembly U-factor, C-factor or F-factor~~-based~~ method. *Building thermal envelope* opaque assemblies shall have a *U*-, *C*- or *F*-factor not greater than that specified in Table C402.1.2. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *U*-, *C*- or *F*-factor from the "*Group R*" column of Table C402.1.2. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *U*-, *C*- or *F*-factor from the "All other" column of Table C402.1.2

C402.1.3 Insulation component R-value method ~~alternatives~~. For opaque portions of the *building thermal envelope* using this section as an alternative to Section C402.1.2, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *R*-values from the "*Group R*" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table C402.1.3.

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE METHOD ~~ALTERNATIVES~~ [a]

Portions of table not shown remain unchanged.

C402.1.4 Component performance method ~~alternative~~. Building envelope values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the *U*-, *F*-, psi-, chi-, and *C*-factors in Tables C402.1.2, C402.1.5, and C402.5 and the maximum allowable fenestration areas in Section C402.5.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.5.3.
(remainder of section unchanged)

Reason: This proposal is a clean-up so that the U-factor, R-value, and component performance methods are all titled the same and referenced the same in Section C402.1. These editorial changes also make the section titles consistent with the titles of Tables C402.1.2 and C402.1.3. Also, two items listed in Section C402.1 are re-ordered to align with the sequence of requirements and sections in C402.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is editorial in making section and table titles consistent. There are no changes in requirements.

Workgroup Recommendation

Proposal # 720

CED1-95-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor based method of Section C402.1.2; the R-value based method of C402.1.3; or the component performance alternative of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5. Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.
5. Air leakage of the building thermal envelope shall comply with C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.
7. *Thermal bridges* in *above-grade walls* shall comply with Section C402.7.

~~Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.~~

Reason: This proposal is editorial clean-up and merely moves a "dangling" allowance for fenestration into item 5 of the list where fenestration is specifically addressed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal makes no technical change and moves existing text to a more appropriate location.

Workgroup Recommendation

Proposal # 721

CED1-96-22

Proponents: Martha VanGeem, representing Masonry Alliance for Codes and Standards; Cortney Fried, representing Brick Industry Association (cfried@bia.org); Scott Campbell, representing NRMCA (scampbell@nrmca.org); Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org); Nicholas Lang, representing Masonry Alliance for Codes & Standards (nlang@ncma.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor based method of Section C402.1.2; the R-value based method of C402.1.3; or the component performance alternative of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.
7. *Thermal bridges* ~~in *above-grade walls*~~shall comply with one of the following:

   7.1 Section C402.7

   7.2 ASHRAE/IES Standard 90.1, Section 5.5.5 Linear Thermal Bridges and Point Thermal Bridges.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Reason: This proposal to the IECC brings the prescriptive portion of the ASHRAE 90.1 thermal bridge mitigation requirements into the IECC as an alternative path. During the last eight years, the ASHRAE 90.1 committee has developed a comprehensive proposal to reduce heat losses through thermal bridges in buildings (addendum av to ASHRAE 90.1-2019 which will be included in 90.1-2022 to be published soon). It is being added as a reference to a section because the requirements are comprehensive and extensive. It is more comprehensive and accurate than the requirements in the current IECC draft. This section number with the requirements is in ASHRAE/IES 90.1-2022, to be published soon. It is also available on the ASHRAE website as addendum av at this link. (or go to ASHRAE.org for technical resources/standards & guidelines/standards addenda/90.1-2019/addendum av)
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_av_20220729.pdf
The ASHRAE standing standards project committee SSPC 90.1 received public review from stakeholders and resolved many of their comments through an ANSI public review process over many years. The individual criteria measures that were analyzed were found to be **cost effective** on their own using the ASHRAE method for cost effectiveness. The proposal covers reduction of heat losses through roof edges, parapets, floor edges, projections including balconies, exterior cladding supports including shelf angles, wall/window interfaces, and other large penetrations through the building envelope. It is more detailed than the current draft but is more applicable to actual construction.

The thermal bridge mitigation criteria in the current draft was developed quickly and has some flaws, which is why this proposal should be considered as an alternative. The thermal bridge mitigation proposal in the draft was a committee-developed document, CECPI-4-21, and was developed in the last month or so before the committee action. It was developed primarily by the proponents of conflicting proposals CEPI 33-21, CEPI 40-21, and CEPI 45-21. It was not developed with input from other important stakeholders such as structural engineers who would need to comply with this or the industries that guide the design.

- The current IECC draft is a severely truncated version of 90.1 addendum av. While it is shorter, many assume that it is simpler, but it is challenging for compliance for many types of typical construction.

- The current draft **hasn't been tried anywhere for any building.**

- The current draft **hasn't been modeled as a whole building to see if it actually saves energy** under actual weather conditions. Cooling energy costs are now on par with heating energy cost in mild to cold climates through Climate zone 5. This means that the thermal mass effects of thermal bridges have to potential to reduce peak loads and reduce cooling costs. There is no indication that all these years of modeling buildings without thermal bridges has any impact on predicted loads or sizing calculations.

- **Constructability was not considered and costs were not provided for the requirements in the current draft.** Cost effectiveness was not provided as required by ICC. The cost statement indicates it provides "*practical mitigation which does not require significant changes to current practices, setting a relatively low performance bar*." While certain types of construction can easily comply, **typical construction cannot easily comply, which means the IECC draft is not practical**.

- The 20 to 70% savings in the reason statement provided with the requirements in the current draft is an often-repeated myth. Just because thermal bridges in some buildings in some climates can result in significant energy loss doesn't mean that this proposal saves that amount of energy**.** California wanted to verify this and did a detailed analysis available online and showed 1% savings; they decided it was not worth the effort in training and compliance because it was so complex. Granted, California is generally warmer and uses different criteria but at least they did an analysis and considered compliance and enforcement.

- This current requirements in the draft will cost the commercial building industry huge design and construction costs with little or no energy saving value. Just because a concept sounds good doesn't mean a proposal on the topic saves energy.

- **There is no analysis by climate zone** for the current requirements in the draft – as we tighten the envelope, more air conditioning and less heating is needed. This changes what saves energy for mixed climate zones.

- As an example of the simple flaws in the current requirements, compliance is required for all fasteners, no matter how small, unless the performance alternative is used.

- **The performance alternative C402.1.4 does not allow the use of actual psi and chi factors for actual thermal bridges.**

- In Section C402.7.1, **Balconies and floor decks, exception 2, an approved thermal break of R-10 is allowed but is much more than what is necessary for a thermal break.** Consider that wood blocking, which is allowed as an exception, has an R-value of about R-1 or less. Even smaller thermal breaks in windows are effective.

- **In Section C402.7.2, Cladding supports, the language is flawed** as it does not allow for structural attachments for cladding systems, as allowed for anchoring in exception 2 for curtain walls. It is not clear how brick cladding on offset shelf angles can be supported.

- **C402.7 allows exceptions for flashing on the roof but not around windows or dissimilar wall materials.**

- The thermal bridge mitigation requirements in the current draft work for walls with board insulation on the outside of the building, but this is not the way many buildings are constructed. Many buildings have a hard exterior surface for security, durability, resilience, or local reasons. ASHRAE 90.1 provides an alternative for these types of construction and cladding attachments.

- The current draft does not provide industry time to adapt to radical changes in the way buildings are constructed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal contains an alternative that will not increase the cost of construction compared to what is in the current draft.

Workgroup Recommendation

Proposal # 730

CED1-97-22

Proponents: Martha VanGeem, representing Masonry Alliance for Codes and Standards; Scott Campbell, representing NRMCA (scampbell@nrmca.org); Stephen Szoke, representing American Concrete Institute (steve.szoke@concrete.org); Nicholas Lang, representing Masonry Alliance for Codes & Standards (nlang@ncma.org); Cortney Fried, representing Brick Industry Association (cfried@bia.org); Brian Trimble, representing International Masonry Institute (btrimble@imiweb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor based method of Section C402.1.2 ; the R-value based method of C402.1.3; or the component performance alternative of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.
7. *Thermal bridges* ~~in above-grade walls~~ shall comply with one of the following:

   7.1. Section C402.7.

   7.2. ACI/TMS 122.1

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

CHAPTER 6 [CE]
REFERENCED STANDARDS

Add new text as follows:

ACI American Concrete Institute, 38800 Country Club Dr., Farmington Hills, MI 48331. ACI Code 122.1-2021 Thermal Bridge Mitigation for Buildings Having Concrete and Masonry Walls and Masonry Veneer—Code Requirements
C402.1

Reason: This proposal to the IECC brings the ACI/TMS 122.1 code on thermal bridge mitigation requirements into the IECC as an alternative path. It includes requirements at slab edges, for parapets, and for shelf angles.
ACI-TMS 122.1-21 is a joint code written using ACI's consensus process including a public comment period and numerous committee ballots at each stage of the process. ACI is an ANSI standards developer and also uses this process for ACI 318 which is the concrete building code. Work began in 2018 to develop a consensus standard by the industry that pushed the concrete and masonry industry further to mitigate thermal bridges but was easier to understand, and therefore would find adoption. The concrete and masonry industry considers themselves leaders in developing this. Use of this code will incur additional expenses in building design and construction but will help mitigate thermal bridges.

ACI-TMS 122.1-21 is free to all code officials as are all ACI codes and standards referenced in codes. Code officials can send an email to codes @concrete.org to obtain a complimentary copy. ACI-TMS 122.1-21 is also added to the reference section.

Alternatives. It is not unusual for the IECC to have separate criteria for separate kinds of walls systems developed by an industry following ANSI procedures. Section R402.1 has an exception for log homes designed according to ICC 400, Standard on the Design and Construction of Log Structures. Using this exception, log homes do not have to follow the IECC residential insulation requirements for walls.

It is common for alternatives and exceptions in the IECC to have different energy savings. For instance, in the IECC 2021, Section C402.4.1 on maximum vertical fenestration area provides alternatives with different energy savings as does section C402.4.2 on minimum skylight fenestration area. Complying with the U factor table (Table C402.1.4) or the R-value table (Table C402.1.3) will provide different energy savings. Exception 2 in section C402.7 of the current draft (for low thermal conductivity materials such as wood) to the thermal bridging requirements provides different energy savings because it allows extensive wood thermal bridges. Compliance with ICC 400 provides different energy savings than the IECC.

Different methods, alternatives, and exceptions consider various costs of construction and are also provided for easy of compliance.

Benefits. The benefit of this standard is that it provides constructible options, and it is easy to understand and implement. This will lead to better adoption, compliance by industry, and enforcement by code officials. The thermal bridge mitigation requirements in the current draft work for walls with board insulation on the outside of the building, but this is not the way many buildings are constructed. Many buildings have a hard exterior surface for **security, durability, resilience**, or local reasons. ACI 122.1 provides an alternative for these types of construction and cladding attachments.

The thermal bridge mitigation criteria in the current draft were developed quickly and have some flaws, which is why this proposal should be considered as an alternative. The thermal bridge mitigation proposal in the draft was a committee-developed document, CECPI-4-21, and was developed in the last month or so before the committee action. It was developed primarily by the proponents of conflicting proposals CEPI 33-21, CEPI 40-21, and CEPI 45-21. It was not developed with input from other important stakeholders, such as structural engineers who would need to comply with this or the industries that guide the design.

- The current draft hasn't been tried anywhere for any building.

- **The current draft hasn't been modeled as a whole building to see if it actually saves energy** under actual weather conditions. Cooling energy costs are now on par with heating energy costs in mild to cold climates through Climate Zone 5. This means that the thermal mass effects of thermal bridges have the potential to reduce peak loads and reduce cooling costs. There is no indication that all these years of modeling buildings without thermal bridges has any impact on predicted loads or sizing calculations.

- **Constructability was not considered and costs were not provided for the requirements in the current draft.** Cost effectiveness was not provided as required by ICC. The cost statement for the current draft indicates it provides "practical mitigation which does not require significant changes to current practices, setting a relatively low performance bar." While certain types of construction can easily comply, typical construction cannot easily comply, which means the current draft is not practical.

- The 20 to 70% savings in the reason statement provided with the requirements in the current draft is an often-repeated myth. Just because thermal bridges in some buildings in some climates can result in significant energy loss doesn't mean that this proposal saves that amount of energy. California wanted to verify this and did a detailed analysis available online and showed 1% savings; they decided it was not worth the effort in training and compliance because it was so complex. Granted, California is generally warmer and uses different criteria but at least they did an analysis and considered compliance and enforcement. This current requirements in the draft will cost the commercial building industry huge design and construction costs with little or no energy saving value. Just because a concept sounds good doesn't mean a proposal on the topic saves energy.

- There is no analysis by climate zone for the current requirements in the draft – as we tighten the envelope, more air conditioning and less heating is needed. This changes what measures save energy for mixed climate zones.

- As an example of the simple flaws in the current draft requirements, compliance is required for all fasteners, no matter how small, unless the performance alternative is used.

- The performance alternative C402.1.4 **does not allow the use of actual psi and chi factors** for actual thermal bridges.

- In Section C402.7.1, Balconies and floor decks, exception 2, an approved thermal break of R-10 is allowed but is much more than what is necessary for a thermal break. Consider that wood blocking, which is allowed as an exception, has an R-value of about R-1 or less. Even smaller thermal breaks in windows are effective.

- In Section C402.7.2, Cladding supports, the language is flawed as **it does not allow for structural attachments** for cladding systems, as allowed for anchoring in exception 2 for curtain walls. It is not clear how brick cladding on offset shelf angles can be supported.

- C402.7 allows exceptions for flashing on the roof but not around windows or dissimilar wall materials.

- The thermal bridge mitigation requirements in the current draft work for walls with board insulation on the outside of the building, but this is not the way many buildings are constructed. Many buildings have a hard exterior surface for security, durability, resilience, or local reasons. ACI/TMS 122.1 provides an alternative for these types of construction and cladding attachments.

- The current draft does not provide industry time to adapt to radical changes in the way buildings are constructed.

In addition, this needs to be added to Chapter 6:

ACI.

American Concrete Institute, 38800 Country Club Dr., Farmington Hills, MI 48331

ACI Code 122.1-2021 Thermal Bridge Mitigation for Buildings Having Concrete and Masonry Walls and Masonry Veneer—Code Requirements

Section C402.1.6

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal contains an alternative that will not increase the cost of construction compared to what is in the current draft.

Workgroup Recommendation

Proposal # 732

CED1-98-22

Proponents: Brian Trimble, representing International Masonry Institute (btrimble@imiweb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either: S ection C402.1.2 ~~the~~ (U-, C- and F-factor based method) ~~of Section C402.1.2~~ ; ~~the~~ Section C402.1.3 (R-value based method) ~~of C402.1.3~~; or ~~the~~ Section C402.1.4 (component performance alternative) ~~of Section C402.1.4~~. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.
7. *Thermal bridges* in *above-grade walls* shall comply with Section C402.7.

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Reason: It is more appropriate to list the Section numbers first and then the title of the section so that it is easier to read.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Proposal # 850

CED1-99-22

Proponents: Sumit Sunthankar, representing Custom Instrumentation Services Corporation (ssunthankar@ciscocems.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.1.3 Equipment Building. Buildings that comply with the following shall be exempt from the *building thermal envelope* provisions of this code:

1. Are separate buildings with floor area not more than 1,200 square feet (110 m^2).
2. Are intended to house electric equipment with installed equipment power totaling not less than 7 watts per square foot (75 W/m^2) and not intended for human occupancy.
3. Have a heating system capacity not greater than ~~(17,000 Btu/hr) (5 kW)~~ (20,000 Btu/hr) (6kW) and a heating thermostat setpoint that is restricted to not more than 50°F (10°C).
4. Have an average wall and roof *U*-factor less than 0.200 in *Climate Zones* 1 through 5 and less than 0.120 in *Climate Zones* 6 through 8.
5. Comply with the roof solar reflectance and thermal emittance provisions for *Climate Zone* 1.
6. Equipment buildings intended to house environmentally sensitive equipment, not intended for human occupancy, and not exceeding 1000 sq. ft. will be exempt from the building thermal envelope provisions of this code.

Reason: Our company, Custom Instrumentation Services Corporation which is located in Denver, Colorado, manufactures small, steel commercial equipment shelters for shipment all around the country. These shelters, generally anywhere from an 8'x8' size to a 12’x20’ size, house sensitive analyzer equipment that monitors the chemical emissions of power plants and other sources for environmental purposes, as well as other electronic components. The analyzer equipment, which monitor these emissions, are working continuously and they generate a lot of heat when monitoring therefore, because our shelters are small, the shelters are naturally heated by this equipment. We install an HVAC unit on the shelter keep the shelter cool to the appropriate set temperature and occasionally, due to customer requests, we install 2 HVAC units on the shelter where one is a redundant or backup unit in case of failure. These HVAC units are rarely used to heat the shelters, perhaps only in extreme cold conditions outside or when the analyzers are down due to failure or maintenance. Also, our shelters are unmanned/unoccupied so they generally fall under a U occupancy code. With the current IECC code standards for thermal envelope, if the criteria under section C402.1.2 for equipment buildings are not met, we are required to install anywhere from 3-6 inches of insulation inside and around our shelters between the interior and exterior panels. Because the shelter is already generating heat from the analyzers, this extra insulation requires us to install larger HVAC units than needed on the shelter in order to keep them cool which is counter-intuitive and an inefficient use of energy. During the winter months when the temperature is colder, if additional insulation is added, the HVAC will be producing more cooling energy which is counterintuitive to what we need since the shelters should be cooling naturally from the outside air. The attached HVAC calculation files provides the details on this. From our calculations and based on a temperature at 0 degrees Fahrenheit and 75 degree shelter temperature, if more insulation is added on our calculations for the HVAC unit, then the cooling BTU energy increases. Generally, another 1000 Btu/hr or so of cooling is generated by the HVAC for every inch of insulation that is added to the shelter walls, floor, and ceiling. The proposed revision to add exception item #6 under the C402.1.1.3 code is an exemption for small equipment buildings that house electronic components generating heat. Back in 2018, the State of Colorado voted to add the same statement in their Administrative Rules for Building Codes and Standards. If the exemption above cannot be received, then we have another proposal in regard to section C402.1.2 item 3 for the heating system capacity criteria of 17,000 Btu/hr (5kW). This capacity is insufficient and low for our shelters so we would like to propose increasing the heating system capacity to 20,000 Btu/hr (6kW). We cannot purchase an HVAC unit from our vendors that are lower than this capacity to meet the cooling requirements for the analyzer equipment in our shelters. Since our shelters require a 480V 3-phase electrical system and an HVAC unit with a large cooling capacity, generally between 20-30 kBTU/hr, the minimum that we can purchase is a unit with a 6 kW heating capacity.

Cost Impact: The code change proposal will decrease the cost of construction.
This change should decrease the cost of construction since less insulation material will be needed if the exemption is provided. This also means that there will be less HVAC energy usage since the equipment will provide the heating in the shelter. We may be able to save on HVAC unit costs if the full exemption is provided for equipment buildings.

Attached Files

- **HVAC Calc Data for Code Change Proposal-6 Inch Insulation.pdf**
  https://energy.cdpaccess.com/proposal/793/1503/files/download/355/

- **HVAC Calc Data for Code Change Proposal-3 Inch Insulation.pdf**
  https://energy.cdpaccess.com/proposal/793/1503/files/download/354/
- **2024 IECC Amendment Proposal updated 10-19-22.docx**
  https://energy.cdpaccess.com/proposal/793/1503/files/download/353/

Workgroup Recommendation

Proposal # 793

CED1-100-22

Proponents: Martha VanGeem, representing Masonry Alliance for Codes and Standards; Emily Lorenz, representing self (emilyblorenz@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C402.1.2 OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-0.077	U-0.077	U-0.077	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.055	U-0.055	U-0.049	U-0.049	U-0.049	U-0.042	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.032	U-0.032
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

For SI: 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.

b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.

c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.

d. “Mass floors” shall be in accordance with Section C402.1.3.6~~C402.2.3~~.

e. These *C*-, *F*- and *U*-factors are based on assemblies that are not required to contain insulation.

f. “Mass walls” shall be in accordance with Section C402.1.3.6~~C402.2.2~~.

g. Swinging door *U*-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly *U*-factor less than or equal to 0.44 in Climate Zones 0 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

C402.1.2.1.4 Mass walls and floors. Compliance with required maximum U-factors for mass walls and mass floors in accordance with Table C402.1.2 shall be permitted for assemblies complying with Section C402.1.3.~~3~~ 6.

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE ALTERNATIVES [a]

Portions of table not shown remain unchanged.

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.2.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted not less than 32 inches or less on center vertically and not less than 48 inches on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 ° F.

d. Where heated slabs are below grade, below-grade walls shall comply with the R-value requirements for above-grade mass walls .

e. “Mass floors” shall be in accordance with Section C402.1.3.6~~2.3~~.

f. “Mass walls” shall be in accordance with Section C402.1.3.6~~2.2~~.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation and full-slab insulation components shall be installed in accordance with Section C402.2.4.1 .

h. The first value is *cavity insulation*; the second value is *continuous insulation*. Therefore, “R-0+R-12ci” means R-12 *continuous insulation* and no *cavity insulation*; “R-13+R-3.8ci” means R-13 *cavity insulation* and R-3.8 *continuous insulation*; “R-20” means R-20 *cavity insulation* and no *continuous insulation*. R-13, R-20, and R-27 *cavity insulation* as used in this table apply to a nominal 4-inch (101 mm), 6-inch (152 mm), and 8-inch (203 mm) deep wood or cold-formed steel stud cavities, respectively.

C402.1.3.6 Mass walls and mass floors. Compliance with required maximum U-factors for mass walls and mass floors in accordance with Table C402.1.2 and minimum R-values for insulation components applied to mass walls and mass floors in accordance with Table C402.1.3 shall be permitted for assemblies complying with the following:

1. Where used as a component of the building thermal envelope, mass walls shall comply with one of the following:

   1.1 Weigh not less that 35 pounds per square foot (171 kg/m^2) of wall surface area.

   1.2 Weigh not less than 25 pounds per square foot (122 kg/m^2) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m^3).

   1.3 Have a heat capacity exceeding 7 Btu/$ft^2 \times$ ºF (144 kJ/$m^2 \times$ K).

   1.4 Have a heat capacity exceeding 5 Btu/$ft^2 \times$ ºF (103 kJ/$m^2 \times$ K) where the material weight is not more than 120 pcf (1900 kg/m^3).

2. Where used as a component of the building thermal envelope of a building, the minimum weight of mass floors shall comply with provide one of the following:

   2.1 35 pounds per square foot (171 kg/m^2)of floor surface area.

   2.2 25 pounds per square foot (122 kg/m^2) of floor surface area where the material weight is not more than 120 pcf (1900 kg/m^3).

Reason: This proposal fixes Section C402.1.3.6, on mass walls and mass floors, to clarify the definition of mass walls and mass floors for U-factor compliance. It also fixes several errata of several section numbers.
First, although the pointers from the U-factor table, footnotes d and f, when corrected for errata, point to Section C402.1.3.6., this section says that mass walls and mass floors are used for the R-value table, Table C402.1.3. This new text clarifies that these definitions for mass walls and mass floors in Section C402.1.3.6 also apply to the U-factor table, C402.1.2.

The word "mass" has been added before "floors" in the section header of C402.1.3.6 so that users searching for "mass floors" clearly land in this section.

Errata:

C402.1.2.1.4 should point to Section C402.1.3.6.

Footnotes e and f in Table C402.1.3 should point to C402.1.3.6.

Footnotes d and f in Table C402.1.2 should point to C402.1.3.6.

Corrected superscripts and various degree and multiplication symbols in C402.1.3.6

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal clarifies text and fixes errata, so it does not affect the cost of construction.

Workgroup Recommendation

Proposal # 856

CED1-101-22

Proponents: Jeff Bradley, representing American Wood Council (jbradley@awc.org); Matthew Hunter, representing American Wood Council (mhunter@awc.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C402.1.2 OPAQUE THERMAL ENVELOPE ASSEMBLY MAXIMUM REQUIREMENTS, U-FACTOR METHOD[a, b]

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**	**All other**	**Group R**
Roofs																
Insulation entirely above roof deck	U-0.048	U-0.039	U-0.039	U-0.039	U-0.039	U-0.039	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.032	U-0.028	U-0.028	U-0.028	U-0.028
Metal buildings	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.035	U-0.031	U-0.029	U-0.029	U-0.029	U-0.026	U-0.026
Attic and other	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.021	U-0.017	U-0.017	U-0.017	U-0.017
Walls, above grade																
Mass[f]	U-0.151	U-0.151	U-0.151	U-0.123	U-0.123	U-0.104	U-0.104	U-0.090	U-0.090	U-0.080	U-0.080	U-0.071	U-0.071	U-0.071	U-0.037	U-0.037
Metal building	U-0.079	U-0.079	U-0.079	U-0.079	U-0.079	U-0.052	U-0.052	U-0.050	U-0.050	U-0.050	U-0.050	U-0.050	U-0.044	U-0.039	U-0.039	U-0.039
Metal framed	U-~~0.077~~ 0.064	U-~~0.077~~ 0.064	U-~~0.077~~ 0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-~~0.055~~ 0.051	U-~~0.055~~ 0.051	U-~~0.049~~ 0.051	U-~~0.049~~ 0.051	U-~~0.049~~ 0.051	U-~~0.042~~ 0.051	U-0.037	U-0.037
Wood framed and other[c]	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.064	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-0.051	U-~~0.032~~ 0.037	strike U-0.032 0.037
Walls, below grade																
Below-grade wall[c]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-1.140[e]	C-0.119	C-0.092	C-0.119	C-0.092	C-0.092	C-0.063	C-0.063	C-0.063	C-0.063	C-0.063
Floors																
Mass[d]	U-0.322[e]	U-0.322[e]	U-0.107	U-0.087	U-0.074	U-0.074	U-0.057	U-0.051	U-0.057	U-0.051	U-0.051	U-0.051	U-0.042	U-0.042	U-0.038	U-0.038
Joist/framing	U-0.066[e]	U-0.066[e]	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.033	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027	U-0.027
Slab-on-grade floors																
Unheated slabs	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.73[e]	F-0.54	F-0.52	F-0.52	F-0.52	F-0.51	F-0.51	F-0.434	F-0.51	F-0.434	F-0.434	F-0.424
Heated slabs	F-0.69	F-0.69	F-0.69	F-0.69	F-0.66	F-0.66	F-0.62	F-0.62	F-0.62	F-0.62	F-0.62	F-0.602	F-0.602	F-0.602	F-0.602	F-0.602
Opaque doors																
Nonswinging door	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31
Swinging door[g]	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37	U-0.37
Garage door < 14% glazing[h]	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31	U-0.31

For SI: 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Where assembly *U*-factors, *C*-factors and *F*-factors are established in ANSI/ASHRAE/IESNA 90.1 Appendix A, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table, and provided that the construction, excluding the cladding system on walls, complies with the appropriate construction details from ANSI/ASHRAE/ISNEA 90.1 Appendix A.

b. Where *U*-factors have been established by testing in accordance with ASTM C1363, such opaque assemblies shall be a compliance alternative where those values meet the criteria of this table. The *R*-value of continuous insulation shall be permitted to be added to or subtracted from the original tested design.

c. Where heated slabs are below grade, below-grade walls shall comply with the *U*-factor requirements for above-grade mass walls.

d. “Mass floors” shall be in accordance with Section C402.2.3.

e. These *C*-, *F*- and *U*-factors are based on assemblies that are not required to contain insulation.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. Swinging door *U*-factors shall be determined in accordance with NFRC-100.

h. Garage doors having a single row of fenestration shall have an assembly *U*-factor less than or equal to 0.44 in Climate Zones 0 through 6 and less than or equal to 0.36 in Climate Zones 7 and 8, provided that the fenestration area is not less than 14 percent and not more than 25 percent of the total door area.

Reason: Reason:
By using the same reference U-factors, frame walls will be evaluated to a single target U-factor in all climate zones. This change would result in wood frame and metal frame walls being required to meet the same performance target in Table C402.1.4. This proposed change is intended to eliminate the inequitable treatment of framing materials that are created by requiring different energy performance requirements. Note that this change eliminates a material bias that is in direct conflict with the preface of the IECC that states “*This code is founded on the principles intended to establish … provisions that do not give preferential treatment to particular types or classes of materials, products, or methods of construction.*”

Cost Impact: The code change proposal will increase the cost of construction.
In some cases this proposal will slightly decrease costs and in some cases this proposal will slightly increase costs; however it treats all framed wall systems equitably.

Workgroup Recommendation

Proposal # 831

CED1-102-22

Proponents: Glen Clapper, representing National Roofing Contractors Association (gclapper@nrca.net)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.2.1.1 Tapered, above-deck insulation based on thickness . For tapered, above-deck roof insulation, the area-weighted U-factor of nonuniform insulation thickness shall be determined by accepted engineering practice. The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

> **Exception:** The area-weighted U-factor shall be permitted to be determined by using the inverse of the average R-value determined in accordance with the exception to Section C402.1.3.2.

C402.1.3.2 Area-weighted averaging of R-values . Area-weighted averaging shall not be permitted for R-value compliance.

> **Exception:** For tapered above-deck roof insulation, compliance with the R-values required in Table C402.1.3 shall be permitted to be demonstrated by the average R-value determined by multiplying the rated R-value per inch of the insulation material by the average thickness of the roof insulation. The average thickness of the roof insulation shall equal the total volume of the roof insulation divided by the area of the roof. The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

Reason: This proposal is an errata for language contained in CEPI-47 AM applying a minimum thickness for tapered, above-deck insulation, as intended, that was omitted in the reorganization of Section C402.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Proposal # 872

CED1-103-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

C402.1.2.1.2 Suspended ceilings. Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the assembly *U*-factor of the roof-ceiling construction.

C402.1.3.3 Suspended ceilings. Insulation installed on suspended ceilings having removable ceiling tiles shall not be considered part of the minimum thermal resistance (R-value) of roof insulation in roof-ceiling construction.

Reason: This proposal restores the suspended ceiling provision that was inadvertently deleted entirely from the code by conflicted actions on CEPI-27 (as modified/replaced) and CEPI-41, both of which did not intend to entirely delete this provision. This proposal adds the suspended ceiling under the U-factor determination requirements and also the R-value compliance provisions since it applies to both.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not impact cost because it is restoring a provision that was not intended to be deleted during the public input phase of developing the draft IECC standard.

Workgroup Recommendation

Proposal # 757

CED1-104-22

Proponents: Greg Johnson, representing Johnson & Associates Consulting Services (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Delete without substitution:

~~**C402.1.2.1.3 Concrete masonry units, integral insulation**~~ **.** ~~Where determining compliance with Table C402.1.2, the U-factor of concrete masonry units with integral insulation shall be permitted to be used.~~

Reason: Duplicative language removed.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Editorial.

Workgroup Recommendation

Proposal # 863

CED1-105-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.2.1.4 Mass walls and floors. Compliance with required maximum U-factors for mass walls and mass floors in accordance with Table C402.1.2 shall be permitted for assemblies complying with the following: ~~Section C402.1.3.3~~.

1. Where used as a component of the building thermal envelope, mass walls shall comply with one of the following:
   1.1 Weigh not less that 35 pounds per square foot (171 kg/m) of wall surface area.

   1.2 Weigh not less than 25 pounds per square foot (122 kg/m) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m).

   1.3 Have a heat capacity exceeding 7 Btu/ft F (144 kJ/m -K).

   1.4 Have a heat capacity exceeding 5 Btu/ft F (103 kJ/m -K) where the material weight is not more than 120 pcf (1900 kg/m).

2. Where used as a component of the building thermal envelope of a building, the minimum weight of mass floors shall comply with provide one of the following:

   2.1 35 pounds per square foot (171 kg/m)of floor surface area.

   2.2 25 pounds per square foot (122 kg/m) of floor surface area where the material weight is not more than 120 pcf (1900 kg/m).

C402.1.3.6 Mass walls and floors. Compliance with required minimum R-values for insulation components applied to mass walls and mass floors in accordance with Table C402.1.3 shall be permitted for assemblies complying with Section C402.1.2.1.4 ~~the following~~:

1. ~~Where used as a component of the building thermal envelope, mass walls shall comply with one of the following:~~

   ~~1.1 Weigh not less that 35 pounds per square foot (171 kg/m) of wall surface area.~~

   ~~1.2 Weigh not less than 25 pounds per square foot (122 kg/m) of wall surface area where the material weight is not more than 120 pcf (1900 kg/m).~~

   ~~1.3 Have a heat capacity exceeding 7 Btu/ft F (144 kJ/m -K).~~

   ~~1.4 Have a heat capacity exceeding 5 Btu/ft F (103 kJ/m -K) where the material weight is not more than 120 pcf (1900 kg/m).~~

2. ~~Where used as a component of the building thermal envelope of a building, the minimum weight of mass floors shall comply with provide one of the following:~~

   ~~2.1 35 pounds per square foot (171 kg/m)of floor surface area.~~

   ~~2.2 25 pounds per square foot (122 kg/m) of floor surface area where the material weight is not more than 120 pcf (1900 kg/m).~~

Reason: This proposal is editorial and moves the mass assembly criteria to the first section where they are addressed in U-factor method of Section C402.1.2. The later reference to mass assemblies in Section C402.1.3 R-value method then references the earlier section and deletes the same criteria in that location.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal makes no change in requirements and just moves existing criteria to a more appropriate location.

Workgroup Recommendation

Proposal # 722

CED1-106-22

Proponents: Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Michael Rosenberg, representing Pacific Northwest National Laboratory (michael.rosenberg@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

WALL, ABOVE-GRADE. A wall associated with the *building thermal envelope* that is more than 15 percent above grade and is on the exterior of the building or any wall that is associated with the *building thermal envelope* that is not on the exterior of the building. This includes, but is not limited to, between-floor spandrels, peripheral edges of floors, roof knee walls, dormer walls, gable end walls, walls enclosing a mansard roof, mechanical equipment petrations and skylight shafts.

Add new text as follows:

C402.1.2.1.5 Area-weighted Averaging of Above-Grade Wall U-factors. For *above-grade walls* which include more than one assembly component type, the area weighted U-factor of the entire *above-grade wall* may be determined by accepted engineering practice.

Revise as follows:

C402.1.2.4 Thermal Resistance of mechanical equipment penetrations. Where the total area of through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above grade wall area, such area shall be calculated as a separate wall assembly, in accordance with either Section C402.1.2.1.5 or Section C402.1.4, ~~with~~ using a published and approved U-factor for that equipment or a default U-factor of 0.5.

Reason: This proposal is editorial and adds language to clarify that above grade wall compliance with U-factor requirements can be based on the area weighted average of different above grade wall components having different U-factors. Without this language it is unclear whether a building meeting the threshold required to account for mechanical equipment penetrations can use the prescriptive U-factor method for demonstrating above grade wall U-factor compliance.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is editorial and does not impact the cost effectiveness of the IECC 2024.

Workgroup Recommendation

Proposal # 650

CED1-107-22

Proponents: Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Michael Rosenberg, representing Pacific Northwest National Laboratory (michael.rosenberg@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

C402.1.2.1.5 Area-weighted Averaging of Above-Grade Wall U-factors. For *above-grade walls* which include more than one assembly component type, the area weighted U-factor of the entire *above-grade wall* may be determined by accepted engineering practice.

Revise as follows:

C402.7.1 Balconies and floor decks. Balconies and concrete floor decks shall not penetrate the building thermal envelope. Such assemblies shall be separately sup-ported or shall be supported by structural attachments or elements that minimize thermal bridging through the building thermal envelope.
Exceptions: Balconies and concrete floor decks shall be permitted to penetrate the *building thermal envelope* where:

1. an area-weighted *U*-factor is used for *above-grade wall* compliance which includes a *U*-factor of 0.8 Btu/h-°F-ft^2 for the area of the *above-grade wall* penetrated by the concrete floor deck in accordance with Section C402.1.2.1.5, or
2. an approved thermal break device of not less than R-10 is installed in accordance with the manufacturer's instructions, or ~~.~~
3. An *approved* design where the *above-grade wall U*-factor used for compliance accounts for all balcony and concrete floor deck *thermal bridges*.

Reason: This proposal is editorial and proposes language to clarify how to account for thermal bridges associated with floors that penetrate the wall plane. New language clarifying that above grade wall U-factors can be area weighted supports compliance Option 1. A new compliance requirement is proposed that aligns with language for the other thermal bridges and would allow a design to use either the Component Alternative Compliance approach or a Performance Compliance path.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not impact cost effectiveness.

Workgroup Recommendation

Proposal # 651

CED1-108-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.2.1.5 ~~**C402.1.2.2 U-factor thermal resistance of c**~~ **Cold-formed steel assemblies.** *U*-factors for building envelopes containing cold-formed steel framed ceilings and walls shall be permitted to be determined in accordance withwith AISI S250 as modified herein.

1. Where the steel-framed wall contains no cavity insulation, and uses continuous insulation to satisfy the U-factor maximum, the steel-framed wall member spacing is permitted to be installed at any on-center spacing.
2. Where the steel-framed wall contains framing at 24 inches (610 mm) on center with a 23 percent framing factor or framing at 16 inches (400 mm) on-center with a 25 percent framing factor, the next lower framing member spacing input values shall be used when calculating using AISI S250.
3. Where the steel-framed wall contains less than 23 percent framing factors the AISI S250 shall be used without any modifications.
4. Where the steel-framed wall contains other than standard C-shape framing members the AISI S250 calculation option for other than standard C-shape framing is permitted to be used.

C402.1.2.1.6 ~~**C402.1.2.3 Thermal Resistance of**~~ **Spandrel Panels.** U-factors of opaque assemblies within fenestration framing systems shall be determined in accordance with the default values in Table C402.1.2.3, ASTM C1363, or ANSI/NFRC 100.

C402.1.2.1.7 ~~**C402.1.2.4 Thermal Resistance of m**~~ **Mechanical equipment penetrations.** Where the total area of through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above grade wall area, such area shall be calculated as a separate wall assembly with a published and approved U-factor for that equipment or a default U-factor of 0.5.

Reason: This proposal is editorial and moves sections that address how to determine U-factors and places them as subsections under Section C402.1.2.1 which is where methods and requirements for determining U-factors are located. In addition the subsection titles are revised to remove reference to "thermal resistance" since the provision is addressing U-factors, not R-values.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal is editorial and does not change requirements. It just places them in the proper location within the intended framework of Section C402.1.2.

Workgroup Recommendation

Proposal # 724

CED1-109-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.2.2 U-factor ~~thermal resistance~~ of cold-formed steel assemblies. *U*-factors for building envelopes containing cold-formed steel framed ceilings and walls shall be permitted to be determined in accordance with~~with~~ AISI S250. For wall assemblies, the application of AISI S250 shall comply with the following: ~~as modified herein.~~

~~1.~~ 3. Where ~~the steel-framed wall contains no cavity insulation, and uses~~ only the R-value of the continuous insulation component is used to ~~satisfy~~ determine the U-factor of a steel-framed wall in accordance with AISI S250 ~~maximum~~, ~~the steel-framed wall member spacing is permitted to be installed at~~ any framing factor or on-center spacing of framing members shall be permitted.

2. Where the steel-framed wall contains framing in addition to top and bottom tracks and studs at a specified spacing, ~~at 24 inches (610 mm) on center with a 23 percent framing factor or framing at 16 inches (400 mm) on center with a 25 percent framing factor ,~~ the ~~next lower~~ framing member spacing input values ~~shall be~~ used to determine the U-factor for the wall in accordance with ~~when calculating using~~ AISI S250 shall be based on the framing factor of the wall assembly as follows:

   a. Framing factor of 0.12 or less, use 24 inches (610 mm) on center.

   b. Framing factor of 0.16 or less, use 16 inches (400 mm) on center.

   c. Framing factor of 0.20 or less, use 12 inches (305 mm) on center.

   d. Framing factor of 0.30 or less, use 6 inches (152 mm) on center.

   The framing factor shall be determined based on the surface area of steel framing members parallel to the exterior plane of the frame wall divided by the surface area of the opaque wall, excluding fenestration and door areas.

~~3.~~ 1. Where the steel-framed wall contains only top and bottom tracks and studs spaced at 24 inches (610 mm), 16 inches (400 mm), 12 inches (305 mm), or 6 inches (152 mm) on center, ~~less than 23 percent framing factors the~~ ~~AISI S250 shall be used without any modifications to~~ the specified framing member spacing shall be used to determine the U-factor for the wall in accordance with AISI S250.

4. Where the steel-framed wall contains other than standard C-shape framing members the AISI S250 calculation option for other than standard C-shape framing is permitted to be used.

Reason: The AISI S250 standard addresses only "clear wall" framing with cold-formed steel studs and top and bottom tracks. The current modifications to AISI S250 in Section C402.1.2.2 in relation to associating framing member spacing to a "framing factor" were needed, but are not accurate and can lead to significant under-estimate (non-conservative) U-factors for assemblies as built vs. as analyzed per AISI S250. In effect, additional wall framing members beyond just the layout studs at a specified on-center spacing are not properly or sufficiently accounted for with the current association of framing factors with stud spacing. This will result, for example, in a steel frame wall assembly with up to a 23% actual framing factor being assigned a U-factor determined using AISI S250 based on a "clear wall" assembly with 24"oc stud spacing with a framing factor of about 10%. This is essentially the reverse of how framing factors are used to conservatively define U-factors for wood framing where a 23% framing factor is actually used to determine the U-factor for the assembly. If the framing factor for steel framing was actually near 23 or 25 percent, then the adjustment needed to AISI S250 would be much greater than achieved by the current modification of using the next lower frame spacing. This proposal addresses the above problems by the following revisions and improvements:

1. First, the list of "modifications" are really conditions or directions for appropriate application of the AISI S250 standard for only steel frame wall assemblies. So, the charging language for the list of "modifications" is revised accordingly.

2. The list is re-ordered to follow a more logical sequence and revised as follows:

   a. Item #1 (previous #3) introduces the framing conditions that are applicable to U-factors determined in accordance with AISI S250 without requiring modification of the frame spacing input values.

   b. Item #2 is revised to address framing conditions that do not apply to the "clear wall" scope of AISI S250 (addressed in Item #1) and provides directions for use of a framing member spacing input to more accurately determine a U-factor per AISI S250 (using its clear wall framing member spacing inputs) based on the actual framing factor of a wall assembly. This provides ability to account for additional framing members that often are present in wall assemblies which include openings for windows and doors and other conditions requiring additional framing beyond a "clear wall" with just top and bottom tracks and studs at a specified on-center spacing. Item #2 also includes direction on how to determine the framing factor for consistency and transparency in application.

c. Item #3 (previous #1) then provides direction for assemblies where continuous insulation is solely relied on to determine the U-factor per AISI S250 and in such case the frame spacing or framing factor does not have an impact on the determined U-factor. The language is revised to allow cavity insulation to be present as often is the case when addressing sound control, even if U-factor compliance is achieved by only the continuous insulation component.

d. Item #4 is unchanged.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is a clarification and avoids potential misapplication of a "framing factor" to proper determination of U-factors for steel frame wall assemblies using the AISI S250 standard.

Workgroup Recommendation

Proposal # 765

CED1-110-22

Proponents: Thomas Culp, representing Glazing Industry Code Committee and Aluminum Extruders Council (culp@birchpointconsulting.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C402.1.2.3 EFFECTIVE U-FACTORS FOR SPANDREL PANELS[a]

Portions of table not shown remain unchanged.

c. This frame type chall be used for systems where a ~~urethan or~~ non-metallic element separates the metal exposed to the exterior from the metal that is exposed to the interior condition.

C402.5.5 Doors. Opaque swinging doors shall comply with Table C402.1.2. Opaque nonswinging doors shall comply with Table C402.1.2. Opaque doors shall be considered as part of the gross area of above-grade walls that are part of the *building thermal envelope*. Opaque doors shall comply with Section C402.5.5.1 or C402.5.5.2. Other doors shall comply with the provisions of Section ~~C402.4.3~~ C402.5.3 for vertical fenestration.

C402.7.4 Vertical fenestration. Vertical fenestration intersections with above grade walls shall comply with one or more of the following:

1. Where above-grade walls include continuous insulation, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within 2 inches (610 mm) of the interior or exterior surface of the continuous insulation.
2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column thermal bridge.
3. The surface of the rough opening, not covered by the fenestration frame, shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inches (457 mm) thick.
4. For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel *U*-factor shall account for *thermal bridges*.

Exceptions:

1. Where an approved design for the above-grade wall *U*-factor used for compliance accounts for *thermal bridges* at the intersection with the vertical fenestration.
2. Doors

C406.2.1.1 EO1 Improved envelope performance 901 Appendix C. *Building* envelope measures shall be installed to improve the energy performance ofthe project. The achieved energy credits shall be determined using Equation 4-15.

(Equation 4-15)

$$EC_{ENV} = 1000 \text{ X } (EPF_B - EPF_P)/EPF_B$$

EC_{ENV}= E01 measure energy credits
EPFB= base envelope performance factor calculated in accordance with ASHRAE 90.1~~-2019~~ Appendix C.
EPF_P= proposed envelope performance factor calculated in accordance with ASHRAE 90.1~~-2019~~ Appendix C.

C505.2.1 Building envelope. Where a *change of occupancy* or use is made to a whole building that the results in fenestration area greater than the maximum fenestration area allowed by Section ~~C402.4.1~~ C402.5.1, the *building* shall comply with Section C402.1.5, with a proposed UA that shall not be greater than 110 percent of the target UA.

Exception: Where the *change of occupancy* or use is made to a portion of the *building*, the new occupancy is exempt from Section ~~C402.4.1~~ C402.5.1 provided that there is not an increase in fenestration area.

Reason: Various errata / corrections:

- In footnote c of Table C402.1.2.3, remove "urethan or" so it is not material specific and parallels footnote b. Or at a minimum, correct the spelling of "urethane."
- In item 3 of C402.7.4, “coved” should be “covered”
- In C402.5.5 Doors, the reference to C402.4.3 should be changed to C402.5.3 due to section renumbering.
- In C406.2.1.1, it should refer just to ASHRAE 90.1 Appendix C, not ASHRAE 90.1-2019 Appendix C. The proper year will be in Chapter 6 Reference Standards, and will be 2022, not 2019.
- In C505.2.1, the reference to sections C402.4.1 should be changed to C402.5.1 due to section renumbering in chapter 4.
- Also, in the pdf version, the titles for C402.5.1.1 and C402.5.1.2 are repeated twice. Remove first one. But this is not showing up in cdpAccess, so maybe fixed already?

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Editorial fixes. No cost impact.

Workgroup Recommendation

CED1-111-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE ALTERNATIVES [a]

Portions of table not shown remain unchanged.

Walls, above grade																
Mass[f]																
Metal building																
Metal framed [h, i]																
Wood framed and other [h, i]																

For SI: 1 inch = 25.4 mm, 1 pound per square foot = 4.88 kg/m^2, 1 pound per cubic foot = 16 kg/m^3.

ci = Continuous Insulation, NR = No Requirement, LS = Liner System.

a. Assembly descriptions can be found in ANSI/ASHRAE/IESNA 90.1 Appendix A.

b. Where using *R*-value compliance method, a thermal spacer block shall be provided, otherwise use the *U*-factor compliance method in Table C402.1.2.

c. R-5.7ci is allowed to be substituted with concrete block walls complying with ASTM C90, ungrouted or partially grouted not less than 32 inches or less on center vertically and not less than 48 inches on center horizontally, with ungrouted cores filled with materials having a maximum thermal conductivity of 0.44 Btu-in/h-f^2 °F.

d. Where heated slabs are below grade, below-grade walls shall comply with the R-value requirements for above-grade mass walls .

e. “Mass floors” shall be in accordance with Section C402.2.3.

f. “Mass walls” shall be in accordance with Section C402.2.2.

g. The first value is for perimeter insulation and the second value is for full, under-slab insulation. Perimeter insulation and full-slab insulation components shall be installed in accordance with Section C402.2.4.1 .

h. The first value is *cavity insulation*; the second value is *continuous insulation*. Therefore, “R-0+R-12ci” means R-12 *continuous insulation* and no *cavity insulation*; “R-13+R-3.8ci” means R-13 *cavity insulation* and R-3.8 *continuous insulation*; “R-20” means R-20 *cavity insulation* and no *continuous insulation*. R-13, R-20, and R-27 *cavity insulation* as used in this table apply to a nominal 4-inch (101 mm), 6-inch (152 mm), and 8-inch (203 mm) deep wood or cold-formed steel stud cavities, respectively.

i. For metal framed walls and wood framed walls where the required R-value in Table C402.1.3 is met by using continuous insulation such that cavity insulation is not required, the wall assembly framing is permitted to be spaced at any spacing up to and including 24 inches on center.

Reason: Footnote 'i' was included as part of the modified CEPI-38 proposal but was inadvertently left out of the public review draft. This proposal includes footnote 'i' to address the omission. As stated in the reason for the modification to CEPI-38: "For R-value options where there is no cavity insulation and only continuous insulation providing the necessary minimum R-value for the wall assembly, the framing spacing (i.e. Framing Factor) becomes not relevant."

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
There is no cost impact as this proposal is corrective to align with the approved modification to CEPI-38 in the public input phase. The footnote does provide added flexibility and ease of compliance which may have a small indirect cost reduction.

Workgroup Recommendation

Proposal # 760

CED1-112-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.3 Insulation component R-value alternatives. For opaque portions of the *building thermal envelope* using this section as an alternative to Section C402.1.2, the *R*-values for cavity insulation and continuous insulation shall be not less than that specified in Table C402.1.3. ~~Commercial~~ *Group R* occupancy buildings or portions of commercial buildings enclosing *Group R* occupancies shall use the *R*-values from the "*Group R*" column of Table C402.1.3. Commercial buildings or portions of commercial buildings enclosing occupancies other than *Group R* shall use the *R*-values from the "All other" column of Table C402.1.3.

Reason: Conflicting language is corrected. As written the code requires all buildings to comply with Group R requirements

Cost Impact: The code change proposal will decrease the cost of construction.
Eliminating conflicting language in the code always saves $.

Workgroup Recommendation

Proposal # 865

CED1-113-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C402.1.3 OPAQUE THERMAL ENVELOPE INSULATION COMPONENT MINIMUM REQUIREMENTS, R-VALUE ALTERNATIVES [a]

Portions of table not shown remain unchanged.

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8	
	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R	All other	Group R
Roofs																
Insulation entirely above roof deck																
Metal buildings[b]																
Attic ~~and other~~																
<u>Other</u>	<u>See Table C402.1.2 for U-factor compliance</u>															
Walls, above grade																
Mass[f]																
Metal building																
<u>Cold-formed steel</u> ~~Metal~~ framed [h]																
Wood framed ~~and other~~ [h]																
<u>Other</u>	<u>See Table C402.1.2 for U-factor compliance</u>															

Reason: This proposal corrects the R-value table by creating a separate category (row) for "other" roof and above-grade wall construction assemblies and types as requested by the envelope subcommittee in its disapproval of CEPI-39. Also, the "metal frame" category is based on cold-formed steel framed walls, not any type of metal framing material or system which would affect the R-values required to meet the U-factor basis for the table. For metal frame wall assemblies other than cold-formed steel frame walls, the R-values are not relevant and the U-factor table should be used. For the "other" cases, the proposal refers the user to the U-factor table as suggested by the envelope subcommittee.
While this clarification or correction is needed for the R-value table, it does now bring into focus a specific underlying or pre-existing problem that also may need to be fixed. This relates to the absence of metal spandrel system U-factor and R-value requirements in Tables C402.1.2 and C402.1.3. In this absence, some have been using the R-value table for "metal frame" to place insulation components in spandrels without consideration that the R-values were actually based on a cold-formed steel frame wall assembly, not an aluminum spandrel/fenestration framing system. Thus, it may be appropriate to consider adding a row for "metal/aluminum frame spandrels" in Tables C402.1.2 and C402.1.3 with U-factors established based on economic cost-benefit analysis in consideration of available systems with R-values determined accordingly, both of which should also address thermal bridging impacts related to spandrel boundaries (as required in the new thermal bridging provisions of Section C402.7).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
In theory, this change is a clarification or correction that should have no cost impact. However, in practice, the potential use of the R-value table for aluminum frame spandrels systems (which is in theory incorrect) may have cost impacts unless specific spandrel requirements are established for the U-factor and R-value tables.

Workgroup Recommendation

Proposal # 763

CED1-114-22

Proponents: Brian Trimble, representing International Masonry Institute (btrimble@imiweb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

STUD CAVITY INSULATION. Insulating material located between framing members.

C402.1.3.1 R-value of multi-layered insulation components . Where stud cavity insulation is installed in multiple layers, the stud cavity insulation R-values shall be summed to determine compliance with the stud cavity insulation R-value requirements. Where cavity wall ~~continuous~~ insulation is installed in multiple layers, the cavity wall ~~continuous~~ insulation R-values shall be summed to determine compliance with the continuous insulation R-value requirements. Stud cavity ~~Cavity~~ insulation R-values shall not be used to determine compliance with the cavity wall ~~continuous~~ insulation R-value requirements in Table C402.1.3.

Reason: This is a big ask, but throughout document change “cavity insulation” to “stud cavity insulation” to differentiate between insulation placed between studs and insulation placed in the cavity. It is time to differentiate these terms since many wall systems including rainscreens now use insulation outboard of the backing which is called cavity insulation. An example of the confusion can be found in Section C402.1.3.1. Is this section referring to multiple layers of batt insulation or multiple layers of rigid board insulation? This section would be much clearer if the adjective “stud” was placed before cavity insulation to clearly state which insulation requirements apply. Insulation placed in the wall cavity is not necessarily “continuous insulation” in all cases so “wall cavity” would be more appropriate for that insulation.
The Rainscreen Association in North America (RAINA) as well as masonry groups use the terms “cavity” and “cavity insulation” which is the insulation placed in that space. When referring to batt insulation or insulation between the studs it should be called “stud cavity insulation”. It is time that the IECC updated their terminology to fit today’s usage by designers and contractors.

In theory, this is not the only section of the code that would need to be modified. Other sections would need to be updated, but this proposal is a trial balloon to see if it is acceptable.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Workgroup Recommendation

Proposal # 848

CED1-115-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Delete without substitution:

~~**C402.1.3.3 Building materials and air spaces.**~~ ~~Building materials that are not insulation components complying with Chapter 3 shall be excluded from demonstrating compliance with the R-values of Table C402.1.3. Air spaces used to demonstrate compliance with Table C402.1.3 shall comply with Section C402.2.7.~~

~~**C402.1.3.4 Assembly construction.**~~ ~~Assembly constructions used for compliance with Table C402.1.3 shall be as described in ANSI/ASHRAE/IES 90.1 Appendix A.~~

~~**C402.1.3.5 Concrete masonry units, integral insulation.**~~ ~~The R-value of integral insulation installed in concrete masonry units shall not be used in determining compliance with Table C402.1.3 except as otherwise noted.~~

Reason: In CEPI-27 (as modified/replaced) three subsections were deleted from the original proposal. However, in the public review draft, these sections were not shown as deleted. This proposal makes those deletions as a procedural "correction" to the draft. I would prefer that these sections be retained (not deleted), but this would not be consistent with compromises made during the public input phase in gaining broad support for CEPI-27.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Deletion of these sub-sections do not change requirements that are found elsewhere in the code (e.g., table footnotes, other sections, etc.).

Workgroup Recommendation

Proposal # 758

CED1-116-22

Proponents: Martha VanGeem, representing Masonry Alliance for Codes and Standards

2024 International Energy Conservation Code [CE Project]

Revise as follows:

~~**C402.1.3.4 Assembly construction.** Assembly constructions used for compliance with Table C402.1.3 shall be as described in ANSI/ASHRAE/IES 90.1 Appendix A.~~

Reason: This proposal deletes a vague sentence. Table C402.1.3 is for added R-values. ASHRAE 90.1 Appendix A is a lengthy and complex appendix. The user will get lost trying to decide what portion of Appendix A applies to the requirement in this section of the IECC. The intent of the table is to offer a simplified path that prescribes the amount of insulation that needs to be added to an assembly.
The structure of this row of criteria for mass walls was developed in the 1990s. The base wall was a 115 pcf concrete masonry unit (CMU) wall. The criteria were meant to apply to all kinds of CMU and concrete walls, regardless of unit weight, because there are hundreds of types and there is limited space in a table. It is also meant to apply to newer innovative mass walls such as ICFs and proprietary systems. This sentence could be construed to mean that the criteria only apply to 115 pcf CMU and this is not the case. Mass walls are defined, so this should not be an issue.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This removes a vague sentence.

Workgroup Recommendation

Proposal # 891

CED1-117-22

Proponents: Michael Waite, representing American Council for an Energy-Efficient Economy (mwaite@aceee.org); Diana Burk, representing New Buildings Institute (diana@newbuildings.org); Amy Boyce, representing Institute for Market Transformation (amy.boyce@imt.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.1.4 Component performance alternative. Building envelope values and fenestration areas determined in accordance with Equation 4-1 shall be an alternative to compliance with the *U*-, *F*-, psi-, chi-, and *C*-factors in Tables C402.1.2, C402.1.5, and C402.5 and the maximum allowable fenestration areas in Section C402.5.1. *Fenestration* shall meet the applicable SHGC requirements of Section C402.5.3.

~~$A_P + B_P + C_P + T_P \le A_T + B_T + C_T + T_T - V_F - V_S$~~ $\underline{HTF_P \le HTF_B}$ **(Equation 4-1)**
where:

$\underline{HTF_P = A_P + B_P + C_P + T_P}$ (proposed envelope heat transfer factor)
$\underline{HTF_B = A_T + B_T + C_T + T_T - V_F - V_S}$ (base envelope heat transfer factor)
A_P = Sum of the (area x U-factor) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies
B_P = Sum of the (length x F-factor) for each proposed slab-on-grade edge condition
C_P = Sum of the (area x C-factor) for each proposed below-grade wall assembly
T_P = Sum of the (ψL_P) and (χN_p) values for each type of thermal bridge condition of the building thermal envelope as identified in Section C402.6 in the proposed building. For the purposes of this section, the (ψL_P) and (χN_P) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_P shall be assigned as zero.
ψL_P= psi-factor × length of the thermal bridge elements in the proposed building thermal envelope.
χN_P = chi-factor x number of the thermal bridge point elements other than fasteners, ties, or brackets in the proposed building thermal envelope.
A_T = Sum of the (area x U-factor permitted by Tables C402.1.2 and C402.5) for each proposed building thermal envelope assembly, other than slab-on-grade or below-grade wall assemblies
B_T = Sum of the (length x F-factor permitted by Table C402.1.2 for each proposed slab-on-grade edge condition
C_T = Sum of the (area x C-factor permitted by Table C402.1.2) for each proposed below-grade wall assembly
T_T = Sum of the (ψL_T) and (χN_T) values for each type of thermal bridge condition in the proposed building thermal envelope as identified in Section C402.6 with values specified as "compliant" in Table C402.1.4. For the purposes of this section, the (ψL_T) and (χNT) values for thermal bridges caused by materials with a thermal conductivity less than or equal to 3.0 Btu-in/h-ft^2-F shall be assigned as zero. For buildings or structures located in Climate Zones 0 through 3, the value of T_T shall be assigned as zero.
ψL_T= (psi-factor specified as "compliant" in Table C402.1.5) × length of the thermal bridge elements in the proposed building thermal envelope.
χN_T = (chi-factor specified as "compliant" in Table C402.1.5) x number of the thermal bridge point elements other than fasteners, ties, or brackets in the proposed building thermal envelope.
P_F = Maximum vertical fenestration area allowable by Section C402.5.1, C402.5.1.1, or C402.5.1.2
Q_F = Proposed vertical fenestration area
$R_F = Q_F – P_F$, but not less than zero (excess vertical fenestration area)
S_F = Area-weighted average U-factor permitted by Table C402.5 of all vertical fenestration assemblies
T_F = Area-weighted average U-factor permitted by Table C402.1.2 of all exterior opaque wall assemblies
$U_F = S_F – T_F$ (excess U-factor for excess vertical fenestration area)
$V_F = R_F$ x U_F (excess UxA due to excess vertical fenestration area)
P_S = Maximum skylight area allowable by Section C402.1.2
Q_S = Actual skylight area
$R_S = Q_S – P_S$, but not less than zero (excess skylight area)
S_S = Area-weighted average U-factor permitted by Table C402.5 of all skylights
T_S = Area-weighted average U-factor permitted by Table C402.1.2 of all opaque roof assemblies
$U_S = S_S – T_S$ (excess U-factor for excess skylight area)
$V_S = R_S$ x U_S (excess UxA due to excess skylight area)
A proposed psi- or chi-factor for each thermal bridge shall comply with one of the following as applicable:

1. Where the proposed mitigation of a thermal bridge is compliant with the requirements of Section C402.6, the "compliant" values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
2. Where a thermal bridge is not mitigated in a manner at least equivalent to Section C402.6, the "non-compliant" values in Table C402.1.4 shall be used for the proposed psi- or chi-factors.
3. Where the proposed mitigation of a thermal bridge provides a psi- or chi-factor less than the "compliant" values in Table C402.1.4, the proposed psi- or chi-factor shall be determined by thermal analysis, testing, or other approved sources.

Staff note existing items removed

C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2(1).
2. An annual energy cost that is less than or equal to the percent of the annual energy cost (PAEC) of the *standard reference design* calculated in Equation 4-32. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

   Exceptions:

   1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.
   2. Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the energy use shall be calculated using source energy factors from Table C407.2(2) For electricity, U.S. locations shall use values eGRID subregions. Locations outside the United States shall use the value for "All other electricity" or locally derived values.

3. The proposed building's envelope heat transfer factor (HTF_P) shall not exceed the base envelope heat transfer factor (HTF_B) by more than 15 percent for Type V construction and by more than 20 percent for all other building types, as determined in accordance with Section C402.1.4.

   Exception: New buildings exceeding the maximum vertical fenestration area permitted in Section C402.5.1 for which the proposed envelope performance factor does not exceed the base envelope performance factor by more than 15 percent in multifamily residential, hotel/motel and dormitory building area types, as determined in accordance with ANSI/ASHRAE/IESNA 90.1 Appendix C. For all other building area types, the limit shall be 7 percent. For buildings with both residential and nonresidential occupancies, the limit shall be based on the area-weighted average of the gross conditioned floor area of each building area type.

(Equation 4-32)

$$PAEC = 100 \times (0.85 + 0.025 - ECr/1000)$$

PAEC = Percentage of annual energy cost applied to standard reference design
EC_r= Energy efficiency credits required for the building in accordance with Section C406.1 (do not include load management and renewable credits)

Reason: The purpose of this code change proposal is to improve the commercial total building performance path by incorporating a mandatory building thermal envelope trade-off backstop (limiting the user's ability to trade off the prescriptive envelope levels) similar to the residential version in Section R405.2 of the 2021 *IECC*. Although the residential provisions of the *IECC* have included mandatory trade-off limits (backstops) for various compliance paths for several editions now, and these trade-off limits were expanded and improved in the 2021 *IECC*, the commercial code compliance paths do not yet have similar trade-off backstops.
Even though the 2021 *IECC* requires a substantially improved level of efficiency in commercial building envelope components, an effective thermal envelope trade-off backstop would provide important additional benefits for the owners and occupants of these buildings by ensuring that all building envelopes exhibit a reasonable level of efficiency:

· The efficiency of the building envelope is the most important factor in a building's long-term performance (unlike equipment, the envelope typically lasts a very long time, even for the life for the building), but is the most costly to retrofit after the building is constructed;

· Occupants will be more comfortable and healthier in a building with a reasonably efficient envelope; and

· Well-insulated buildings are more resilient and will provide better protection for occupants and property in long-term power outages.

An effective thermal envelope backstop is crucial to ensure that the building retains reasonable envelope performance under the performance path, and that the envelope is not unduly traded-off for other measures. Trading off envelope and associated occupant comfort can have direct negative impacts on energy usage. For example, if the occupant responds to discomfort from a "cold" or "hot" room due to an inadequate building envelope by adjusting the thermostat, the additional energy use from the adjusted thermostat can be substantial. As a result, backstops can save significant energy and energy costs in buildings.

Because the commercial performance path provides code users wider latitude than the residential chapters to trade efficiency among envelope, mechanical equipment, renewables and lighting, it is even more important that a backstop be included in the commercial performance path.

A backstop for Section C407 was proposed in the public input phase (CEPI-204-21) and disapproved by the Commercial Consensus Committee. Some stakeholders opposed the proposal because they were concerned the trade-off provisions for some individual envelope components were too restrictive. Some stakeholders sought additional flexibility through a UA-based approach, but the Component Performance Approach (C402.1.4) in the 2021 IECC was not constructed in a way to allow this to be done simply. However, Section C402.1.4 was revised in the public input phase (CEPI-46-21, as modified) to follow a more traditional UA equation approach with additional considerations for thermal bridging (CECPI-4). This proposal goes one step further to revise the approach and simplify it to comparison of a baseline and proposed heat transfer factor (HTF) which is even more consistent with a traditional total UA method equation format. Thus, the envelope backstop can be characterized as a multiplier on the base envelope heat transfer factor (HTF_B) which allows the U-factors, F-factors, C-factors (and now also psi- and chi-factors for thermal bridging) to vary by more than 15% (for Type V wood frame construction) or 20% (all others) so long as the total HTF_P for the proposed building envelope does not exceed a percentage of the HTF_B. This is consistent with how envelope backstops are applied in other parts of the IECC. The 1.15 x HTF_B also is consistent with backstops for wood frame building in accordance with the IECC-Residential provisions (known as Type V construction in the IBC). The 1.20 x HTF_B is added for the IECC-Commercial provisions because the IECC includes more assembly types for commercial buildings, some of which may include fenestration/spandrel systems where a greater backstop allowance is needed to accommodate available systems without creating significant difficulty or cost impacts (e.g., requiring triple-pane glazing to help offset impact of spandrel U-factors that typically exceed the opaque above-grade wall U-factors by a significant margin).

In addition, an exception is provided that allows even greater flexibility in the backstop to permit larger fenestration areas to be achieved in the C407 Simulated Building Performance path while still retaining a modest backstop against trading off long-term building thermal envelope performance. This exception relies on an approach developed for ASHRAE 90.1 (as already referenced in Section C406.2.1.1 of the IECC public comment draft) and is based on a percentage of the building energy use (performance factor), not a percentage of the “UA” or HTF_B of the envelope. Thus, the 7% and 15% of base envelope “performance factor” provides substantially more flexibility to achieve large window to wall area ratios (WWR) where needed for a proposed building. The exception is only applied to new buildings because flexible provisions for existing building alterations are already addressed separately in Section C503.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not increase the baseline stringency of the prescriptive requirements of the IECC, but merely limits trade-offs under a voluntarily chosen alternate compliance path. The mandatory minimum values proposed are less stringent than prescriptive values of the IECC and only apply if an alternative compliance path is chosen. The user can be expected to choose an alternate compliance path, with the mandatory measures, when it produces lower costs than prescriptive compliance. As a result, whether costs of construction increase or decrease ultimately depends on choices made by the code user.

This proposal does not increase the stringency of the code or result in increased costs, so a cost-effectiveness analysis does not apply. The ICC Board of Directors set the 2021 IECC as the baseline for future IECC development – and by extension made the 2021 IECC the basis for cost-effectiveness analyses. This means for purposes of analyzing code proposals, the existing provisions of the 2021 IECC are considered cost-effective and reasonable (since they are the starting point for analyses of code changes and no rollbacks are permitted). Establishing trade-off backstops like this code change proposal does not increase the stringency of that baseline or impose any additional costs to meet specific measures. In addition, if the prescriptive values are cost-effective, then the backstop values would be cost-effective. These backstops serve only as a consumer protection against excessive trade-offs, but do not require anything more than what would be required for base code prescriptive compliance.

Attached Files

- **Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/830/1731/files/download/387/

Workgroup Recommendation

Proposal # 830

CED1-118-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.2.1 Roof-ceiling construction ~~assembly~~. ~~Roof i~~ Insulation materials in the roof-ceiling construction shall be installed between the roof framing, continuously below ~~above~~ the ceiling framing, continuously above, below, ~~on~~ or within the roof deck ~~assembly~~ or in any approved combination thereof. Insulation installed above the roof deck shall comply with Sections C402.2.1.1 through C402.2.1.3.

Add new text as follows:

C402.2.1.3 Minimum thickness, lowest point. The minimum thickness of above-deck roof insulation at its lowest point, gutter edge, roof drain or scupper, shall be not less than 1 inch (25 mm).

Reason: The proposal clarifies the title and wording of Section C402.2.1 and avoids misusing a defined term "roof assembly" in the building codes. Instead, a term roof-ceiling construction is used which more broadly encompasses the overall roof structure and components. In addition, a subsection that was inadvertently deleted from the CEPI-27 proposal approved during the public input phase is restored. This occurred because of competing proposals attempting to move this requirement into different places leaving it absent in the final correlation.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal is a clarification and restores a section that was inadvertently omitted due to proposal correlation issues during the public input phase.

Workgroup Recommendation

Proposal # 725

CED1-119-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.2.6 Insulation of radiant heating systems~~s~~ panels. *Radiant heating system* panels, and their associated components that are installed in interior or exterior assemblies, shall be insulated to an *R*-value of not less than R-3.5 on all surfaces not facing the space being heated. *Radiant heating system* panels that are installed in the *building thermal envelope* shall be separated from the exterior of the building or unconditioned or exempt spaces by not less than the *R*-value of insulation installed in the opaque assembly in which they are installed or the assembly shall comply with Section C402.1.2.

~~**Exception:**~~ Heated slabs on grade shall be insulated in accordance with Section C402.2.4 and Section C402.1.

Reason: This proposal clarifies that Section C402.2.6 is addressing radiant heating system panels. Also, heated slabs on grade are not an exception for heating system panels. It is an assembly that is addressed elsewhere in the code. Thus, the exception is moved to the last sentence and changed to a requirement that references appropriate sections for heated slab provisions.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal clarifies an existing provisions without any changes in requirements.

Workgroup Recommendation

Proposal # 727

CED1-120-22

Proponents: Theresa Weston, representing Rainscreen Association in North America (RAiNA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.2.7 Airspaces. Where the *R*-value of an airspace is used for compliance in accordance with Section C402.1, the airspace shall be enclosed in an unventilated cavity bounded on all sides by building components and constructed to minimize airflow into and out of the enclosed airspace. Airflow shall be deemed minimized where one of the following conditions occur:

1. The enclosed airspace is unventilated.
2. The enclosed airspace is bounded on at least one side by an anchored masonry veneer, constructed in accordance with Chapter 14 of the International Building Code, and vented by veneer weep holes located only at the bottom of the airspace and space not less than 15 inches (381 mm) on center with top of the cavity airspace closed.
3. The enclosed airspace located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material is ventilated and the effect of the ventilation is determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.

~~**Exception:** For ventilated cavities, the effect of the ventilation of airspaces located on the exterior side of the continuous air barrier and adjacent to and behind the exterior wall-covering material shall be determined in accordance with ASTM C1363 modified with an airflow entering the bottom and exiting the top of the airspace at an air movement rate of not less than 70 mm/second.~~

Reason: This proposal transforms the "exception" into a third option to reduce confusion. The current text (with two options and an exception) is unclear as to whether the exception is to the basic section or to the 2nd listed option.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not add or delete code provisions or option. It is editiorial.

Workgroup Recommendation

Proposal # 867

CED1-121-22

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

101 New Code Section. north-oriented: facing within 67.5 degrees of true north in the northern hemisphere; (however, facing within 67.5 degrees of true south in the southern hemisphere.)
south-oriented: facing within 45 degrees of true south in the northern hemisphere; (however, facing within 45 degrees of true north in the southern hemisphere.)

east-oriented: facing within 45 degrees of true east to the south and within less than 22.5 degrees of true east to the north in the northern hemisphere; (however, facing within 45 degrees of true east to the north and within less than 22.5 degrees of true east to the south in the southern hemisphere.)

west-oriented: facing within 45 degrees of true west to the south and within less than 22.5 degrees of true west to the north in the northern hemisphere; (however, facing within 45 degrees of true west to the north and within less than 22.5 degrees of true west to the south in the southern hemisphere.)

Revise as follows:

C402.3 Above-Grade Wall Solar Reflectance. For Climate Zone 0, above-grade east-oriented, south-oriented, and west-oriented walls shall comply with either of the following:

1. Not less than 75 percent of the **opaque** above-grade wall area shall have an area-weighted initial solar reflectance of not less than 0.30 where tested in accordance with ASTM C1549 with AM1.5GV, output or ASTM E903 with AM1.5GV output, or determined in accordance with an approved source. This above-grade wall area shall have an emittance or emissivity of not less than 0.75 where tested in accordance with ASTM C835, C1371, E408, or determined in accordance with an approved source. For the portion of the above-grade wall that is glass spandrel area, a solar reflectance of not less than 0.29, as determined in accordance with NFRC 300 or ISO 9050, shall be permitted. Area-weighted averaging is permitted only using ***south-, east-, and west-oriented walls*** enclosing the same occupancy classification.
2. Not less than 30 percent of the opaque above-grade wall area shall be shaded by manmade structures, existing buildings, hillsides, permanent building projections, on-site renewable energy systems, or a combination of these. Shade coverage shall be calculated by projecting the shading surface downward on the above-grade wall at an angle of 45 degrees.

Exception: Above-grade walls of low energy buildings complying with Section C402.1.1.1, greenhouses complying with Section C402.1.1.2, and equipment buildings complying with Section C402.1.1.3.

Reason: We added the word opaque and the definitions of east-, west-, north-, and south-oriented to be consistent with ASHRAE 90.1 and the analysis performed in ASHRAE 90.1.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
An analysis was performed on the entire section that showed this proposal was cost effective in Climate zone 0. For the changes in this proposal there are no cost impacts

Workgroup Recommendation

Proposal # 709

CED1-122-22

Proponents: Emily Morin, representing Self (emorin@smartsurfacescoalition.org); Emma Gonzalez-Laders, representing Dept. of State/DBSC (emma.gonzalez-laders@dos.ny.gov); Melissa Kops, representing CT Green Building Council (melissa@ctgbc.org); Khaled Mansy, representing self (khaled.mansy@okstate.edu); Ronnen Levinson, representing Self (rmlevinson@lbl.gov); David Goldstein, representing Natural Resources Defense Council (dgoldstein.nrdc@gmail.com)**; co-proponent Diana Burk, representing New Buildings Institute (diana@newbuildings.org)**

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.4 Roof solar reflectance and thermal emittance. Low-sloped roofs directly above cooled conditioned spaces ~~in *Climate Zones* 0 through 3~~ shall comply with one or more of the options in Table C402.4.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.4:

1. Portions of the roof that include or are covered by the following:
   1.1. Photovoltaic systems or components.
   1.2. Solar air or water-heating systems or components.
   1.3. Vegetative roofs or landscaped roofs.
   1.4. Above-roof decks or walkways.
   1.5. Skylights.
   1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (74 kg/m^2) or 23 psf (117 kg/m^2) pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.
5. Roofs in Climate Zone 6 that are in a jurisdiction with a population of less than 50,000.

TABLE C402.4 MINIMUM ROOF REFLECTANCE AND EMITTANCE OPTIONS[a]

Climate Zone	0-6	7-8
Three-year-aged solar reflectance[b] /~~- of 055 and~~ 3-year aged thermal emittance[c] ~~of 0.75~~	0.63/0.75	NR
Three-year-aged solar reflectance index[d]	~~of 64~~ 75	NR

a. The use of area-weighted averages to comply with these requirements shall be permitted. Materials lacking 3-year-aged tested values for either solar reflectance or thermal emittance shall be assigned both a 3-year-aged solar reflectance in accordance with Section C402.4.1 and a 3-year-aged thermal emittance of 0.90.

b. Aged solar reflectance tested in accordance with ASTM C1549, ASTM E903, ASTM E1918 or CRRC-S100.

c. Aged thermal emittance tested in accordance with ASTM C1371, ASTM E408 or CRRC-S100.

d. Solar reflectance index (SRI) shall be determined in accordance with ASTM E1980 using a convection coefficient of 2.1 Btu/h × ft^2 × °F (12 W/m^2 × K). Calculation of aged SRI shall be based on aged tested values of solar reflectance and thermal emittance.

Reason: The 2024 International Energy Conservation Code (IECC) should extend the requirements of section C402.4 on roof solar reflectance and thermal emittance standards to include Climate Zones 4, 5, and cities in Climate Zone 6. This modification is cost-effective and will provide benefits felt by building owners, occupants, and the energy system. This code update would save building owners and occupants money, reduce overall energy consumption and GHG emissions, mitigate and adapt to climate change, address longstanding environmental justice issues, and improve health outcomes by reducing the risk of summer heat deaths.

The Smart Surfaces Coalition (SSC) strongly supports the update to code C402.4 in the 2024 IECC. SSC, a 501(c)(3), is a coalition of 40+ industry-leading organizations including the American Institute of Architects (AIA), the National League of Cities (NLC), the American Council for an Energy-Efficient Economy (ACEEE), the Alliance to Save Energy, the American Public Health Association (APHA), the American Planning Association (APA), and many other organizations. What unites the coalition is the dedication to support cities in adopting cost-effective reflective, green, and porous surfaces and solutions that help combat climate change. This statement reflects the entire coalition's stance on the necessary changes to the 2024 IECC.

The beneficiaries of expanding reflective roof requirements to Climate Zones 4, 5, and cities in Zone 6 include property owners, occupants, and the Climate Zone's respective populations at large. The changes would improve people's health and wellbeing, lower their energy bills, deliver environmental justice, and strengthen the economies of cities, and industries such as tourism. The only consistent opposition to the expansion of reflective roof requirements are dark roofing manufacturers and their industry groups. For example, a 2016 roofing industry review discusses these "erroneous, claims against cool roofs despite the science supporting their general benefits… The success of … cool roof technologies has created an anxiety among the manufacturers of 'non-cool' roofs. They have initiated a campaign through the ERA to discredit, or at least cast doubt, on the fundamental science behind cool roofing [1]."

In a more recent example, in Spring 2022 two roofing materials industry groups: the Asphalt Roofing Manufacturers Association (ARMA) and the EPDM Roofing Association (ERA) submitted a document to the Baltimore City Council opposing a new roof ordinance to increase roof reflectivity. These organizations sought to raise doubts about the legitimacy and benefit of increasing the use of reflective/cool surfaces in Baltimore. The objections made in Baltimore by these two groups which have been persuasively rebutted by other roofing industry organizations are discussed and dismissed again below.

The 2024 International Energy Conservation Code (IECC) should extend the requirements of section C402.4 on roof solar reflectance and thermal emittance standards to Climate Zones 4, 5, and cities in Climate Zone 6. Cities and non-rural areas in Climate Zone 6 should incorporate reflective roof requirements because in dense urban environments reflective roofs not only cool their respective building but also provide city-wide cooling to a city.

The benefit-cost value of reflective roofs is greater in cities than in rural areas because of the secondary cooling, energy-cost saving, climate health, and equity benefits that are shared throughout a city. For Zone 6, roofs in jurisdictions of at least 50,000 people, qualifying as a small city according to the National League of Cities definition should be subject to reflective requirements [2].

Many major cities already require the use of reflective roofs. Those cities include Chicago, Dallas, Denver, Houston, Los Angeles, Miami Beach, New York City, Philadelphia, and Washington, D.C. New York, and Chicago are cities in Zones 4 and 5, respectively, demonstrating the value of commercial reflective roof requirements in these climate zones.

A. Energy and Heat Reduction

Cool or reflective roofs reflect far more sunlight back into the atmosphere than a conventional, dark roof, which absorbs roughly 80 - 95% of incoming sunlight. Asphalt and EPDM-based materials are examples of these dark, lower-cost roofing options. These dark roofs heat buildings, worsen city-wide urban heat, increase air conditioning demand, aggravate smog and air pollution, and impose large economic and equity burdens. As a result of such costs, these types of dark roofs are increasingly being rejected by cities and by national and international energy codes in favor of reflective roofs. In contrast to their dark counterparts, reflective roofs reduce heat in buildings and across the city, thereby reducing air conditioning demand and unwanted outside heat, smog, energy bills, and a range of health costs and risks [3]. The US Cool Roof Rating Council lists a variety of commercially available roofing products and paints that are highly reflective on their roof product directory. These products are applied nationally, including in zones in climate zones 4, 5, and 6, demonstrating the value and effectiveness of reflective roof strategies in these climate zones.

For almost all the U.S., including Climate Zones 4, 5, and cities in Zone 6, the cool roof summer cooling benefit far outweighs the winter heating penalty. For example, a Concordia University study done to test the impact of reflective roofs on new and older commercial buildings in Anchorage, Milwaukee, Montreal, and Toronto. The study which factored in snow cover concluded that “cool roofs for the simulated buildings resulted in annual energy expenditure savings in all cold climates [4].” In most northern locations, winter solar irradiance–a major factor impacting energy savings–is only about 20% of what is experienced in the summer months, because winter days are shorter with lower-angle sunlight (so the sun provides far less heat in the winter months) [5]. Since days are shorter, sunlight is at a lower angle (so it’s not as hot), and there are more clouds, the already small winter heating penalty of reflective roofs is shrinking. Global warming is making cities hotter and winters warmer, making reflective roofs even more cost-effective [6]. Also, many commercial buildings require space cooling all year due to heat from human activity and equipment, so they generally don’t benefit from heat from the sun.

It should also be noted that buildings in northern climates often have high levels of roof insulation. There is a common misconception that higher insulation levels reduce or negate the energy-saving impact of cool roofs. A study of black and white roof membranes over various levels of insulation by the Princeton Plasma Physics Lab showed that the relationship between roof reflectivity and insulation was not a tradeoff. This means that for a building owner to have a roof that minimizes heat gain in the summer and heat loss in the winter, both insulation and reflectivity are necessary [7].

Given climate projections from the Intergovernmental Panel on Climate Change (IPCC), city-wide cooling strategies like reflective roofs are moving from optional to essential to protect city livability [8]. Over the last two decades, the American Society of Heating, Refrigerating and Air-Conditioning Engineers (ASHRAE) has found that heating degree days have dropped 15% while cooling degree days have increased by about 15%. These findings were drawn from out-of-date data. Given accelerated global warming, the shift from heating to cooling degree days is substantially larger than the ASHRAE estimations indicate [9]. Given the reality of global warming and the decrease in heating degree days, reflective roofs are a strong and suitable solution across climate zones.

B. Health

Reflective roofs can reduce urban heat, smog, heat deaths, and costs, building a strong public health argument for their deployment in Climate Zones 4, 5, and cities in Zone 6. Heat deaths typically occur on the top floor of a building as a direct result of the heating of dark roofs [10]. For example, a Chicago multi-day heat event in 1995 killed 793 people [11]. With the value of a statistical life at about $10 million, the deaths alone quantify this tragedy at $800 million [12]. This is without any attempt to quantify the cost of the larger number of people who suffered from, though survived the heat event. Chicago is in Zone 5, but on the cusp of Zone 6, illustrating that with the increased severity and frequency of heat events across Climate Zones, reflective roofs should be included in updated codes for all of Zone 5, and urban roofs in Zone 6 as well.

More generally, reflective roofs can improve health outcomes with the health benefits that come with reducing indoor and outdoor extreme heat. The impacts of excess urban heat are large and complex including increased risk of chronic diseases, obesity, occupational accidents, and reduced work capacity [13]. Reflective roofs measurably reduce urban temperature, protecting the lives and health of populations.*C. Moisture* Cool roofs reduce energy demand, mitigate urban heat islands, and can be built without the presence of moisture. Moisture and condensation risks on cool roofs can be easily eliminated by using a variety of commercially available products or roof designs. In colder climates, warm, humid air travels upward in a building during the cold winter months and can infiltrate the roof assembly from the bottom. In a paper presented to the 2011 NRCA International Roofing Symposium, the Single Ply Roofing Industry (SPRI) reported on a field survey and modeling studies to verify whether cool roofs were susceptible to condensation buildup. SPRI found that though moisture was observed on the underside of the membrane on three roofs, researchers noted “no detrimental effects due to moisture in any of the roofs [14].” In all cases, the minimal moisture build-up detected in the winter months dried up by the summer. Moreover, condensation risk for low-slope roofs can be easily reduced by applying spray products or using a vapor retardant layer under the roof [15]. These design tactics and products are well-understood and commonly used in the roofing community.

The Smart Surfaces Coalition has worked with multiple cities to undertake city-wide cost-benefit analysis of Smart Surfaces including reflective commercial roofs. For example, in 2021, the Smart Surfaces Coalition conducted a 248-page analysis with/for the city of Baltimore and a range of partners such as the American Institute of Architects, the National League of Cities, and the American Public Health Association that demonstrated how reflective roofs are both cost-effective (with a benefit-cost ratio greater than 9:1) and provide broad benefits including in the areas of health, employment, risk reduction, reduced energy bills and improved resilience. The report quantified the benefits that reflective roofs deliver including reduced heat, better air quality, lower energy bills, reduced risk of summer heat deaths, and improved urban structural inequality, and large health benefits.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will increase the cost of construction.
SSC's agrees with the broad roofing and building industry consensus on the cost-effectiveness of reflective roofs. The leading industry publication, Roofing Magazine, for example, asserts that "decades of real-world examples from the marketplace indicate that reflective roofs are an effective net energy (and money) saver even in our coldest cities." If examined from just a surface life-extension perspective, implementing cool roof requirements in Climate Zones 4, 5, and cities in Zone 6 is the cost-effective choice. [16]. Reflective roof requirements would help remove the cost burden of dark roofs from home and property owners by guiding them to make the more cost-effective choice.

Additionally, with rapidly rising market demand and the desire to respond to climate change, roofing manufacturers are increasingly investing in more reflective roofing products. Reflective roofs not only reduce unwanted heat and cut pollution, energy bills, smog, and GHG emissions but also commonly command larger profit margins for roofing product companies. This dynamic makes cool roofs more desirable for both manufacturers and consumers in most cities.

The Smart Surfaces Coalition has worked with multiple cities to undertake city-wide cost-benefit analysis of Smart Surfaces including reflective commercial roofs. For example, in 2021, the Smart Surfaces Coalition conducted a 248-page analysis with/for the city of Baltimore and a range of partners such as AIA, the National League of Cities, and the American Public Health Association demonstrating that reflective roofs are very cost-effective, with a benefit-cost ratio of over 9:1.

Clearly, there is broad documentation and consensus – with the exception of dark roof companies and their industry groups – that reflective roofs are cost-effective and important design elements across the country including in Zones 4 and 5. The higher heat in cities (called the urban heat island effect) means that in cities in Zone 6 reflective roofs are also very cost-effective and provide a broad range of health, energy bill, economic and resilience, and climate benefits. The case for extending reflective surface requirements in IECC is clear and compelling.

Bibliography: [1] FiberTite Blog "A Cool Roof Myth" https://www.fibertite.com/blog/a-cool-roof-myth[2] National League of Cities "Small: 50K" https://www.nlc.org/resources/city-size/small-50k/[3] US Department of Energy "Cool Roofs" https://www.energy.gov/energysaver/cool-roofs
[4] Energy and Buildings "Effect of cool roofs on commercial buildings energy use in cold climates" https://www.sciencedirect.com/science/article/abs/pii/S0378778815300256

[5] Office of Energy Efficiency & Renewable Energy "Solar Radiation Basics" https://www.energy.gov/eere/solar/solar-radiation-basics

[6] Environmental Protection Agency "Climate Change Indicators; Heating and Cooling Degree Days" https://www.epa.gov/climate-indicators/climate-change-indicators-heating-and-cooling-degree-days

[7] Princeton University "The joint influence of albedo and insulation on roof performance: A modeling study" https://www.osti.gov/servlets/purl/1254734

[8] States at Risk https://statesatrisk.org/

[9] Building Services Engineering Research and Technology “A method to estimate the heating and cooling degree-days for different climatic zones of Saudi Arabia” 2016 https://www.researchgate.net/publication/311238888_A_method_to_estimate_the_heating_and_cooling_degree-days_for_different_climatic_zones_of_Saudi_Arabia

[10] The New England Journal of Medicine “Heat-Related Deaths during the July 1995 Heat Wave in Chicago” 1996.https://www.nejm.org/doi/full/10.1056/nejm199607113350203

[11] EPA “Chicago, IL Adapts to Improve Extreme Heat Preparedness” 2022. https://www.epa.gov/arc-x/chicago-il-adapts-improve-extreme-heat-preparedness

[12] EPA “Mortality Risk Evaluation” 2022. https://www.epa.gov/environmental-economics/mortality-risk-valuation

[13] Annual Review of Public Health “Heat, Human Performance, and Occupational Health: A Key Issue for the Assessment of Global Climate Change Impacts” 2016. https://www.annualreviews.org/doi/abs/10.1146/annurev-publhealth-032315-021740

[14] Concordia University “Hygrothermal behavior of flat cool and standard roofs on residential and commercial buildings in North America” https://spectrum.library.concordia.ca/id/eprint/974482/

[15] RCI International Convention and Trade Show “Avoiding Condensation in Low Slope Roofing Assemblies” https://www.abbae.com/wp-content/uploads/2020/04/RCI_33rd_Houston_TX_Trade-Show-AVOIDING-CONDENSATION-IN-LOW-SLOPED-ROOFING-ASSEMBLIES.pdf

[16] Cool Roof Rating Council “CA Title 24” https://coolroofs.org/resources/california-title-24

II.

Some Resources

Below are several directly relevant rigorous industry resources/studies documenting that/why/where reflective/cool roofs are cost-effective. These generally include analysis of the cost-effectiveness and value of reflective roofs, including in Climate Zones 4, 5, and 6.

Cool Roofs in the US: The Impact of Roof Reflectivity, Insulation and Attachment Method on Annual Energy Cost. Athanasios Tzempelikos and Seungjae Lee. 2021

Effect of cool roofs on commercial buildings energy use in cold climates. Mirata Hosseini and Hashem Akbari. 2015

The joint influence of albedo and insulation on roof performance: An observational study P. Ramamurthy, T. Sun, K. Rule, and E. Bou-Zeid. 2015

The joint influence of albedo and insulation on roof performance: A modeling study P. Ramamurthy, T. Sun, K. Rule, and E. Bou-Zeid. 2015

Hygrothermal behavior of flat cool and standard roofs on residential and commercial buildings in North America. Moghaddaszadeh Ahrab, Mohammad Ali. 2012

Cool Roofs and Thermal Insulation: Energy Savings and Peak Demand Reduction. Marcus Bianchi, Andre Desjarlais, William Miller, and Thomas Petrie. 2007

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/684/1711/files/download/358/

Workgroup Recommendation

CED1-123-22

Proponents: Amanda Hickman, representing RIMA International (amanda@thehickmangroup.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.4 Roof solar reflectance and thermal emittance. Low-sloped roofs directly above cooled conditioned spaces in *Climate Zones* 0 through 3 shall comply with one or more of the options in Table C402.4.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.4:

1. Portions of the roof that include or are covered by the following:
    1.1. Photovoltaic systems or components.
    1.2. Solar air or water-heating systems or components.
    1.3. Vegetative roofs or landscaped roofs.
    1.4. Above-roof decks or walkways.
    1.5. Skylights.
    1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (74 kg/m^2) or 23 psf (117 kg/m^2) pavers.
4. Roofs with a radiant barrier product with an emittance of 0.07 or less.

~~4~~ 5. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.

Reason:
Cool roof products are effective in reducing heat transfer into structures when installed on the exterior of roof assemblies. Radiant Barriers are equally effective in providing the same benefit, but from the interior of the building. Radiant Barriers typically have an emittance of 0.07 and as a result, only retransmit 7% of the radiant energy a hot roof would typically transfer into the interior of the building. Cool roof products typically have a reflectivity of 85% and an emittance of 0.90 resulting in a reduction in heat transfer into the structure. Because both products provide comparable benefits in reducing heat transfer into the building, it is appropriate to add radiant barrier to the list of exceptions.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

There is no cost impact to this proposal as it only adds to the list of exceptions. However, when compared to the base requirement or other exceptions, radiant barriers are more cost effective.

Workgroup Recommendation

Proposal # 828

CED1-124-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.4 Roof solar reflectance and thermal emittance. Low-sloped roofs directly above ~~cooled~~ conditioned spaces in *Climate Zones* 0 through 3 shall comply with one or more of the options in Table C402.4.

Exceptions: The following roofs and portions of roofs are exempt from the requirements of Table C402.4:

1. Portions of the roof that include or are covered by the following:
   - 1.1. ~~Photovoltaic~~ Renewable energy systems or components.
   - 1.2. Solar air or water-heating systems or components.
   - 1.3. Vegetative roofs or landscaped roofs.
   - 1.4. Above-roof decks or walkways.
   - 1.5. Skylights.
   - 1.6. HVAC systems and components, and other opaque objects mounted above the roof.
2. Portions of the roof shaded during the peak sun angle on the summer solstice by permanent features of the building or by permanent features of adjacent buildings.
3. Portions of roofs that are ballasted with a minimum stone ballast of 17 pounds per square foot (74 kg/m^2) or 23 psf (117 kg/m^2) pavers.
4. Roofs where not less than 75 percent of the roof area complies with one or more of the exceptions to this section.

Reason: Occasionally buildings in CZs 0-3 may be heated. The provisions should be applicable to any space conditioning circumstance.
Also, there are other than PV systems for roof mounted renewable energy production.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No cost impact.

Workgroup Recommendation

Proposal # 877

CED1-125-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

Add new definition as follows:

C202 CURTAIN WALL. An external non-bearing wall intended to separate the exterior nonconditioned and interior conditioned spaces consisting of any combination of framing materials, fixed glazing, opaque glazing, operable windows, or other in-fill materials.

Revise as follows:

TABLE C402.5 BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

CLIMATE ZONE	0 AND 1		2		3		4 EXCEPT MARINE		5 AND MARINE 4		6		7		8
Vertical fenestration															
***U*-factor**															
	All other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other	Group R	All Other
Fixed fenestration	0.50	0.50	0.45	0.40	0.42	0.30	0.36	0.30	0.36	0.28	0.34	0.28	0.29	0.27	0.26
Operable fenestration	0.62	0.50	0.60	0.40	0.54	0.30	0.45	0.30	0.45	0.28	0.42	0.28	0.36	0.27	0.32
Entrance doors	0.83	0.83	0.77	0.77	0.68	0.68	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63	0.63
SHGC															
Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable	Fixed	Operable
PF < 0.2	0.23	0.21	0.25	0.23	0.25	0.23	0.36	0.33	0.38	0.33	0.38	0.34	0.40	0.36	0.40
0.2 ≤ PF < 0.5	0.28	0.25	0.30	0.28	0.30	0.28	0.43	0.40	0.46	0.40	0.46	0.41	0.48	0.43	0.48
PF ≥ 0.5	0.37	0.34	0.40	0.37	0.40	0.37	0.58	0.53	0.61	0.53	0.61	0.54	0.64	0.58	0.64
Skylights															
U-factor	0.70		0.65		0.55		0.50		0.50		0.50		0.44		0.4
SHGC	0.30		0.30		0.30		0.40		0.40		0.40		NR		N

a. Standard/Specification for an Architectural Window (AW) in Group R occupancies shall be permitted to use the U-factors for All Other.
NR = No Requirement, PF = Projection Factor.

C402.5.3 Maximum U-factor and SHGC. The maximum *U*-factor and solar heat gain coefficient (SHGC) for fenestration shall be as specified in Table C402.5.
The window projection factor shall be determined in accordance withEquation 4-4.

$$PF = A/B \quad \textbf{(Equation 4-4)}$$

where:

PF = Projection factor (decimal).

A = Distance measured horizontally from the farthest continuous extremity of any overhang, eave or permanently attached shading device to the vertical surface of the glazing.

B = Distance measured vertically from the bottom of the glazing to the underside of the overhang, eave or permanently attached shading device.

Where different windows or glass doors have different *PF* values, they shall each be evaluated separately.

Exception: Curtain wall fenestration and fenestration products certified to meet the North American Fenestration Standard/Specification for an Architectural Window (AW) in Group R occupancies shall be permitted to use the U-factors for All Other.

Reason: This proposal seeks to align the window requirements of multifamily dwelling units between the Residential and Commercial codes in order to ensure consistency between substantially similar multifamily buildings. Currently there are large discrepancies in terms of system design, control and stringency between a three-story multifamily building (regulated by the residential code) and a four-story multifamily building (regulated by the commercial code). This leads to market confusion, enforcement inconsistencies, and large potential untapped energy savings. This revision and its companion, which was accepted by the 2024 IECC Residential Consensus Committee, seeks to close these gaps and create a common set of window requirements for multifamily buildings.

The 2022 version of Title 24 has created a new section to regulate multifamily buildings - similar to a more "omnibus" proposal submitted by NBI previously. Based on feedback from that submission to not create a new section, this proposal instead works to align the sections that currently

exist.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
These changes match current market availability of products and should not change the cost of construction.

Bibliography: https://newbuildings.org/resource/multifamily-building-guide/
https://www.energy.ca.gov/programs-and-topics/programs/building-energy-efficiency-standards/2022-building-energy-efficiency

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/695/1673/files/download/365/

Workgroup Recommendation

Proposal # 695

CED1-126-22

Proponents: Helen Sanders, **Technoform North America** representing The Facade Tectonics Institute (helen.sanders@technoform.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C402.5 BUILDING ENVELOPE FENESTRATION MAXIMUM U-FACTOR AND SHGC REQUIREMENTS

<table>
<tr><th>CLIMATE ZONE</th><th colspan="2">0 AND 1</th><th colspan="2">2</th><th colspan="2">3</th><th colspan="2">4 EXCEPT MARINE</th><th colspan="2">5 AND MARINE 4</th><th colspan="2">6</th><th colspan="2">7</th><th colspan="2">8</th></tr>
<tr><td colspan="17">Vertical fenestration</td></tr>
<tr><td colspan="17">U-factor</td></tr>
<tr><td>Fixed fenestration</td><td colspan="2">0.50</td><td colspan="2">0.45</td><td colspan="2">~~0.42~~ 0.38</td><td colspan="2">~~0.36~~ 0.34</td><td colspan="2">~~0.36~~ 0.34</td><td colspan="2">0.34</td><td colspan="2">~~0.29~~ 0.28</td><td colspan="2">~~0.26~~ 0.25</td></tr>
<tr><td>Operable fenestration</td><td colspan="2">0.62</td><td colspan="2">0.60</td><td colspan="2">0.54</td><td colspan="2">0.45</td><td colspan="2">0.45</td><td colspan="2">0.42</td><td colspan="2">0.36</td><td colspan="2">0.32</td></tr>
<tr><td>Entrance doors</td><td colspan="2">0.83</td><td colspan="2">0.77</td><td colspan="2">0.68</td><td colspan="2">0.63</td><td colspan="2">0.63</td><td colspan="2">0.63</td><td colspan="2">0.63</td><td colspan="2">0.63</td></tr>
<tr><td colspan="17">SHGC</td></tr>
<tr><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td>Fixed</td><td>Operable</td><td></td></tr>
<tr><td>PF < 0.2</td><td>0.23</td><td>0.21</td><td>0.25</td><td>0.23</td><td>0.25</td><td>0.23</td><td>0.36</td><td>0.33</td><td>0.38</td><td>0.33</td><td>0.38</td><td>0.34</td><td>0.40</td><td>0.36</td><td>0.40</td><td>0.36</td></tr>
<tr><td>0.2 ≤ PF < 0.5</td><td>0.28</td><td>0.25</td><td>0.30</td><td>0.28</td><td>0.30</td><td>0.28</td><td>0.43</td><td>0.40</td><td>0.46</td><td>0.40</td><td>0.46</td><td>0.41</td><td>0.48</td><td>0.43</td><td>0.48</td><td>0.43</td></tr>
<tr><td>PF ≥ 0.5</td><td>0.37</td><td>0.34</td><td>0.40</td><td>0.37</td><td>0.40</td><td>0.37</td><td>0.58</td><td>0.53</td><td>0.61</td><td>0.53</td><td>0.61</td><td>0.54</td><td>0.64</td><td>0.58</td><td>0.64</td><td>0.58</td></tr>
<tr><td colspan="17">Skylights</td></tr>
<tr><td>U-factor</td><td colspan="2">0.70</td><td colspan="2">0.65</td><td colspan="2">0.55</td><td colspan="2">0.50</td><td colspan="2">0.50</td><td colspan="2">0.50</td><td colspan="2">0.44</td><td colspan="2">0.41</td></tr>
<tr><td>SHGC</td><td colspan="2">0.30</td><td colspan="2">0.30</td><td colspan="2">0.30</td><td colspan="2">0.40</td><td colspan="2">0.40</td><td colspan="2">0.40</td><td colspan="2">NR</td><td colspan="2">NR</td></tr>
</table>

NR = No Requirement, PF = Projection Factor.

Reason: The Department of Energy identified a “net zero energy” window as having a U-factor of 0.10 BTU/ºF.hr.ft^2 (Reference [1]) and they identified that fenestration with U-factors of 0.15 BTU/ºf.hr.ft^2 could save 1 Quadrillion BTUs annually over the current (2006) building stock (0.71 Quads from heating and 0.31 Quads from cooling) if implemented in all US buildings. This report also demonstrates the importance of U-factor in cooling climates based on the cooling energy reduction, as does a paper from the Façade Tectonics Institute’s World Congress in 2020, which is included in the bibliography [2]. We recognize that to reach net zero goals by 2030, the IECC needs to ratchet down envelope energy efficiency quickly over the next two or three code revisions to achieve that goal. The fixed fenestration U-factors proposed here are a result of a cost-effectiveness evaluation done by the Façade Tectonics Institute (FTI), whose members include architects, engineers, consultants, general and sub-contractors, and glass, window and curtain wall suppliers.

Updated average costs have been gathered for a range of strategies that can be used to increase fenestration performance. These include, for example, adding argon gas to insulating glass, adding a warm-edge spacer, adding a fourth surface low-e, adding wider thermal barriers to the aluminum frame, move from double to triple pane etc. These updated average component costs have been used to estimate average costs to decrease U-factors in curtainwall from a baseline of 0.50 BTU/ºF.hr.ft^2 (the current climate zone 1 requirement) to achieve a range of U-factors from 0.46 to 0.24 BTU/ºf.hr.ft^2.These costs to achieve U-factors have then been used to assess cost effectiveness based on 3% and 7% discount rates, with and without including the social cost of carbon (SCC). Energy cost savings brought about by reducing U-factors from the current prescriptive value in each climate zone have been calculated using the regression models for the medium office, medium apartment, and a modified medium office (modified for fuel mix) which was used several years ago to support fenestration performance changes in the ASHRAE 90.1 2016 revision. The cost of energy (electric and gas) has not been updated for recent inflation, nor for expected future energy cost increases, from that 2016 analysis, and is likely to be higher than past historical trends. So, the energy cost savings in this analysis are likely to be underestimated and resulting U-factor change recommendations for products that will be impacting building energy use for decades into the future, will be very conservative. Resources from PNNL were not available to support completion of regression analyses of additional building types during the public comment period, which was why we used the regression equations developed for ASHRAE 90.1-2016.

We also note that the costs we have documented for thermal improvements in 2022 will also drop in the future as a specialty products transition to become standard practice, as higher demand triggers manufacturing investment in more efficient, lower cost manufacturing processes and as new R&D results in lower costs. The fenestration industry has seen these effects in the residential window market where a combination of the above code voluntary EnergyStar program and homeowner tax credits have driven above code EnergyStar windows to ~85% of all U.S. residential window sales. EPA announced this week that the new ENERGY STAR requirements, effective 10/2023, for the northern zone in the U.S. will require a U-factor of 0.22, a significant reduction from its current level of 0.27 which will provide significant market pressure to deliver even better performing products that will perform at these levels. We note that the EnergyStar requirements for residential windows are not directly translatable to commercial fenestration because of the increased structural requirements in commercial construction, but that the residential market has been pulled ahead of commercial fenestration in terms of performance because of this combination of standards and incentives. The drive to triple pane which will likely ensue in residential windows accompanying the new EnergyStar requirements may spill over into the commercial market and support reductions in costs for commercial triple pane units.

The details of the methodology, assumptions and the results of the analysis are shown in the attached documentation and are briefly reviewed by climate zone below. Values are given below in dollars per square foot of fenestration area and are the difference between the upfront cost incurred to improve the fenestration and the 40-year energy savings for the 4 measures: 3% and 7% discount rates with and without including the SCC. Negative numbers indicate the U-factor change is cost-effective based on the input assumptions (energy savings higher than upfront costs) and are highlighted in green:

Climate zone 8:

U=0.26 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft
0.25	$ (0.53)	$ (0.34)	$ (0.80)	$ (0.56)	$ (0.04)	$ 0.08	$ (0.37)	$ (0.18)	$ (0.22)	$ (0.07)	$ (0.57)	$ (0.35)
0.24	$ 0.39	$ 0.77	$ (0.15)	$ 0.33	$ 1.38	$ 1.61	$ 0.71	$ 1.09	$ 1.01	$ 1.31	$ 0.30	$ 0.75

A reduction in U-factor from 0.26 to 0.25 is shown to be cost-effective for every building type in all of the 4 measures (except at the worst case 7% discount rate for the apartment). FTI recommends making a change to 0.25 BTU/^{o}F.hr.ft^{2} at a minimum, based on this analysis. U=0.24 is cost-effective based on 3%+SCC for the medium office. A case could be made that 0.24 could be cost-effective in the apartment and without SCC if the energy costs of the analysis were increased to today's or future expected rates.

Climate zone 7:

U=0.29 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft
0.26	$ 0.99	$ 1.43	$ 0.36	$ 0.92	$ 2.15	$ 2.41	$ 1.39	$ 1.82	$ 1.70	$ 2.05	$ 0.88	$ 1.40
0.27	$ 0.04	$ 0.34	$ (0.37)	$ 0.00	$ 0.82	$ 1.00	$ 0.31	$ 0.60	$ 0.52	$ 0.75	$ (0.03)	$ 0.32
0.28	$ (0.23)	$ (0.09)	$ (0.44)	$ (0.26)	$ 0.15	$ 0.24	$ (0.10)	$ 0.04	$ 0.00	$ 0.12	$ (0.27)	$ (0.16)

A U-factor of 0.28 is cost-effective for the medium office building in all 4-measures (3%, 7% with and without the SCC) and for the adjusted office except for at the 7% discount rate. U=0.28 is cost-effective for the medium apartment based on the SCC at 3%. FTI recommends making the change from 0.29 to 0.28 in this climate zone. A case could be made to make a change to 0.27 since that is cost-effective based on the social cost of carbon in the medium office, and any increase in energy cost assumptions could make it cost-effective in the office building and in other of the measures. Also, the cost of the strategies to achieve lower U-factors (like triple pane constructions) are currently higher than they could be because they are not currently "business as usual". Triple panes in Europe are business-as-usual and are reported to be substantially less expensive than those sold in North America.

Climate zone 6:

U=0.34 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, $/sq.ft
0.31	$ 0.70	$ 1.07	$ 0.20	$ 0.65	$ 1.60	$ 1.83	$ 0.95	$ 1.32	$ 1.29	$ 1.57	$ 0.62	$ 1.05
0.32	$ 0.63	$ 0.87	$ 0.29	$ 0.59	$ 1.22	$ 1.37	$ 0.79	$ 1.04	$ 1.02	$ 1.21	$ 0.57	$ 0.85
0.33	$ 0.23	$ 0.35	$ 0.06	$ 0.21	$ 0.52	$ 0.60	$ 0.31	$ 0.43	$ 0.42	$ 0.52	$ 0.20	$ 0.34

None of the U-factors tested below the current value of U=0.34 are shown to be cost-effective using the previous energy costs. Note that the cost-effectiveness situation is not only driven by older energy costs, but also because the strategies to achieve the lower U-factor are not yet "business-as-usual" (triple pane, fourth surface low-e etc.) and are therefore higher priced than they would be if used more regularly. If these strategies were used more, then cost-effectiveness would likely be seen. Based on this current analysis, FTI is not proposing a change to U-factor in this climate zone.

Climate zone 5

U=0.36 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @ 3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft
0.32	$ 0.49	$ 0.83	$ 0.00	$ 0.43	$ 1.44	$ 1.63	$ 0.86	$ 1.18	$ 1.03	$ 1.29	$ 0.39	$ 0.79
0.33	$ (0.10)	$ 0.15	$ (0.47)	$ (0.14)	$ 0.61	$ 0.76	$ 0.18	$ 0.42	$ 0.30	$ 0.50	$ (0.18)	$ 0.12
0.34	$ (0.52)	$ (0.35)	$ (0.76)	$ (0.55)	$ (0.04)	$ 0.05	$ (0.33)	$ (0.17)	$ (0.25)	$ (0.12)	$ (0.57)	$ (0.37)

A change from 0.36 to 0.34 is shown to be cost-effective in all building types evaluated at all four measures (except the most stringent test of 7% discount on energy alone in the medium apartment, where it misses by $0.05c/ft and would probably be cost-effective if higher energy costs were assumed). A larger change to 0.33 is cost-effective on 3 of the 4 measures in the unadjusted medium office. FTI is proposing a 0.34 requirement in this climate zone, based on this data.

Climate zone 4:

U=0.36 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @ 3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft
0.32	$ 1.05	$ 1.28	$ 0.71	$ 1.01	$ 1.73	$ 1.86	$ 1.35	$ 1.56	$ 1.42	$ 1.60	$ 0.98	$ 1.26
0.33	$ 0.32	$ 0.49	$ 0.07	$ 0.29	$ 0.83	$ 0.93	$ 0.55	$ 0.70	$ 0.60	$ 0.73	$ 0.27	$ 0.47
0.34	$ (0.24)	$ (0.12)	$ (0.41)	$ (0.26)	$ 0.10	$ 0.17	$ (0.09)	$ 0.02	$ (0.05)	$ 0.04	$ (0.27)	$ (0.13)

A change from 0.36 to 0.34 has been shown to be cost effective for the medium office building across all 4 measures and in the adjusted office building for 3 of the 4 measures (and close to breakeven with 7% discount rate on energy alone). It is cost effective in the medium apartment for the 3% + SCC measure (and close to breakeven on the three other measures). With higher energy cost assumptions, it is likely that the medium apartment would show cost-effectiveness. The City of Seattle (CZ 4) has already changed its fixed fenestration U-factor from 0.36 to 0.34 on the grounds of cost-effectiveness and ease of availability of products at this performance. For these reasons, FTI is proposing reducing the U-factor in this climate zone to 0.34. This would provide a uniform requirement for fixed fenestration of 0.34 from climate zone 4 to climate zone 6, responding to feedback from the subcommittee to not have a different number for each zone.

Climate zone 3:

U=0.42 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @ 3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	above (below) breakeven @ 7% discount rate with SCC, $/sq.ft
0.38	$ (0.15)	$ 0.01	$ (0.36)	$ (0.18)	$ 0.32	$ 0.41	$ 0.07	$ 0.21	$ 0.11	$ 0.24	$ (0.20)	$ (0.01)
0.39	$ (0.17)	$ (0.05)	$ (0.26)	$ (0.16)	$ 0.18	$ 0.24	$ (0.03)	$ 0.04	$ (0.01)	$ 0.05	$ (0.17)	$ (0.07)
0.40	$ (0.14)	$ (0.06)	$ (0.35)	$ (0.19)	$ 0.09	$ 0.14	$ (0.01)	$ 0.10	$ 0.02	$ 0.12	$ (0.21)	$ (0.07)

This analysis indicates that a change from U=0.42 to 0.38 is cost-effective for the medium office building on 3 of the 4 measures (and within 1c/sq.ft of breakeven at 7%) and the adjusted medium office building when including the social cost of carbon. U= 0.38 is cost-effective at 3%+SCC in the medium apartment and 4c/sq.ft away from breakeven at 7%+SCC. It likely would be cost-effective if higher energy costs were used instead of the older 90.1-2016 analysis values and there is no fundamental limitation to product/technology availability, as more stringent U-factors have been required in more northern climate zones for several code cycles. On this basis, FTI is recommending a move to 0.38.

Climate zone 2

U=0.45 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sq ft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @ 3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft	upfront cost above (below) breakeven @3% discount rate, $/sqft	upfront cost above (below) breakeven @ 7% discount rate, $/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, $/sqft	upfront cost above (below) breakeven @ 7% discount rate with SCC, $/sq.ft
0.40	$ 0.28	$ 0.33	$ 0.20	$ 0.27	$ 0.49	$ 0.50	$ 0.44	$ 0.47	$ 0.36	$ 0.41	$ 0.26	$ 0.33
0.41	$ 0.29	$ 0.34	$ 0.23	$ 0.29	$ 0.46	$ 0.47	$ 0.43	$ 0.45	$ 0.36	$ 0.40	$ 0.28	$ 0.33
0.42	$ 0.10	$ 0.13	$ 0.05	$ 0.09	$ 0.23	$ 0.24	$ 0.20	$ 0.22	$ 0.15	$ 0.18	$ 0.09	$ 0.13
0.43	$ 0.16	$ 0.18	$ 0.13	$ 0.15	$ 0.24	$ 0.25	$ 0.22	$ 0.23				
0.44	$ 0.12	$ 0.13	$ 0.11	$ 0.12								

The analysis for 5 different U-factor changes (from 0.45 to 0.40, 0.41, 0.42, 0.43, and 0.44) shows that the cost-effectiveness results go through an optimum at 0.42. In going from 0.45 to 0.44, there isn't enough improvement in energy performance to offset the small, but finite, increased upfront fenestration cost (est. $0.18/sq.ft). In going from 0.45 to 0.40, the energy savings are greater, but the higher upfront cost (est. $0.56/sq.ft) doesn't offset it sufficiently. Whereas changing to a U-factor of 0.42 achieves a minimum in the cost-effectiveness calculation (albeit not quite negative) - it delivers enough energy savings to balance an moderate increase in cost (est. \$0.27/sq.ft). In this analysis, U=0.42 is not sufficient to get to breakeven using current energy and modeling assumptions.

Part of the challenge in CZ2 (and CZ1) in modeling the impact of U-factor is the modeling assumptions.

Modeling in solar heat gain dominated climates can show that lower U-factors can keep the building insulated, trapping solar heat gain, but typically it doesn't account for the use of night ventilation (free) nor the use of economizers that address these issues. Also, reducing the U-factor reduces the SHGC of the fenestration, but we have not modeled this correlated relationship in this analysis, which would show reduced energy usage. Using higher energy costs as experiencing currently and likely in the future, plus improved modeling that supports the use of night ventilation and use of economizers to dissipate heat at night may show cost-effectiveness at 0.42. A case could be made to reduce the U-factor to 0.42 in climate zone 2, but in the spirit of achieving a consensus proposal, we are suggesting no change.

Climate zone 1:

U=0.50 currently	Medium office building				Medium apartment				Adjusted medium office			
Fenestration U-factor	upfront cost above (below) breakeven @3% discount rate, \$/sqft	upfront cost above (below) breakeven @7% discount rate, \$/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, \$/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, \$/sq.ft	upfront cost above (below) breakeven @3% discount rate, \$/sqft	upfront cost above (below) breakeven @7% discount rate, \$/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, \$/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, \$/sq.ft	upfront cost above (below) breakeven @3% discount rate, \$/sqft	upfront cost above (below) breakeven @7% discount rate, \$/sqft	upfront cost above (below) breakeven @3% discount rate with SCC, \$/sqft	upfront cost above (below) breakeven @7% discount rate with SCC, \$/sq.ft
0.45	\$ 0.28	\$ 0.28	\$ 0.29	\$ 0.29	\$ 0.23	\$ 0.24	\$ 0.22	\$ 0.23	\$ 0.28	\$ 0.28	\$ 0.29	\$ 0.28
0.46	\$ 0.01	\$ 0.01	\$ 0.01	\$ 0.01	\$ (0.03)	\$ (0.03)	\$ (0.04)	\$ (0.03)	\$ 0.01	\$ 0.01	\$ 0.01	\$ 0.01

For curtainwall systems, this analysis suggests that there is no additional cost to go from U=0.50 to U=0.46 because this lower U-factor is typically delivered while meeting the SHGC requirements. U=0.46 is cost-effective in this analysis in the medium apartment across all measures. It is not shown to be cost-effective for the medium office building because of the modeling assumptions, which suggest energy use will rise with lower U-factors. But the modeling does not include the use of free night ventilation nor economizer systems, and as such, the heat gain during the day is not allowed to dissipate as much as could be achieved if the building was designed with those strategies. Also, lower U-factor typically delivers lower SHGC, and the impacts of a correlated reduction in SHGC was not evaluated. For many curtainwall systems, a U=0.46 is already delivered by achieving the prescriptive SHGC, although that may not be the case for storefront systems. Therefore, FTI proposes to maintain the U-factor at 0.50, focusing on making changes in the other climate zones.

Additional discussion

According to Steve Selkowitz from LBNL, the results of several of studies indicate that fenestration U-factors between 0.10 to 0.20 Btu/ºf.hr.ft^2 are likely to be appropriate to get to net zero fenestration performance across even the northern climate zones, with variation also depending on orientation and window area (more area needing lower U-factor) and in some cases with dynamic solar control. U-factors in this range are already in use in some European countries. Whether 0.20 or 0.10 or somewhere in between is considered the future net-zero target, the IECC window performance change from cycle to cycle is not on a track to achieving close to net zero window performance by 2030. Even if we assume 0.15 BTU/ºf.hr.ft^2 is the target to meet, and we consider the current 0.29 in climate zone 8, the 2024, 2027 and 2030 values would need to be 0.24, 0.19 and 0.15 respectively. The lower climate zones need to have larger changes. For climate zone 6, to get to 0.15 BTU/ºf.hr.ft^2 in 2030, the values in 2024 and 2027 if changed linearly would need to be 0.28 and 0.21 respectively. If the target is 0.20, the reduction would be 0.29 and 0.24 in 2024 and 2027. This represents a significantly more aggressive path than we have proposed here, and the committee could consider taking larger steps in the IECC net zero path. The proposals here are in-line with what is deemed to be cost-effective (albeit with aged energy cost), and most recommendations FTI is making are on average cost-effective in at least one of the two building types without including the social cost of carbon and are proposed to drive to consensus. A more aggressive approach based on SCC and recognizing that higher energy costs will be higher in the future (and are currently higher) could be considered, especially since this code will not be used widely until 2026 or beyond. Higher performance fenestration may also allow HVAC system downsizing and resultant cost savings that represent offsets against the increased first cost of the façade. These higher performing solutions will also provide real, but difficult to quantify, benefits to owners in terms of the resilience of buildings to extreme weather and loss of power.

We have not included changes for operable fenestration because we do not want to discourage the use of operable fenestration, as this is very important for natural ventilation and indoor air quality. We would be open to suggestions on U-factor values for operable fenestration that would be equivalent to the fixed fenestration, with this in mind. More broadly there is a growing interest in the role of fenestration design and optimization with respect to occupant comfort, health and productivity, with its direct impact on daylight and access to views.

Cost Impact: The code change proposal will increase the cost of construction.
The cost-effectiveness analysis for each climate zone is detailed in the rationale and more detail can be found in the attached documentation. The proposals FTI is making here are in-line with what is deemed to be cost-effective (with old energy cost assumptions), and most recommendations

are on average cost-effective in at least one if not both of the two building types analyzed without including the social cost of carbon.

A more aggressive approach based on using SCC only and recognizing that higher energy costs will be higher in the future (and are currently higher) could be considered by the committee, especially since this code will not be used widely until 2026 and beyond.

Bibliography: [1] LBNL 60049: Zero Energy Windows; https://eta-publications.lbl.gov/sites/default/files/60049.pdf
[2] H. Sanders, U-factor matters in hot climates, Façade Tectonics World Congress 2020. https://www.facadetectonics.org/papers/u-factor-mattersin-hot-climates

Attached Files

- **CZ6.png**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/399/
- **CZ7.jpg**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/398/
- **CZ8.jpg**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/397/
- **CZ5.jpg**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/396/
- **CZ4.jpg**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/395/
- **CZ3.jpg**
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- **CZ2.jpg**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/393/
- **CZ1.jpg**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/392/
- **FTI - Fenestration U-factor cost-effectiveness analysis - IECC proposal.pdf**
  https://energy.cdpaccess.com/proposal/826/1700/files/download/381/

Workgroup Recommendation

Proposal # 826

CED1-127-22

Proponents: Emily Toto, representing ASHRAE (etoto@ashrae.org)

2024 International Energy Conservation Code [CE Project]

Add new definition as follows:

NORTH-ORIENTED. facing within 67.5 degrees of true north in the northern hemisphere; (however, facing within 67.5 degrees of true south in the southern hemisphere.)

SOUTH-ORIENTED. facing within 45 degrees of true south in the northern hemisphere; (however, facing within 45 degrees of true north in the southern hemisphere.)

EAST-ORIENTED. facing within 45 degrees of true east to the south and within less than 22.5 degrees of true east to the north in the northern hemisphere; (however, facing within 45 degrees of true east to the north and within less than 22.5 degrees of true east to the south in the southern hemisphere.)

WEST-ORIENTED. facing within 45 degrees of true west to the south and within less than 22.5 degrees of true west to the north in the northern hemisphere; (however, facing within 45 degrees of true west to the north and within less than 22.5 degrees of true west to the south in the southern hemisphere.)

Add new text as follows:

C402.5.1.3 Fenestration Orientation. The *vertical fenestration* shall comply with equation C402.5.1.3.1 for *Climate Zones* 0 through 8 or for *Climate Zones* 0 through 3 equation C402.5.1.3.2 or for *Climate Zones* 4 through 8 equation C402.5.1.3.3.

$A_w \leq (A_t)/4$ and $A_e \leq (A_t)/4$ (equation C402.5.1.3.1)

$A_w \times SHGC_w \leq (A_t \times SHGC_c)/4$ and $A_e \times SHGC_e \leq (A_t \times SHGC_c)/4$ (equation C402.5.1.3.2)

$A_w \times SHGC_w \leq (A_t \times SHGC_c)/5$ and $A_e \times SHGC_e \leq (A_t \times SHGC_c)/5$ (equation C402.5.1.3.3)

where:

A_w = *west-oriented vertical fenestration* area
A_e = *east-oriented vertical fenestration* area

A_t = total *vertical fenestration* area

$SHGC_c$ = SHGC criteria in Tables C402.5

$SHGC_e$ = SHGC for *east-oriented vertical fenestration*

$SHGC_w$ = SHGC for *west-oriented vertical fenestration*

Exceptions:

1. *Buildings* with shade on more than 75 percent of the *east-oriented* and *west-oriented vertical fenestration* areas from permanent projections, existing buildings, existing permanent infrastructure, or topography at 9 a.m. and 3 p.m., respectively, on the summer solstice.
2. *Buildings* where the *west-oriented* and *east-oriented vertical fenestration* area is not greater than 20% of the gross wall area for each of those façades.
3. *Buildings* in *Climate Zone* 8.

Reason: This proposal to the building/fenestration orientation requirements provides requirements for east and west facing fenestration while also providing more flexibility for complying. Analyses indicate that east and west facing fenestration increases building energy consumption compared to north and south facing glazing in all climates. The criteria can be met by limiting fenestration area, changing the fenestration SHGC, or orienting the building so that the long axis is in the east-west direction. A number of exceptions are provided. Exceptions include one for buildings with less than 20% fenestration on the east and west facades and one for buildings in Climate Zone 8. The definitions for the areas east and west oriented fenestration have also been further refined.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal has no cost impact as we are not requiring any physical material changes or increase in insulation values or fenestration technology improvements that would impact a projects first cost.

Workgroup Recommendation

Proposal # 696

CED1-128-22

Proponents: Emily Lorenz, representing self (emilyblorenz@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.1 Air barriers. A continuous *air barrier* shall be provided throughout the *building thermal envelope*. The *air barrier* is permitted to be located~~any combination of~~ inside, outside, or within the *building thermal envelope*. The *air barrier* shall comply with Sections C402.6.1.2, and C402.6.1.3. The *air leakage* performance of the *air barrier* shall be verified in accordance with Section C402.6.2.

Exception: *Air barriers* are not required in buildings located in *Climate Zone* 2B.

C402.6.1.1 Air barrier design and documentation requirements . Design of the continuous *air barrier* shall be documented as follows~~in the following manner~~:

1. Components comprising the continuous *air barrier* and their position within each *building thermal envelope* assembly shall be identified.
2. Joints, interconnections, and penetrations of the continuous *air barrier* components shall be detailed.
3. The continuity of the *air barrier* building element assemblies that enclose conditioned space or provide a boundary between conditioned space and unconditioned space shall be identified.
4. Documentation of the continuous *air barrier* shall detail methods of sealing the *air barrier* such as wrapping, caulking, gasketing, taping or other *approved* methods at the following locations:

   4.1 Joints around fenestration and door frames.

   4.2 Joints between walls and floors, between walls at building corners, between walls and roofs including parapets and copings, where above-grade walls meet foundations, and similar intersections.

   4.3 Penetrations or attachments through the continuous *air barrier* ~~in building envelope roofs, walls, and floors~~.

   4.4 Building assemblies used as ducts or plenums.

   4.5 Changes in continuous *air barrier* materials and assemblies.

5. Identify where testing will or will not be performed in accordance with Section C402.6~~5~~.2 Where testing will not be performed, a plan for field inspections required by C402. 6~~5~~.2.3 shall be provided that includes the following:

   5.1 Schedule for periodic inspection,

   5.2 Continuous *air barrier* scope of work,

   5.3 List of critical inspection items,

   5.4 Inspection documentation requirements, and

   5.5 Provisions for corrective actions where needed.

C402.6.2.1 Whole building test method and reporting. The *building thermal envelope* shall be tested by an *approved* third ~~thrid~~ party for *air leakage* in accordance withASTM E3158 or an equivalent *approved* method. ~~method~~ A report that includes the tested surface area, floor area, air by volume, stories above grade, and *air leakage* rates shall be submitted to the code official and the building owner.

Exceptions: ~~Add optional paragraph text here~~

1. For buildings less than 10,000 ft^2 (1000 m^2) the entire *building thermal envelope* shall be permitted to be tested in accordance with ASTM E779, ASTM E3158, ~~or~~ ASTM E1827 , or an equivalent *approved* method.
2. For buildings greater than 50,000 ft^2 (4645 m^2), portions of the building shall be permitted to be tested and the measured *air leakage* shall be area-weighted by the surface areas of the *building thermal envelope* in each portion. The weighted average tested *air leakage* shall not be greater than the whole building *air leakage* limit. The following portions of the building shall be tested:

   2.1 The entire *building thermal envelope* area of stories that have any conditioned spaces directly under a roof.

   2.2 The entire *building thermal envelope* area of stories that have a building entrance, a floor over unconditioned space, a loading dock, or that are below grade.

   2.3 Representative above-grade portions of the building totaling not less than 25 percent of the wall area enclosing the remaining conditioned space.

Reason: This proposal is editorial and is not meant to change the meaning or stringency of the requirements. Any changes submitted as part of the errata proposal for CECPI-3 are also included in this proposal to assist with correlation. Only five changes are included in this proposal that are new:
1. Section C402.6.1, changed "any combination of" to "located"

2. Section C402.6.1.1, changed "in the following manner" to "as follows"

3. Section C402.6.2.1, added "air" to "...and air leakage rates shall be submitted..." in the second sentence.

4. Section C402.6.2.1, exception 1, deleted "or" in "...ASTM E3158, ~~or~~ ASTM E1827, or an equivalent..."

5. Section C402.6.2.1, exception 2, added "air" to "...building air leakage limit." in the second sentence.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Proposal only includes editorial changes to language.

Workgroup Recommendation

Proposal # 715

CED1-129-22

Proponents: Theresa Weston, representing Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.1 Air barriers. A continuous air barrier shall be provided throughout the *building thermal envelope*. The air barrier is permitted to be any combination of inside, outside, or within the *building thermal envelope*. The air barrier shall comply with Sections C402.6.1.2, and C402.6.1.3. The air leakage performance of the air barrier shall be verified in accordance with Section C402.6.2.

Exception: Air barriers are not required in <u>single wythe concrete masonry</u> buildings located in *Climate Zone* 2B.

C402.6.1.3 Air leakage compliance. Air leakage of the building thermal envelope shall be tested by an approved third party in accordance with C402.6.2.1. The measured air leakage shall not be greater than 0.35 cfm/ft (1.8 L/s x m) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated building thermal envelope surface area being the sum of the above- and below-grade building thermal envelope.

Exceptions: Add optional paragraph text here

1. Where the measured air leakage rate is greater than 0.35 cfm/ft^2 (1.8 L/s x m^2) but is not greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), the approved third party shall perform a diagnostic evaluation using smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized along with a visual inspection of the air barrier in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the code official and the building owner. Where the measured air leakage rate is greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), corrective actions must be made to the building and an additional test completed for which the results are 0.45 cfm/ft^2 (2.3 L/s x m^2), or less.
2. <u>Single wythe concrete masonry buildings</u> ~~Buildings~~ in Climate Zone 2B.
3. Buildings larger than 25,000 square feet (2300 m) floor area in Climate Zones 0 through 4, other than Group R and I occupancies, that comply with C402.6.2.3
4. As an alternative, buildings or portions of building, containing Group R and I occupancies, shall be permitted to be tested by an approved third party in accordance with C402.6.2.2. The reported air leakage of the building thermal envelope shall not be greater than 0.27 cfm/ft^2 (1.4 L/s x m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).

Reason: This proposal aligns the air barrier requirement exception in the IECC-C with that in ASHRAE 90.1. In ASHRAE 90.1 the exception applied only to "single wythe concrete masonry buildings" in Climate zone 2B and not all buildings in Climate Zone 2B.
Climate Zone 2B is a large area of land west of San Antonio TX, and very populated and fast growing area of south Arizona. Although these areas are dry and getting drier, they are experiencing more “hard rain events” with flash flooding even though the average annual rainfall decreases. In addition to direct energy savings, a main benefit of an air barrier is the moisture control. Even though these areas are “dry”, their risk for moisture infiltration well actually increase with climate change. Likewise, these areas are warm/hot and hot air can hold considerably more moisture than cold air. Moisture intrusion can reduce the durability and performance of insulation and other building components and, therefore, deteriorate energy performance of building assemblies.

Cost Impact: The code change proposal will increase the cost of construction.
This proposal will increase the cost of construction only for a subset of buildings in Climate Zone 2B, but that cost increase will be balanced against energy savings and the prevention of moisture deterioration of the building assemblies. The long inclusion of the exception in ASHRAE 90.1 indicates that it has been found cost effective.

Workgroup Recommendation

Proposal # 868

CED1-130-22

Proponents: Bob Zabcik, representing Metal Construction Association (bob@ztech-consulting.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.1.2 Air barrier construction. The *continuous air barrier* shall be constructed to comply with the following:

1. The air barrier shall be continuous for all assemblies that comprise the building thermal envelope and across the joints and assemblies.
2. Air barrier joints and seams shall be sealed, including sealing transitions in places and changes in materials. The joints and seals shall be securely installed in or on the joint for its entire length so as not to dislodge, loosen or otherwise impair its ability to resist positive and negative pressure differentials such as those from ~~design~~ wind ~~loads~~, stack effect and mechanical ventilation.
3. Penetrations of the air barrier shall be caulked, gasketed or otherwise sealed in a manner compatible with the construction materials and location. Sealing shall allow for expansion, contraction and mechanical vibration.Sealing materials shall be securely installed around the penetration so as not to dislodge, loosen or otherwise impair the pnetrations' ability to resist positive and negative pressure. Sealing of concealed fire sprinklers, where required, shall be in a manner that is recommended by the fire sprinkler manufacturer. Caulking or other adhesive sealants shall not be used to fill voids between fire sprinkler cover plates and walls or ceilings.
4. Recessed lighting fixtures shall comply with Section C402.6.1.2.1. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.
5. Electrical and communication boxes shall comply with C402.6.1.2.2 to maintain the integrity of the air barrier.
6. Electrical and communication boxes shall comply with C402.6.1.2.2. Where similar objects are installed that penetrate the air barrier, provisions shall be made to maintain the integrity of the air barrier.

Reason: Using the term "design wind loads" implies that the continuous air barrier should be designed to the pressure as a structural element would be. Design wind speeds for typical buildings (i.e., Risk Category II in ASCE-7) are based on a 7% probability of exceedance in 50 years, which equated to a mean recurrence interval of 700 years. Higher Risk Category buildings are even higher. Designing the CAB for a 700-year wind event is excessive.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This change is needed to correct misuse of a term commonly used in building design for a completely different purpose.

Workgroup Recommendation

Proposal # 897

CED1-131-22

Proponents: Theresa Weston, representing Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.1.3 Air leakage compliance. Air leakage of the building thermal envelope shall be tested by an approved third party in accordance with C402.6.2.1. The measured air leakage shall not be greater than 0.35 cfm/ft (1.8 L/s x m) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated building thermal envelope surface area being the sum of the above- and below-grade building thermal envelope.

Exceptions: Add optional paragraph text here

1. Where the measured air leakage rate is greater than 0.35 cfm/ft^2 (1.8 L/s x m^2) but is not greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), the approved third party shall perform a diagnostic evaluation using smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized <u>or depressurized </u>along with a visual inspection of the air barrier in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the code official and the building owner. Where the measured air leakage rate is greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), corrective actions must be made to the building and an additional test completed for which the results are 0.45 cfm/ft^2 (2.3 L/s x m^2), or less.
2. Buildings in Climate Zone 2B.
3. Buildings larger than 25,000 square feet (2300 m) floor area in Climate Zones 0 through 4, other than Group R and I occupancies, that comply with C402.6.2.3
4. As an alternative, buildings or portions of building, containing Group R and I occupancies, shall be permitted to be tested by an approved third party in accordance with C402.6.2.2. The reported air leakage of the building thermal envelope shall not be greater than 0.27 cfm/ft^2 (1.4 L/s x m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).

Reason: This proposal adds the option of inspection with the building under depressurization in addition to the current requirement for the building to pressurized. ASTM E1186 contains instructions for conducting the evaluation under either depressurization or pressurization. In some situations, depressurization may be more efficient than pressurization to conduct the inspection.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not add or delete requirements from the code. It provides more options on conducting a field evaluation to locate building air leakage.

Workgroup Recommendation

Proposal # 871

CED1-132-22

Proponents: Theresa Weston, representing Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.1.3 Air leakage compliance. Air leakage of the building thermal envelope shall be tested by an approved third party in accordance with C402.6.2.1. The measured air leakage shall not be greater than 0.35 cfm/ft (1.8 L/s x m) of the building thermal envelope area at a pressure differential of 0.3 inch water gauge (75 Pa) with the calculated building thermal envelope surface area being the sum of the above- and below-grade building thermal envelope.

Exceptions: Add optional paragraph text here

1. Where the measured air leakage rate is greater than 0.35 cfm/ft^2 (1.8 L/s x m^2) but is not greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), the approved third party shall perform a diagnostic evaluation using smoke tracer or infrared imaging. The evaluation shall be conducted while the building is pressurized along with a visual inspection of the air barrier in accordance with ASTM E1186. All identified leaks shall be sealed where such sealing can be made without damaging existing building components. A report specifying the corrective actions taken to seal leaks shall be deemed to establish compliance with the requirements of this section where submitted to the code official and the building owner. Where the measured air leakage rate is greater than 0.45 cfm/ft^2 (2.3 L/s x m^2), corrective actions must be made to the building and an additional test completed for which the results are 0.45 cfm/ft^2 (2.3 L/s x m^2), or less.
2. Buildings in Climate Zone 2B.
3. Buildings larger than 25,000 square feet (2300 m) floor area in Climate Zones 0 through 4, other than Group R and I occupancies, that comply with C402.6.2.3
4. As an alternative, buildings or portions of building, containing Group R-2 and I -1 occupancies, shall be permitted to be tested by an approved third party in accordance with C402.6.2.2. The reported air leakage of the building thermal envelope shall not be greater than 0.27 cfm/ft^2 (1.4 L/s x m^2) of the testing unit enclosure area at a pressure differential of 0.2 inch water gauge (50 Pa).

Reason: This proposal reflects the text that was approved during the committee review of CEPI-58, and so may be considered errata. It limits the dwelling/sleeping unit testing exception (vs. whole building testing) to R-2 and I-1 occupancies instead of the entire R and I occupancies.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not change which buildings are tested. It only provides more precise guidance on which buildings are appropriate to use dwelling unit testing as an alternate to whole building testing.

Workgroup Recommendation

Proposal # 736

CED1-133-22

Proponents: Anjana Agarwal, representing Aeroseal, LLC (anjana@theadhocgroup.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.2.1 Whole building test method and reporting. The *building thermal envelope* shall be tested by an approved thrid party for air leakage in accordance withASTM E3158 or an equivalent approved. method A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exceptions: Add optional paragraph text here

1. For buildings less than 10,000 ft^2 (1000 m^2) the entire building thermal envelope shall be permitted to be tested in accordance with ASTM E779, ASTM E3158, or ASTM E1827 or an equivalent approved method.
2. For buildings greater than 50,000 ft^2 (4645 m^2), portions of the building shall be permitted to be tested and the measured air leakage shall be area-weighted by the surface areas of the building thermal envelope in each portion. The weighted average tested air leakage shall not be greater than the whole building leakage limit. The following portions of the building shall be tested:

   2.1 The entire building thermal envelope area of stories that have any conditioned spaces directly under a roof.

   2.2 The entire building thermal envelope area of stories that have a building entrance, a floor over unconditioned space, a loading dock, or that are below grade.

   2.3 Representative above-grade portions of the building totaling not less than 25 percent of the wall area enclosing the remaining conditioned space.

<u>3. Where technology providers or vendors are able to certify reduction in leakage in accordance with the above mentioned approved methods, no additional independent third party testing will be required.</u>

Reason: Certain technology providers, such as Aeroseal and AeroBarrier, measure envelope leakage pre- and post-delivery of their service for every project. As part of each project, they deliver an instantly verifiable envelope sealing report which eliminates the need for additional third party testing.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No cost impact.

Workgroup Recommendation

Proposal # 869

CED1-134-22

Proponents: Theresa Weston, representing Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.6.2.2 Dwelling and sleeping unit enclosure method and reporting. The *building thermal envelope* shall be tested for air leakage in accordance with ASTM E779, ANSI/RESNET/ICC 380, ASTM E1827 or an equivalent approved method. Testing shall be conducted by an approved third party.Where multiple dwelling units or sleeping units or other spaces are contained within one *building thermal envelope*, each shall be considered an individual testing unit, and the building air leakage shall be the weighted average of all tested unit results, weighted by each *testing unit enclosure area*. ~~testing unit's enclosure area~~. Units shall be tested without simultaneously testing adjacent units and shall be separately tested as follows:

1. Where buildings have less than eight total dwelling or sleeping units, each unit shall be tested.
2. Where buildings have eight or more dwelling or sleeping units, the greater of seven units or 20 percent of the units in the building shall be tested, including a top floor unit, a middle floor unit, a ground floor unit and a unit with the largest testing unit enclosure area. For each tested unit that exceeds the maximum air leakage rate, an additional three units shall be tested, including a mixture of testing unit types and locations.
3. Enclosed spaces with not less than one exterior wall in the building thermal envelope shall be tested in accordance with Section C402.6.2.1.

    Exception: Corridors, stairwells, and enclosed spaces having a conditioned floor area not greater than 1,500 ft (139 m2)shall be permitted to comply with Section C402.6.2.3 and either Section C402.6.2.3.1 or Section C402.6.2.3.2.

Reason: This proposal updates to the text to use defined terms.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not add or delete requirements. It is solely intended to use current defined terminology with in the text.

Workgroup Recommendation

Proposal # 892

CED1-135-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

APPENDIX DD
THERMAL BRIDGES IN ABOVE-GRADE WALLS

Delete and substitute as follows:

~~**C402.7 Thermal bridges in above-grade walls.** Thermal bridges in above-grade walls shall comply with the section or an approved design.~~

~~**Exceptions:**~~

1. ~~*Buildings* and structures located in Climate Zones 0 through 3.~~
2. ~~Any *thermal bridge* with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.~~
3. ~~Blocking, coping, flashing, and other similar materials for attachment of roof coverings.~~
4. ~~*Thermal bridges* accounted for in the *U*-factor or *C*-factor for a *building thermal envelope*.~~

DD101.1 Thermal bridges in above-grade walls. Thermal bridges in above-grade walls shall comply with the section this appendix or an approved design.

Exceptions:

1. *Buildings* and structures located in Climate Zones 0 through 3.
2. Any *thermal bridge* with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.
3. Blocking, coping, flashing, and other similar materials for attachment of roof coverings.
4. *Thermal bridges* accounted for in the *U*-factor or *C*-factor for a *building thermal envelope*.

Revise as follows:

~~**C402.7.1**~~ **DD101.1.1 Balconies and floor decks.** Balconies and concrete floor decks shall not penetrate the building thermal envelope. Such assemblies shall be separately sup-ported or shall be supported by structural attachments or elements that minimize thermal bridging through the building thermal envelope.
Exceptions: Balconies and concrete floor decks shall be permitted to penetrate the *building thermal envelope* where:

1. an area-weighted *U*-factor is used for *above-grade wall* compliance which includes a *U*-factor of 0.8 Btu/h-°F-ft^2 for the area of the *above-grade wall* penetrated by the concrete floor deck, or
2. an approved thermal break device of not less than R-10 is installed in accordance with the manufacturer's instructions.

~~**C402.7.2**~~ **DD 101.1.2 Cladding supports.** Linear elements supporting opaque cladding shall be off-set from the structure with attachments that allow the continuous insulation, where present, to pass behind the cladding support element.

Exceptions:

1. An *approved* design where the above-grade wall *U*-factor used for compliance accounts for the cladding support element *thermal bridge*.
2. Anchoring for curtain wall and window wall systems.

~~**C402.7.3**~~ **DD101.1.3 Structural beams and columns.** Structural steel and concrete beams and columns that project through the *building thermal envelope* shall be covered with not less than R-5 insulation for not less than 2 feet (610 mm) beyond the interior or exterior surface of an insulation component within the *building thermal envelope*.

Exceptions:

1. Where an approved thermal break device is installed in accordance with the manufacturer's instructions.
2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or col-umn thermal bridge.

~~C402.7.4~~ DD101.1.4 **Vertical fenestration.** Vertical fenestration intersections with above grade walls shall comply with one or more of the following:

1. Where above-grade walls include continuous insulation, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within 2 inches (610 mm) of the interior or exterior surface of the continuous insulation.
2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column thermal bridge.
3. The surface of the rough opening, not coved by the fenestration frame, shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inches (457 mm) thick.
4. For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel *U*-factor shall account for *thermal bridges*.

Exceptions:

1. Where an approved design for the above-grade wall *U*-factor used for compliance accounts for *thermal bridges* at the intersection with the vertical fenestration.
2. Doors

~~C402.7.5~~ DD101.1.5 **Parapets.** Parapets shall comply with one or more of the following as applicable:

1. Where continuous insulation is installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the continuous insulation shall extend up both sides of the parapet not less than 2 feet (610 mm) above the roof covering or to the top of the parapet, whichever is less. Parapets that are an integral part of a fire-resistance rated wall, and the exterior continuous insulation applied to the parapet, shall comply with the fire resistance ratings of the building code.
2. Where continuous insulation is installed on the exterior side of the above-grade wall and the roof insulation is below the roof deck, the continuous insulation shall extend up the exterior side of the parapet to not less than the height of the top surface of the roof assembly.
3. Where continuous insulation is not installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the wall cavity or integral insulation shall extend into the parapet up to the exterior face of the roof insulation or equivalent R-value insulation shall be installed not less than 2 feet (610 mm) horizontally inward on the underside of the roof deck.
4. Where continuous insulation is not installed on the exterior side of the *above-grade wall* and the roof insulation is below the roof deck, the wall and roof insulation components shall be adjacent to each other at the roof-ceiling-wall intersection.

Exception: An *approved* design where the *above-grade wall U*-factor used for compliance accounts for the parapet *thermal bridge*.

C402.1 General. *Building thermal envelope* assemblies for buildings that are intended to comply with the code on a prescriptive basis in accordance with the compliance path described in Item 1 of Section C401.2.1 shall comply with the following:

1. The opaque portions of the *building thermal envelope* shall comply with the specific insulation requirements of Section C402.2 and the thermal requirements of either the U-, C- and F-factor based method of Section C402.1.2; the R-value based method of C402.1.3; or the component performance alternative of Section C402.1.4. Where the total area of the through-wall penetrations of mechanical equipment is greater than 1 percent of the opaque above-grade wall area, the building thermal envelope shall comply with Section C402.1.2.4.
2. Wall solar reflectance and thermal emittance shall comply with Section C402.3.
3. Roof solar reflectance and thermal emittance shall comply with Section C402.4.
4. Fenestration in building envelope assemblies shall comply with Section C402.5.
5. Air leakage of the building thermal envelope shall comply with C402.6.
6. Walk-in coolers, walk-in freezers, refrigerated warehouse coolers and refrigerated warehouse freezers shall comply with Section C403.12.
7. ~~*Thermal bridges* in *above-grade walls* shall comply with Section C402.7.~~

Alternatively, where buildings have a vertical fenestration area or skylight area exceeding that allowed in Section C402.5, the building and *building thermal envelope* shall comply with Item 2 of Section C401.2.1 or Section C401.2.2.

Reason: The original code change, CECPI-4-21, was committee developed in the few months before the vote. It was developed mainly by the proponents of conflicting proposals CEPI-33-21, CEPI-40-21, and CEPI-45-21. It was developed without input from key stakeholders – structural engineers who would need to comply with this.

· This has **not been tried anywhere** for any building to see if it is realistic.

· **It hasn't been modeled as a whole building** to see if it saves energy under actual weather conditions**.** Cooling energy costs are now on par with heating energy costs in mild to cold climates through climate zone 5 per PNNL reports, meaning thermal bridges have less effect than steady state analysis may indicate. Also, thermal mass effects of thermal bridges have the potential to reduce peak loads and reduce cooling costs. There is no indication that these many years of modeling buildings without consideration of thermal bridges has any impact on predicted loads or sizing calculations.

· **There is no analysis by climate zone** – as the envelope is tightened more air conditioning and less heating is needed. This changes the lens for mixed climate zones and what measures save energy.

· ASHRAE has developed Addendum av, likely to soon be published as part of 90.1-2022. CECPI-4-21 is a very truncated version of Addendum av and possibly violates ASHRAE copyright**.**

The simplification of CECPI-4-21 compared to Addendum av impacts constructability and the ability to comply. Addendum av was developed over 12 years, starting in 2010, with significant input from stakeholders whereas CECPI-4-21 was just developed without input from those primarily affected. It is oversimplified to the point of not allowing common construction methods.

· **Constructability was not considered, and costs and cost effectiveness were not provided** as required by ICC. The cost statement indicates it provides "*practical mitigation which does not require significant changes to current practices, setting a relatively low performance bar.*"

This statement is not true.

While certain types of construction can easily comply, some typical construction cannot – these provisions are not practical. The (20 to 70%) energy savings in the reason statement is not related to this proposal (it is an oft-repeated myth).

California wanted to verify this and did a detailed analysis available online (beginning on slide 68) and showed 1% savings; it was decided that adopting comparable requirements was not worth the effort in training and compliance because it was so complex. Additional detail:

"The Statewide CASE Team is not pursuing this measure due to significant concerns about the absence of a nonresidential registry or third-party entity ready to perform field inspection and verification by 2022 nor an established format for professionals to sign off that calculations had been properly performed."

Granted, California is generally warmer, and uses different criteria, but its analysis considered compliance and enforcement. **This proposal will have extraordinary design and construction costs for the commercial building industry with little or no energy saving value.** Even though a concept sounds good doesn't mean a related proposal saves energy. **This proposal still allows thermal bridges – it just discriminates against some in favor of others**. It favors point connections through insulation which increases the potential for corrosion.

· The predictable result of this proposal will be that some forward-leaning jurisdictions will require it and find it has **unintended consequences.** Remaining jurisdictions and developers will not know how to enforce it or comply with it. It will require extensive education on the new requirements for the design and regulatory communities. Every structural and envelope designer, and every plan reviewer and building inspector, will need education on these provisions. It takes a long time for the various professional associations to develop and deliver new content. Big new concepts in code trigger big new education development and administration.

· An example of the basic flaws in the thermal bridging language: compliance is required for all fasteners, no matter how small, unless the performance path is used. Section C402.6.1, Balconies and floor decks, which requires an excessive thermal break of R-10, is another example. Consider that wood blocking, which is allowed as an overall exception, has an R-value of about R-1.25 Very small thermal breaks in window frames are effective and are a fraction of an R-value.

· **Designers are not familiar with psi and chi factors.** These factors cannot be calculated except via costly research, and they are variable depending on the type of thermal bridge and insulation in adjacent assemblies. **Values are not available for most assemblies.** The default psi and chi factors in 90.1 Addendum av are problematic; they do not account for these complexities. The performance alternative of this proposal truncates the number of psi and chi factors compared to Addendum av, resulting in even more significant inaccuracies. Since users will be new to these, they will think they are accurate when they are not. They can be off by many multiples.

· The component performance alternative in Section C402.1.5 does not allow the use of actual psi and chi factors for actual thermal bridges. Actual values from the major source of values - Morrison Hershfield, should be allowed.

· CEPI-30-21, which was disapproved, would have allowed for the ACI/TMS 122.1 as the standard for mitigating thermal bridges. This standard was developed by concrete and masonry professionals. This should be considered an alternate path.

· **The biggest thermal bridge in a building is the fenestration.** For perspective, a concrete slab edge has the same steady state heat transfer as a strip of one-foot-high fenestration. Granted, a slab edge has thermal mass, and glass has other benefits, but this shows the oversimplification of this proposal.

· The proposal does not provide industry time to adapt to radical changes in the way buildings are constructed.

Proposed resolution:

Make a non-mandatory appendix, which would permit beta testing by forward-leaning jurisdictions, and identification of needed improvements of the provisions, as well as development of critical educational offerings by the professional associations of the affected parties.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
It is currently uncertain what cost impacts this proposal may have. Proponent did not provide a detailed analysis.

Workgroup Recommendation

Proposal # 676

CED1-136-22

Proponents: Vladimir Kochkin, representing NAHB (vkochkin@nahb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.7 Thermal bridges in above-grade walls. Thermal bridges in above-grade walls shall comply with the section or an approved design.
Exceptions:

1. *Buildings* and structures located in Climate Zones 0 through ~~3~~ 4.
2. Any *thermal bridge* with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.
3. Blocking, coping, flashing, and other similar materials for attachment of roof coverings.
4. *Thermal bridges* accounted for in the *U*-factor or *C*-factor for a *building thermal envelope*.

Reason: There was no cost-effectiveness analysis provided with the proposal for thermal bridging. The statement that these provisions are already implied by the code is incorrect and inadequate. Until a cost-effectiveness analysis is provided, at a minimum climate zone 4 should be added to the list of exceptions.
The provisions should be vetted through the IBC structural committee – the structural engineering community will have to meet these requirements.

The state of California considered adding thermal bridging provisions but after conducting an analysis did not adopt such provisions. This supports adding Climate Zone 4 as there are parts of California in CZ 4 and 5.

Requirements for balconies are overly restrictive. An ASHRAE version of this proposal offered allowances for balconies by climate zone to make these requirements more feasible. For Climate Zone 4, up to 35% of the floor perimeter can be allocated to balconies in 90.1.

These highly complex provisions have not been tried on any design projects in the field and are not part of any above-code programs. Demonstrated experience with the newly proposed energy modeling provisions should be accumulated before locating them in the main body of the code.

This proposal offers to resolve these concerns by extending the exception to Climate Zone 4.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal will reduce the cost of construction in climate zone 4.

Workgroup Recommendation

Proposal # 812

CED1-137-22

Proponents: Bob Zabcik, representing Metal Construction Association (bob@ztech-consulting.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

PSI-FACTOR (ψ-FACTOR). The heat loss factor per unit length of a _linear_ *thermal bridge* ~~characterized as a linear element of a building thermal envelope~~ (Btu/h × ft × °F)[W/(m × K)].

THERMAL BRIDGE. An element or interface of elements that has a higher thermal conductivity than the surrounding *building thermal envelope*, which creates a path of least resistance for heat transfer.

Add new definition as follows:

LINEAR THERMAL BRIDGE. A *thermal bridge* characterized as a linear element of a *building thermal envelope* which penetrates the insulation.

POINT THERMAL BRIDGE. A *thermal bridge* characterized as a point element of a *building thermal envelope* which penetrates the insulation

2024 International Energy Conservation Code [CE Project]

Revise as follows:

CHI-FACTOR (χ-FACTOR). The heat loss factor for a single *point thermal bridge* ~~characterized as a point element of a building thermal envelope~~ (Btu/h x °F)[W/K].

C402.7 Thermal bridges in above-grade walls. _Point_ *thermal bridges* and *linear thermal bridges* in above-grade walls shall comply with the section or an approved design.

Exceptions:

1. *Buildings* and structures located in Climate Zones 0 through 3.
2. Any _linear_ *thermal bridge* with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.
3. Blocking, coping, flashing, and other similar materials for attachment of roof coverings.
4. _Point_ *thermal bridges* *and linear thermal bridges* accounted for in the *U*-factor or *C*-factor for a *building thermal envelope*.

C402.7.2 Cladding supports. Linear elements supporting opaque cladding shall be off-set from the structure with attachments that allow the continuous insulation, where present, to pass behind the cladding support element.

Exceptions:

1. An *approved* design where the above-grade wall *U*-factor used for compliance accounts for the cladding support element _linear_ *thermal bridge*.
2. Anchoring for curtain wall and window wall systems.

C402.7.3 Structural beams and columns. Structural steel and concrete beams and columns that project through the *building thermal envelope* shall be covered with not less than R-5 insulation for not less than 2 feet (610 mm) beyond the interior or exterior surface of an insulation component within the *building thermal envelope*.

Exceptions:

1. Where an approved thermal break device is installed in accordance with the manufacturer's instructions.
2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column _point_ *thermal bridge*.

C402.7.4 Vertical fenestration. Vertical fenestration intersections with above grade walls shall comply with one or more of the following:

1. Where above-grade walls include continuous insulation, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within 2 inches (610 mm) of the interior or exterior surface of the continuous insulation.
2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column thermal bridge.

3. The surface of the rough opening, not coved by the fenestration frame, shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inches (457 mm) thick.
4. For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel *U*-factor shall account for *thermal bridges*.

Exceptions:

1. Where an approved design for the above-grade wall *U*-factor used for compliance accounts for *point* *thermal bridges* and ~~*linear thermal bridges*~~ at the intersection with the vertical fenestration.
2. Doors

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
	Solar absorptance: 0.75, except as specified in Section C402.4 and Table C402.4 for Climate Zones 0, 1, 2, and 3	As proposed
	Emittance: 0.90, except as specified in Section C402.4 and Table C402.4 for Climate Zones 0, 1, 2, and 3	As proposed
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
	Thermal bridges: Account for heat transfer consistent with compliant *psi*- and *chi*-factors from Table C402.1.4 for *linear thermal bridges* and *point thermal bridges* as identified in Section C402.7 that are present in the proposed design.	As proposed; *psi*- and *chi*-factors for proposed *linear thermal bridges* and *point thermal bridges* shall be determined in accordance with requirements in Section C402.1.4.
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.2 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.2	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed

Skylights	Area 1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Outdoor airflow	Where the proposed design specifies mechanical ventilation: 1. For systems 1-4 as specified in Tables C407.4.1(2) and C407.4.1(3), the outdoor airflow rate shall be determined in accordance with Section C403.7 and *International Mechanical Code* Section 403.3.1.1.2.3.4 Equation 4-8, using a system ventilation efficiency (Ey) of 0.75. 2.For systems 5-11 as specified in Tables C407.4.1(2) and C407.4.1(3), the outdoor airflow rate shall be determined in accordance with Section C403.7 and *International Mechanical Code* Section 403.3. Where the proposed design specifies natural ventilation, as proposed.	As proposed, in accordance with Section C403.2.2.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed

Heating systems	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed
Cooling systems	Fuel type: same as proposed design	As proposed
	Equipment type[c]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.	As proposed
	Economizer[d]: same as proposed, in accordance with Section C403.5.	As proposed
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	As proposed
<u>Energy Recovery</u>	Where the proposed design specifies mechanical ventilation, as specified in Section C403.7.4 based on the *standard reference design* airflows. Where the proposed design specifies natural ventilation, as proposed.	As proposed
Fan power	As specified in Section C403.8 for the proposed design. **Exceptions:** 1. Where the fan power of the proposed design is exempted from the requirements of Section C403.8, as proposed. 2. Fan systems addressed by Section C403.8.1: Fan system BHP power shall be as proposed or to the limits specified in Section C403.8.1, whichever is smaller. If the limit is reached, the power or each fan shall be reduced proportionally until the limit is met. 3. Fan systems serving areas where the mechanical ventilation is provided in accordance with an engineered ventilation system design of Section 403.2 of the *International Mechanical Code* shall not use the particulate filtration or air cleaner pressure drop adjustment available in Table C403.8(1) when calculating the fan system BHP limit for the portion of the airflow being treated to comply with the engineered ventilation system design.	As proposed
	Where a system providing on-site renewable energy has been modeled in the proposed design the same system shall be modeled identically in the *standard reference design* except the rated capacity shall meet the requirements of Section C405.15.1	

On-site Renewable Energy	Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following characteristics: **Size:** Rated capacity per Section C405.15.1 **Module Type**: Crystalline Silicone Panel with glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C, Performance shall be based on a reference temperature of 77°F (25°C), airmass of 1.5 atmosphere and irradiance of 317 Btu/h x ft^2 (1000 W/m^2). **Array Type:** Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total System Losses (DC output to AC output): 11.3%. **Tilt:** 0-degrees (mounted horizontally). **Azimuth:** 180 degrees.	As proposed

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 – (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

C103.2 Information on construction documents. Construction documents shall be drawn to scale on suitable material. Electronic media documents are permitted to be submitted where *approved* by the *code official*. Construction documents shall be of sufficient clarity to indicate the location, nature and extent of the work proposed, and show in sufficient detail pertinent data and features of the building, systems and equipment as herein governed. Details shall include, but are not limited to, the following as applicable:

1. Energy compliance path.
2. Insulation materials and their *R*-values.
3. Fenestration *U*-factors and solar heat gain coefficients (SHGCs).
4. Area-weighted *U*-factor and solar heat gain coefficient (SHGC) calculations.
5. Mechanical system design criteria.
6. Mechanical and service water-heating systems and equipment types, sizes and efficiencies.

7. Economizer description.
8. Equipment and system controls.
9. Fan motor horsepower (hp) and controls.
10. Duct sealing, duct and pipe insulation and location.
11. Lighting fixture schedule with wattage and control narrative.
12. Location of *daylight* zones on floor plans.
13. Air barrier and air sealing details, including the location of the air barrier.
14. Location of pathways for routing of raceways or cable from the on-site renewable energy system to the electrical distribution equipment.
15. *Point thermal bridges* and *linear thermal bridges* as identified in Section C402.~~6~~ 7.
16. Location reserved for inverters, metering equipment, ESS, and a pathway reserved for routing of raceways or conduit from the renewable energy system to the point of interconnection with the electrical service and the ESS.
17. Location and layout of a designated area for ESS.
18. Rated energy capacity and rated power capacity of the installed or planned ESS.

Reason: The current definition of thermal bridge is too broad and needs further distinction in order to properly link thermal bridges to their respective psi and chi factors.
The definition of Building Thermal Envelope includes all wall and roof assembly components, not just insulation. Yet it is only the penetration of the insulation that is relevant to a thermal bridge. So, if an element with a thermal conductivity in excess of 3 Btu/hr-ft-F (From Exception 2 of Section C402.7) penetrates the sheathing but not the insulation, it meets the definition of thermal bridge and very well might require the calculation of a psi- or chi-factor, yet the energy use impact of such a penetration is inconsequential.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is simply a clarification to the current proposed language and will not impact the cost of construction.

Workgroup Recommendation

Proposal # 887

CED1-138-22

Proponents: Alyson Hallander, representing Schoeck

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.7.1 Balconies and floor decks. Balconies and concrete floor decks shall not penetrate the building thermal envelope. Such assemblies shall be separately sup-ported or shall be supported by structural attachments or elements that minimize thermal bridging through the building thermal envelope.

Exceptions: Balconies and concrete floor decks shall be permitted to penetrate the *building thermal envelope* where:

1. an area-weighted *U*-factor is used for *above-grade wall* compliance which includes a *U*-factor of 0.8 Btu/h-°F-ft^2 for the area of the *above-grade wall* penetrated by the concrete floor deck, or
2. an approved <u>structural</u> thermal break device ~~of~~ <u>with</u> not less than R-10 <u>insulation material</u> is installed in accordance with the manufacturer's instructions.

C402.7.5 Parapets. Parapets shall comply with one or more of the following as applicable:

1. Where continuous insulation is installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the continuous insulation shall extend up both sides of the parapet not less than 2 feet (610 mm) above the roof covering or to the top of the parapet, whichever is less. Parapets that are an integral part of a fire-resistance rated wall, and the exterior continuous insulation applied to the parapet, shall comply with the fire resistance ratings of the building code.
2. Where continuous insulation is installed on the exterior side of the above-grade wall and the roof insulation is below the roof deck, the continuous insulation shall extend up the exterior side of the parapet to not less than the height of the top surface of the roof assembly.
3. Where continuous insulation is not installed on the exterior side of the *above-grade wall* and the roof is insulated with insulation entirely above deck, the wall cavity or integral insulation shall extend into the parapet up to the exterior face of the roof insulation or equivalent R-value insulation shall be installed not less than 2 feet (610 mm) horizontally inward on the underside of the roof deck.
4. Where continuous insulation is not installed on the exterior side of the *above-grade wall* and the roof insulation is below the roof deck, the wall and roof insulation components shall be adjacent to each other at the roof-ceiling-wall intersection.
5. <u>Where an approved structural thermal break device with not less than R-10 insulation material aligned with the above-grade wall and roof insulation is installed in accordance with the manufacturer's instructions.</u>

Exception: An *approved* design where the *above-grade wall U*-factor used for compliance accounts for the parapet *thermal bridge*.

TABLE C402.1.4 PSI- and CHI-FACTORS TO DETERMINE THERMAL BRIDGES FOR THE COMPONENT PERFORMANCE ALTERNATIVE

Thermal Bridge per Section C402.7	Thermal Bridge Compliant with Section C402.7		Thermal Bridge Non-Compliant with Section C402.7	
	psi-factor (Btu/h-ft-°F)	chi-factor (Btu/h-~~ft-~~°F)	psi-factor (Btu/h-ft-°F)	chi-factor (Btu/h-~~ft-~~°F -)
C402.7.1 Balconies, slabs, and decks	0.2	n/a	0.5	n/a
C402.7.2 Cladding supports	0.2	n/a	0.3	n/a
C402.7.3 Structural beams and columns	n/a	1.0-carbon steel 0.3-concrete	n/a	2.0-carbon steel 1.0-concrete
C402.7.4 Vertical fenestration	0.15	n/a	0.3	n/a
C402.7.5 Parapets	0.2	n/a	0.4	n/a

For SI: W/m-K = 0.578 Btu/h-ft-°F; 1 W/K = 1.90 Btu/h-°F
n/a = not applicable

Reason: C402.7.1 reasons:
The proposed wording will make it feasible to meet thermal performance requirements with current structural thermal break products on the market.

The tweaks to the wording clarify that a manufactured structural thermal break is acceptable and that the R-value applies only to the **insulated material** of the manufactured assemblies.

Typical manufactured structural thermal breaks incorporate at least R-15 insulation material; however, when the thermal properties of the stainless steel reinforcement and the compression material of the devices are considered, the resulting assembly R-value is less than R-10 for nearly all structural thermal break assemblies.

C402.7.5 reasons:

Regarding parapets with adding C402.7.5.5, incorporating a structural thermal break within the parapet ensures a truly continuous building envelope compared to extending insulation 2' up along the parapet.

See below image for where a structural thermal break can be incorporated at a parapet to maintain continuous insulation:

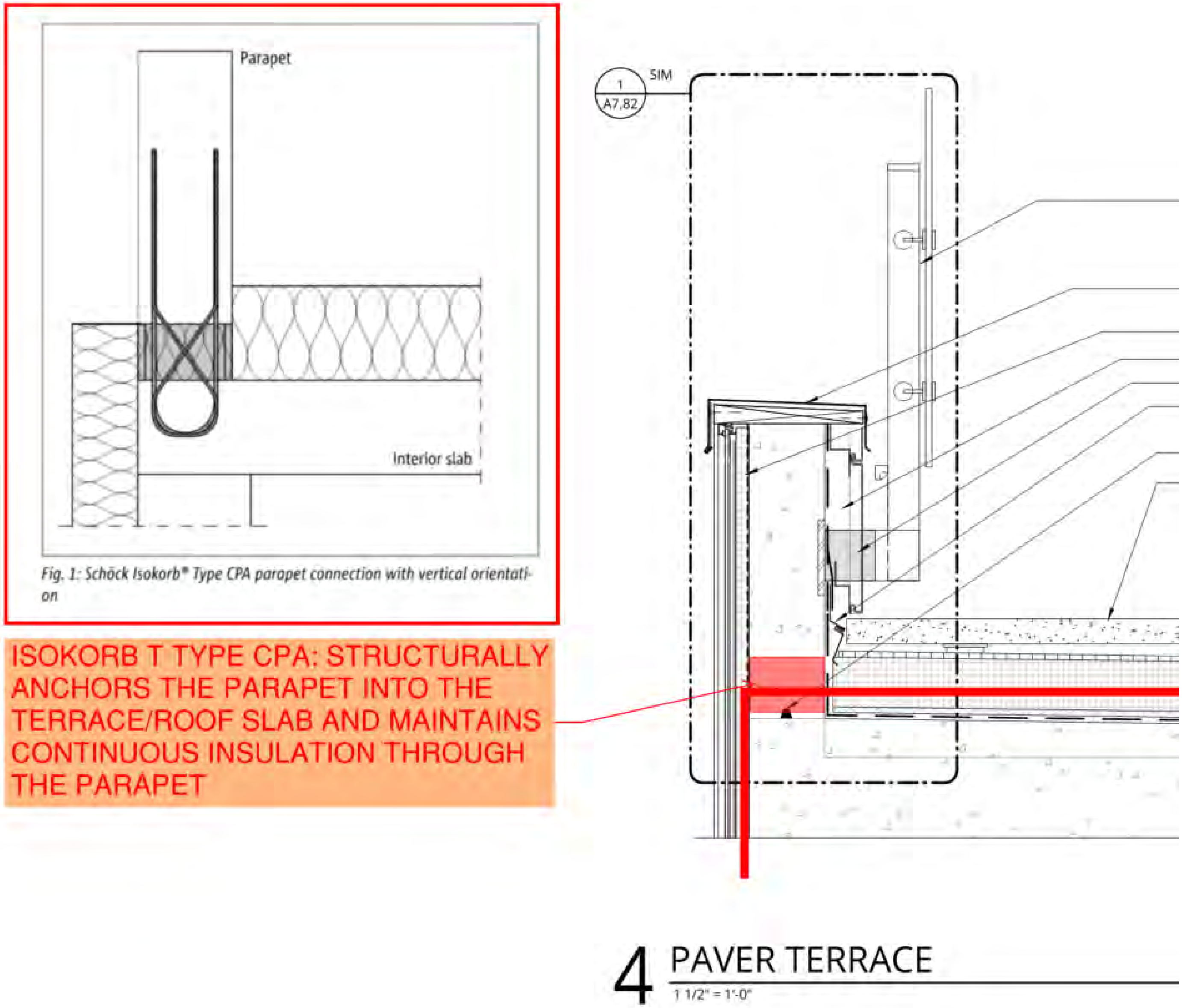

Table C402.1.4 reasons:

The units for chi are Btu/h-°F. The units are currently correct in the footnotes of the table but not in the table.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed code changes will make it feasible to meet thermal performance requirements with current structural thermal break products on the market.

Workgroup Recommendation

Proposal # 841

CED1-139-22

Proponents: Theresa Weston, representing Rainscreen Association in North America (RAiNA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.7.2 Cladding supports. Linear elements supporting opaque cladding shall be off-set from the structure with attachments that allow the continuous insulation, where present, to pass behind the cladding support element.

Exceptions:

1. An *approved* design where the above-grade wall *U*-factor used for compliance accounts for the cladding support element *thermal bridge*.
2. Anchoring for curtain wall and window wall systems <u>complying with C402.7.4.</u>

Reason: This proposal's intention is to make it clear that curtain wall and window wall systems are not being exempted from thermal bridge mitigation, but rather they are covered by a different section.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
There is no addition or deletion of code requirements. It only includes which sections cover which materials/assemblies.

Workgroup Recommendation

Proposal # 646

CED1-140-22

Proponents: Bob Zabcik, representing Metal Construction Association (bob@ztech-consulting.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C402.7.4 Vertical fenestration. Vertical fenestration intersections with above grade walls shall comply with one or more of the following:

1. Where above-grade walls include continuous insulation, the plane of the exterior glazing layer or, for metal frame fenestration, a non-metal thermal break in the frame shall be positioned within 2 inches (610 mm) of the interior or exterior surface of the continuous insulation.

~~2. An approved design where the above-grade wall U-factor used to demonstrate compliance accounts for the beam or column thermal bridge.~~

2~~3~~. The surface of the rough opening, not coved by the fenestration frame, shall be insulated with insulation of not less than R-3 material or covered with a wood buck that is not less than 1.5 inches (457 mm) thick.

3~~4~~. For the intersection between vertical fenestration and opaque spandrel in a shared framing system, manufacturer's data for the spandrel *U*-factor shall account for *thermal bridges*.

Exceptions:

1. Where an approved design for the above-grade wall *U*-factor used for compliance accounts for *thermal bridges* at the intersection with the vertical fenestration.
2. Doors

Reason: The second exception is not relevant to the scoping statement of the parent section and should be deleted.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal deletes a statement which does not apply to the scoping language and will not impact cost of construction.

Workgroup Recommendation

Proposal # 893

CED1-141-22

Proponents: Reid Hart, rep. Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**); Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Ellen Franconi, representing Pacific Northwest National Laboratory (ellen.franconi@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.3.4 G03 Automated Shading Load Management. Where fenestration on east, south, and west exposures exceeds 20 percent of wall area, load management credits shall be achieved as follows:

1. Automatic exterior shading devices or dynamic glazing that are capable of reducing solar gain (SHGC) through sunlit fenestration by at least 50 percent when fully closed shall receive the full credits in Tables C406.3(1) through C406.3(9). The exterior shades shall have fully open and fully closed SHGC determined in accordance with AERC 1.
2. Automatic interior shading devices with a minimum solar reflectance of 0.50 for the surface facing the fenestration shall receive 40 percent of the credits in Tables C406.3(1) through C406.3(9).
3. All shading devices, dynamic glazing, or shading attachments shall:

    3.1 Provide at least 90 percent coverage of the total fenestration on east, south, and west exposures in the *building* to achieve the credits determined in items 1 or 2. Alternatively, provide at least 70 percent coverage of the total fenestration on the south and west exposures in the *building* to achieve 50 percent of the credits determined in items 1 or 2.

    3.2 Be automatically controlled and shall modulate in multiple steps or continuously the amount of solar gain and light transmitted into the space in response to peak periods and either daylight levels or solar intensity.

    3.3 Include a manual override located in the same enclosed space as the shaded vertical fenestration that shall override operation of automatic controls no longer than four hours. Such override shall be locked out during peak periods.

For this section, directional ~~east, south, or west~~ exposures shall exclude fenestration that ~~is plus or minus~~ has an orientation deviating by more than 45 degrees of facing the cardinal direction. ~~true north in the northern hemisphere.~~ In the southern hemisphere, where the south exposure is referred to, it shall be replaced by the north exposure ~~and the referenced sourth exposure shall be replaced by the north exposure~~.

Reason: The alternative approach for reduced credits for a reduced automatic shading area allows flexibility for certain building types and configurations. A simplified alternative approach was preferred to a formula that adjusts for actual shading area as it is less complex and aligned with a typical alternative choice regarding building exposures with automated shading.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The selection of individual load management credits is up to the designer, so individual specific credits are not specifically required by the code. Allowing for a reduced credit option here with less shading required could reduce cost in some situations when this option is chosen.

Workgroup Recommendation

Proposal # 662

CED1-142-22

Proponents: Helen Sanders, **Technoform North America** representing The Facade Tectonics Institute (helen.sanders@technoform.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2(1).
2. An annual energy cost that is less than or equal to the percent of the annual energy cost (PAEC) of the *standard reference design* calculated in Equation 4-32. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.
3. For climate zones 5 to 8, the proposed building's *thermal envelope* shall meet the following performance:

   1. Fixed fenestration: The weighted average U-factor of the combined fenestration assemblies shall not exceed 110% of the value in Table C402.4 for fixed fenestration

   2. Operable fenestration: The weighted average U-factor of the combined fenestration assemblies shall not exceed 110% of the value in Table C402.4 for operable fenestration

   Exceptions: Fire-protection-rated fenestration assemblies, fire-resistance-rated fenestration assemblies, blast resistant fenestration assemblies, tornado resistant fenestration assemblies, fenestration in *historic buildings.*

Exceptions:

1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.
2. Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the energy use shall be calculated using source energy factors from Table C407.2(2) For electricity, U.S. locations shall use values eGRID subregions. Locations outside the United States shall use the value for "All other electricity" or locally derived values.

(Equation 4-32)

$$PAEC = 100 \times (0.85 + 0.025 - ECr/1000)$$

PAEC = Percentage of annual energy cost applied to standard reference design
EC_r= Energy efficiency credits required for the building in accordance with Section C406.1 (do not include load management and renewable credits)

Reason: The Façade Tectonics Institute is supportive of the need to promote the implementation of higher performing façades and to make it less easy to trade off poor envelope performance with higher internal system performance. Since envelopes are the one of the longest-lived elements of the building and impact the building's resilience in severe weather/power interruptions, supporting high envelope performance is important. This proposal creates maximum allowable thermal transmittance values (U-factor) for fenestration for use in buildings following the total performance compliance path.
The goal of this proposal is to prevent poor performing fenestration (with performance significantly worse than the prescriptive requirements) being installed because of the ability to trade off with higher performing HVAC and lighting in the total performance compliance path.

This trade off happens quite often, and is a challenge being seen across the country, where fenestration with U-factors higher than the prescriptive path are used in performance path compliance. This is the reason why envelope backstops (a similar concept) have already been enacted in building energy codes in Washington State, New York City, Massachusetts, and more recently in ASHRAE 90.1. This can be considered as an alternative backstop approach to these UA type backstops. This proposal has been revised based on feedback from the committee in the last committee review period.

It matters how total performance is achieved

While in principle, it shouldn't matter how the total energy performance of the building is achieved, as long as it is better than the base building, a building with poorer envelope leads to reduced resilience to acute weather events (human health and survivability consequences) and climate change, challenges with driving towards net-zero goals, poor thermal comfort next to the envelope, and potentially condensation issues leading to mold and indoor air quality problems (depending on the climate zone).

The use of a single metric around which the building is optimized – energy use intensity (or worse, energy cost) - can lead to buildings with sub-optimal occupant comfort and poor resilience and passive survivability. This does not help jurisdictions manage the impact of climate change, nor move quickly towards net zero energy performance.

The heat waves that have afflicted the western US this year, which has caused brown and black outs illustrate the importance of a high-performance envelope to maintain a functional indoor environment for a reasonable amount of time. Heat is the silent killer, which takes more lives than the acute impacts of storms [see reference 1]. A high-performance HVAC system is of no help to occupants if there is no power. Atelier 10 simulated the impact of high-performance envelope versus current building stock and code compliant envelope performance for Urban Green, and demonstrated the importance of the thermal performance of the building envelope for maintaining passive survivability in the buildings during power outages in both winter and summer conditions [see reference 2].

In addition, there is a big push to electrify buildings along with decarbonization of the grid. This means a switch from gas heating/boilers to heat pumps. In new construction an aggressive envelope should mean not only lower energy bills but lower peak loads and lower costs for HVAC systems and lower cost for PV/storage and grid upgrades; Utilities will have massive new heating loads that occur 6AM in winter when solar power is not available. So, loads will need to be reduced during those periods, which is why a focus on better facades is needed as one strategy to minimize those loads. Larger HVAC systems also come with increased greenhouse gas emissions from refrigerants, again pointing to the need for better envelope focus.

Also, since the performance of the building envelope is already overestimated because thermal bridging is ignored or not fully accounted for, making the envelope worse does not seem to be going in the right direction for actual energy savings nor moving closer to our nation's net zero carbon goals.

The Institute agrees that some architectural design flexibility is needed to manage innovation and challenging applications and believe that this can be achieved by identifying exceptions and through setting the area weighted limits somewhat higher than the prescriptive values.

We recognize that there may be specialty applications (e.g. fire, blast, historic renovation) that may need to be excepted.

Our proposal recommends:

1. The maximum area weighted U-factors be separated according to the type of fenestration e.g. fixed fenestration or operable windows. It is also our desire to encourage the use of operable windows to achieve more natural ventilation in buildings. Since operable fenestration typically has higher U-factors than fixed fenestration, the committee could consider modifying the proposal such that the area weighted U-factor for operable fenestration may be traded off with better area weighted average of the fixed fenestration types in the building, so long as the total area weighted U-factor of the fixed and operable fenestration does not exceed the sum of the maximum allowable U-factor (operable)xArea of operable fenestration plus maximum allowable U-factor (fixed fenestration)xArea fixed fenestration divided by the total fenestration area.

We strongly prefer a fenestration maximum (a fenestration backstop), rather than creating a whole envelope maximum by combining into an area weighted value for opaque and transparent areas (an envelope backstop). This is because the fenestration maximum approach does not result in the potential negative consequence of trading off fenestration for opaque elements and it supports continued use of curtainwall for high-rise construction. We recognize the need for sufficient fenestration to be used in buildings to provide daylight and views for the health and well-being of occupants [see for example reference 3, but there is a large body of data on the human benefits of daylight and views] and for capturing daylight harvesting energy savings when combined with lighting controls.

2. The maximum area weighted U-factors be set at values 10% higher than the respective prescriptive requirement, to give design teams some flexibility. The cost effectiveness of the prescriptive values has already been shown, so allowing 10% above these values should also be cost-effective. We recommend using a percentage above the prescriptive baseline so that when the prescriptive U-factors are reduced, this requirement automatically changes with it.

3. Including exceptions are as follows (updated based on committee feedback in the first round of review):

a. Fire-protection and fire-resistant glazing

b. Blast resistant glazing

c. Tornado resistant glazing

d. Historic buildings.

We believe that an exception for just "renovation" is much too broad and that design teams should be made to increase the performance of the façade in all renovations unless they are true historic preservations or restorations. After all, renovations generally only happen once in a generation, and if we want to address existing building energy performance which is where most of the energy savings and resiliency impacts will be, we need to have higher expectations of post renovation performance.

4. Limiting the requirement to the more heating dominated climate zones, where envelope thermal performance is most impactful.

To illustrate the maximum values of fenestration U-factors proposed for the total performance path compared with the current prescriptive values, the maximum numbers are included in parenthesis next to the prescriptive values from Table C402.4 in the attached table. These U-factors are easy to meet in the given climate zone relative to the prescriptive values. The products are widely available and cost-effective based on the prescriptive values being 10% lower (more stringent). Note that in this amended proposal, no limits on performance in zones 1-4 are required, even though backstop limits are shown in the table.

CLIMATE ZONE	0 AND 1	2	3	4 EXCEPT MARINE	5 AND MARINE 4	6	7	8
Vertical fenestration								
U-factor (fenestration maximum values in parenthesis next to the prescriptive values for comparison)								
Fixed fenestration	0.50 (0.55)	0.45 (0.50)	0.42 (0.46)	0.36 (0.40)	0.36 (0.40)	0.34 (0.37)	0.29 (0.32)	0.26 (0.29)
Operable fenestration	0.62 (0.68)	0.60 (0.68)	0.54 (0.59)	0.45 (0.50)	0.45 (0.50)	0.42 (0.46)	0.36 (0.40)	0.32 (0.35)
Entrance doors	0.83	0.77	0.68	0.63	0.63	0.63	0.63	0.63

Cost Impact: The code change proposal will increase the cost of construction.
This proposal still allows for the use of lower performance fenestration in the total performance path than prescriptively allowed and the prescriptive values have already been shown to be cost-effective. While the proposal still provides some flexibility in moving dollars spent on the envelope to dollars spent on internal building systems like lighting and HVAC, it prevents larger transfers of cost/budget. It is possible that design teams trade off lower performance fenestration with higher efficiency HVAC and lighting because it is the less expensive route to deliver their design intent. This proposal will constrain this budget trade off and so may increase the cost of constructing a building if compared to one that could have used even poorer fenestration, but likely not relative to a building built to the prescriptive compliance path which would use higher performance fenestration.

Bibliography: [1] Examples of articles discussing heat as a silent killer:
https://www.congress.gov/event/117th-congress/house-event/113942?q=%7B%22search%22%3A%5B%22%5C%22Science%2C%5C%5C%22%2C%22Space%2C%5C%5C%22%2C%22and%5C%5C%22%2C%22Technology%7CEnvironment%5C%22%22%5D%7D&s=1&r=24

https://www.noaa.gov/stories/excessive-heat-silent-killer

[2] https://www.urbangreencouncil.org/babyitscoldinside

Workgroup Recommendation

Proposal # 874

CED1-143-22

Proponents: Jeff Bradley, representing American Wood Council (jbradley@awc.org); Matthew Hunter, representing American Wood Council (mhunter@awc.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

Portions of table not shown remain unchanged.

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
	Solar absorptance: 0.75,	As proposed
	Emittance: 0.90,	As proposed
Walls, above-grade	Type: ~~same as proposed~~ framed walls, same as wood framed. Same as proposed for mass walls and metal building.	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
	Solar absorptance: 0.75	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.2 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.2	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
	Area 1. The proposed skylight area; where the proposed skylight area is less than that	

Skylights	permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
		As proposed, in accordance with Section C403.2.2.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed
Cooling systems	Fuel type: same as proposed design	As proposed
	Equipment type[c]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are	As proposed

	larger cooling capacity safety factors are provided than in the proposed design.	
	Economizer[d]: same as proposed, in accordance with Section C403.5.	As proposed
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.

b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.

c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.

d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.

e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 – (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

Reason: The only proposed change is to Table C407.4.1(1) and the following row that reads:

Walls, above-grade. Type: ~~same as proposed~~ wood framed
By setting the reference design to "wood framed" rather than the current "as proposed," frame walls will be evaluated to a single target U-factor per climate zone. This change would result in wood frame and metal frame walls being required to meet the same performance target in Table C402.1.4 - the more stringent U-factors for wood frame assemblies. This proposed change eliminates the inequitable treatment of framing materials embedded in the performance path that would be created by requiring higher energy performance requirements for wood frame walls than steel frame walls. Note that this change eliminates a material bias that is in direct conflict with the preface of the IECC that states "*This code is founded on the principles intended to establish … provisions that do not give preferential treatment to particular types or classes of materials, products, or methods of construction.*" This change also saves energy by reducing the target U-factors for metal framed walls.

Cost Impact: The code change proposal will increase the cost of construction.
Projects constructed with metal frame walls may have to meet lower U-factors, necessitating additional insulation.

Workgroup Recommendation

Proposal # 794

CED1-144-22

Proponents: Aaron Phillips, representing Asphalt Roofing Manufacturers Association (aphillips@asphaltroofing.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C503.2.1 ~~Roof alterations, insulation entirely above deck~~ Roof, ceiling, and attic alterations. Insulation complying with Section C402.1 and Section C402.2.1, or an *approved* design that minimizes deviation from the insulation requirements, shall be provided for the following ~~roof~~ alterations:

1. An alteration of roof-ceiling construction where there is no insulation above conditioned space.
2. Roof replacement for roofs with insulat~~ii~~on entirely above deck.

    Exceptions: Where compliance with Section C402.1 cannot be met due to limiting conditions on an existing roof, an *approved* design shall be submitted with the following:

    1. *Construction documents* that include a report by a registered design professional or other *approved* source documenting details of the limiting conditions affecting compliance with the insulation requirements.
    2. *Construction documents* that include a roof design by a registered design professional or other *approved* source that minimizes deviation from the insulation requirements.

3. Conversion of unconditioned attic space into conditioned space.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof-ceiling construction.

Insulation shall be installed in accordance with the requirements of Sections C402.2.1.2 through C402.2.1.5.

Reason: This proposal makes three minor modifications to Section C503.2.1:
1. A section title that encompasses the four enumerated alterations is added.
2. The word "roof" is removed because not all the alterations in the list are roof alterations.
3. A spelling error is corrected.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal improves clarity of the section without making technical changes. No change in cost of construction should be expected if this comment is adopted.

Workgroup Recommendation

Proposal # 712

CED1-145-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C503.2.1 . Insulation complying with Section C402.1 and Section C402.2.1, or an *approved* design that minimizes deviation from the insulation requirements, shall be provided for the following roof alterations:

1. An alteration of roof-ceiling construction where there is no insulation above conditioned space.
2. Roof replacement for roofs with insulaiton entirely above deck.

   Exceptions: Where compliance with Section C402.1 cannot be met due to limiting conditions on an existing roof, an *approved* design shall be submitted with the following:

   1. *Construction documents* that include a report by a registered design professional or other *approved* source documenting details of the limiting conditions affecting compliance with the insulation requirements.
   2. *Construction documents* that include a roof design by a registered design professional or other *approved* source that minimizes deviation from the insulation requirements.

3. Conversion of unconditioned attic space into conditioned space.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof-ceiling construction.

~~Insulation shall be installed in accordance with the requirements of Sections C402.2.1.2 through C402.2.1.5.~~

Reason: The deleted sentence is redundant with requirements already referenced in the charging language of Section C503.2.1. It also was not included as part of CEPI-221 which updated this section.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is a clean-up and removes redundant text without any technical or cost impact.

Workgroup Recommendation

Proposal # 761

CED1-146-22

Proponents: Jeff Mang, representing Polyisocyanurate Insulation Manufacturers Association (PIMA) (jeff@jcmangconsulting.com); Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C503.2.1 . Insulation complying with Section C402.1 and Section C402.2.1, or an *approved* design that minimizes deviation from the insulation requirements, shall be provided for the following roof alterations:

1. An alteration of roof-ceiling construction where there is no insulation above conditioned space.
2. Roof replacement, including any *reroofing* other than a roof *recover*, where the *roof assembly* contains insulation ~~for roofs with insulaiton~~ entirely above the roof deck.

   Exceptions: Where compliance with Section C402.1 cannot be met due to limiting conditions on an existing roof, an *approved* design shall be submitted with the following:

   1. *Construction documents* that include a report by a registered design professional or other *approved* source documenting details of the limiting conditions affecting compliance with the insulation requirements.
   2. *Construction documents* that include a roof design by a registered design professional or other *approved* source that minimizes deviation from the insulation requirements.

3. Conversion of unconditioned attic space into conditioned space.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof-ceiling construction.

Insulation shall be installed in accordance with the requirements of Sections C402.2.1.2 through C402.2.1.5.

Reason: This proposed amendment clarifies which types of roof alterations trigger the insulation requirements under Section C503. As reflected in the Public Review Draft #1, the Commercial Consensus Committee has already approved several improvements related to roof alterations under Section C503.2.1. This proposed amendment builds on these improvements with further clarifying language.
The changes under Section C503.2.1 already approved by the Committee reinforce the long-standing requirement that all alterations involving roofs with insulation entirely above deck, other than roof recovers, are required to meet the insulation requirements under the energy code. This proposed amendment will eliminate confusion that can arise on jobs due to unique circumstances or work involved in completing a specific roof alteration project.

For example, this proposal clarifies that compliance with the energy code's insulation requirements is required where the roof membrane is removed, and various amounts of other existing roof materials are left in place (including existing insulation). This result is consistent with both the letter and the long-standing spirit of the code.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal clarifies an existing provision in the code and does not add any new requirements.

Workgroup Recommendation

Proposal # 762

CED1-147-22

Proponents: Glen Clapper, representing National Roof Contractors Association (gclapper@nrca.net)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C503.2.1 Roof Alterations. Insulation complying with Section C402.1 and Section C402.2.1, or an *approved* design that minimizes deviation from the insulation requirements, shall be provided for the following roof alterations:

1. An alteration of roof-ceiling construction where there is no insulation above conditioned space.
2. Roof replacement for roofs with ~~insulaiton~~ insulation entirely above deck.

   Exceptions: Where compliance with Section C402.1 cannot be met due to limiting conditions on an existing roof, an *approved* design shall be submitted with the following:

   1. *Construction documents* that include a report by a registered design professional or other *approved* ~~source~~ entity documenting details of the limiting conditions affecting compliance with the insulation requirements.
   2. *Construction documents* that include a roof design by a registered design professional or other *approved* ~~source~~ entity that minimizes deviation from the insulation requirements.

3. Conversion of unconditioned attic space into conditioned space.
4. Replacement of ceiling finishes exposing cavities or surfaces of the roof-ceiling construction.

Insulation shall be installed in accordance with the requirements of Sections C402.2.1.2 through C402.2.1.5.

Reason: This proposal adds the omitted section title included in CEPI-221 AM and corrects a typo. In addition, the proposal modifies who is allowed to provide the report and roof design, since *approved source* is a newly defined term approved as modified in the first Public Input Initial Draft and excludes qualified parties, such as the contractor and the suppliers. The proposed term "entity" is more inclusive as to who may provide the information required of this section and more closely aligns with published Addendum t of ASHRAE Standard 90.1-2019.

Cost Impact: The code change proposal will decrease the cost of construction.
This code change proposal will decrease the cost of construction when the information required is provided by an entity already on site to perform the work.

Workgroup Recommendation

Proposal # 885

CED1-148-22

Proponents: Jeff Mang, representing Polyisocyanurate Insulation Manufacturers Association (PIMA) (jeff@jcmangconsulting.com); Marcin Pazera, representing Polyisocyanurate Insulation Manufacturers Association (mpazera@pima.org)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

503.3.8 Replacement or added roof mounted mechanical equipment. For *roofs* with insulation entirely above the roof deck and where existing roof-mounted mechanical equipment is replaced or new equipment is added, and the existing roof does not comply with the insulation requirements for new construction in accordance with Section C402.1 and Section C402.2.1, any new equipment curbs and existing curbs shall be of sufficient height to accommodate the addition of above-deck roof insulation during a future roof replacement in accordance with Section C503.2.1, Item 2. Alternatively, the curb height shall comply with Table C503.3.8.

Table 503.3.8 Roof Mounted Mechanical Equipment Curb Heights

CLIMATE ZONE	CURB HEIGHT, MINIMUM[a]
0 and 1	15.0 inches (381 mm)
2 and 3	16.0 inches (406.4 mm)
4, 5 and 6	17.0 inches (431.8 mm)
7 and 8	18.0 inches (457.2 mm)

a. Curb height shall be the distance measured from the top of the curb to the roof deck.

Reason: This proposed amendment complements the revisions to C503.2.1 of the Public Comment Draft #1 related to the insulation requirements for roof replacements. C503.2.1 of the Public Comment Draft creates a new exception regarding insulation requirements for roof replacements where there are practical difficulties for compliance caused by existing rooftop features. Equipment curbs that are too short are one of the most common difficulties to meeting the insulation requirements when roofs are replaced.
This intention of this proposed amendment is to mitigate challenges caused by low curb heights by requiring, at a relatively low (or no) cost, the installation of higher curbs when rooftop mechanical equipment is replaced even if the replacement work does not occur at the same time as the roof replacement project. The intent of the IECC is to move existing buildings toward compliance as alterations occur, which results in continual improvements to building energy efficiency. Modifying existing roof curbs during equipment replacement work adds minimal upfront costs and eliminates the cost of having to install a higher curb later during a roof replacement and when it would be more expensive.

Installation of curbs with minimum heights calculated to accommodate the amount of insulation needed for each climate zone would be required. Compliance can be met by either following the minimum heights listed in Table C503.3.8 or the contractor's or designer's best judgement. This flexibility may be needed to address situations that arise with tapered roof assemblies or sloped roofs. In these cases, the minimum curb heights listed under Table C503.3.8 may not be necessary or may be insufficient to achieve the goals of this amendment, depending on where the curb is located within the tapered or sloped system (i.e., at the low point, high point, or somewhere in between).

A similar amendment proposed by PIMA (CEPI-74) was disapproved by a close vote of 17-14-2 during consideration by the Commercial Subcommittee in May. In response to specific concerns raised about the original amendment, this amendment adds flexibility to deal with unusual roof conditions, drops the proposed changes to Chapter 4, and makes editorial changes. With respect to the potential burden on building owners, the intent of this requirement is to make it easier and less expensive to comply with the energy code when a roof is eventually replaced, which happens every 15 or 20 years on average. Adding a higher curb (if needed) when the equipment is being replaced is far less expensive than having to lift the equipment to install a higher curb during a roof replacement.

Explanation of Table C503.3.8: the minimum heights in the table would accommodate: (1) the 10 inches of curb height that is above the roof membrane/covering specified under the AHRI/SMACNA Guideline B-1997, "Guidelines for Roof Mounted Outdoor Air-Conditioner Installations"; (2) the amount of insulation necessary to comply with the prescriptive R-value requirements for each climate zone under the IECC; and (3) other materials that are typically part of the roof assembly, such as cover boards, slip sheets and membranes. While this proposal would require heights of between 15 to 18 inches depending on the specific climate zone, the Committee may decide to simply require 18 inches as the minimum curb height for all climate zones if that approach makes it easier for purposes of product supply and inventory.

Cost Impact: The code change proposal will increase the cost of construction.
A small increase in cost related to the purchase and installation of a new curb may be incurred. However, over the service life of the curb and mechanical equipment, this code change proposal is life-cycle cost effective due to decreased compliance costs for future reroofing work that is common for all buildings to undergo during the building service life as well as reduced energy costs resulting from the installation of a future, IECC-compliant replacement roof system.

Bibliography: *Guidelines for Roof Mounted Outdoor Air-Conditioner Installations* (Guideline B-1997), Air-Conditioning, Heating, and Refrigeration Institute (AHRI) and Sheet Meal and Air-Conditioning Contractors National Association (SMACNA). Available at: https://www.ahrinet.org/App_Content/ahri/files/Guidelines/AHRI_Guideline_B_1997.pdf.

Workgroup Recommendation

Proposal # 770

CED1-149-22

Proponents: Jay Crandell, representing Foam Sheathing Committee of the American Chemistry Council (jcrandell@aresconsulting.biz)

2024 International Energy Conservation Code [CE Project]

Delete without substitution:

~~**EXTERIOR WALL ENVELOPE.** A system or assembly of exterior wall components, including exterior wall finish materials, that provides protection of the building structural members, including framing and sheathing materials, and conditioned interior space, from the detrimental effects of the exterior environment.~~

Revise as follows:

C503.6 Additional energy efficiency credits. *Alterations* shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone.* Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.

Exceptions:

1. *Alterations* that include replacement of no more than one of the following:
   - 1.1 HVAC unitary systems or HVAC central heating or cooling equipment serving the *work area* of the *alteration*.
   - 1.2 Water heating equipment serving the *work area* of the alteration.
   - 1.3 50 percent or more of the lighting fixtures in the *work area* of the alteration.
   - 1.4 50 percent or more of the area of interior surfaces of the thermal envelope in the *work area* of the alteration.
   - 1.5 50 percent or more of the ~~building's~~ *exterior wall* <u>area of the *building thermal*</u> *envelope*, including <u>vertical</u> fenestration <u>area</u>.
2. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
3. *Alterations* that do not contain conditioned space.
4. Portions of *buildings* devoted to manufacturing or industrial use.
5. *Buildings* in Climate Zone 0A.
6. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.
7. *Alterations* that comply with Section C407.

Reason: The newly added "exterior wall envelope" definition is used only once in the entire IECC in the newly added Section C503.6, exception 1.5. The term is deleted and existing defined terms are used instead to revise exception 1.5 in Section C503.6 to retain its intent while not requiring a new term to be created and defined. The exception is also clarified to apply the percentage trigger on the basis of area, not length of walls, number of walls, or other possible metrics that are currently left open to interpretation. In addition, it is clarified that only vertical fenestration should be included in the area, not fenestration (which includes skylights). Finally, the new "exterior wall envelope" definition overlaps with the defined term "exterior wall covering" as used in the IBC and IRC and this could create confusion in coordination between the I-codes. Deleting the term and using existing definitions resolves this concern as well.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal deletes and unnecessary definition and clarifies wording without changing requirements.

Workgroup Recommendation

Proposal # 719

CED1-150-22

Proponents: Jonathan Humble, representing American Iron and Steel Institute (jhumble@steel.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

AISI

American Iron and Steel Institute
25 Massachusetts Avenue, NW, Suite 800
Washington, DC 20001

AISI S250-~~21~~ 22 North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing, with Supplement 1, dated 2022

Reason: Supplement #1 - 2022 modified Section B4.2 Standard Truss Framing equations by removing the parenthesis in the denominator, which were not intended to be included, in order to correctly illustrate the equation. No other modifications were made to Standard S250.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This modification to Standard S250 corrected an error to the 2021 edition.

Bibliography: AISI S250-21w/S1-22 North American Standard for Thermal Transmittance of Building Envelopes with Cold-Formed Steel Framing, American Iron and Steel Institute, Washington, DC, 2022.

Workgroup Recommendation

Proposal # 673

CED1-151-22

Proponents: Theresa Weston, representing Air Barrier Association of America (ABAA) (holtweston88@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

ASTM

ASTM International
100 Barr Harbor Drive, P.O. Box C700
West Conshohocken, PA 19428-2959

D8052/D8052M~~—2017~~ 2022:	Standard Test Method for Quantification of Air Leakage in Low-Sloped Membrane Roof Assemblies
E283/E283M-2019~~—2004(2012)~~:	Test Method for Determining the Rate of Air Leakage Through Exterior Windows, Skylights, Curtain Walls and Doors Under Specified Pressure Differences Across the Specimen
E779~~—10(2018):~~ 2019:	Standard Test Method for Determining Air Leakage Rate by Fan Pressurization
E1186~~-17~~ 2022:	Standard Practices for Air Leakage Site Detection in Building Envelopes and Air Barrier Systems
E1677~~—11:~~ 2019:	Specification for Air Barrier (AB) Material or ~~Systems~~ Assemblies for Low-rise Framed Building Walls
E1827~~—2011(2017):~~ 2022:	Standard Test Methods for Determining Airtightness of Buildings Using an Orifice Blower Door
E2178~~—13:~~ 2021a:	Standard Test Method for Determining Air Leakage Rate and Calculation of Air Permanence of Building Materials
E2357~~—2018:~~ 2022:	Standard Test Method for Determining Air Leakage of Air Barriers Assemblies

Reason: This proposal updates the ASTM standards that relate to air leakage performance (Section C402.6) to their most recent version.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does add or delete any requirements, but only updates currently referenced standards to their most recent version.

Workgroup Recommendation

Proposal # 875

CED1-152-22

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

DEDICATED OUTDOOR AIR SYSTEM (DOAS). A *ventilation* system that supplies 100 percent outdoor air primarily for the purpose of *ventilation*, either directly or in conjunction with the space-conditioning system and whose fans supply outdoor air independently ~~and that is a separate system~~ from the zone space-conditioning system.

Reason: The definition revision helps clarify that a DOAS may be separate or part of a space-conditioning system, but the primary differentiator is that the DOAS fan system delivers outside air and does not need to rely on the space-conditioning system to do so.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This definition change places no additional requirements on the equipment selection.

Workgroup Recommendation

Proposal # 697

CED1-153-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.10 Buildings with High-Capacity Space-Heating Gas Boiler Systems . Gas hot-water boiler systems for space heating with system input capacity capacities of at least not less than 1,000,000 Btu/h (293 kW) but not more and not greater than 10,000,000 Btu/h (2931 kW) in new buildings shall comply with Sections C403.10.1 and C403.10.2 **Exceptions:**

1. Where 25 percent of the annual space heating requirement is provided by ~~on-site~~ renewable energy, site-recovered energy, or heat recovery chillers.
2. Space heating boilers installed in individual dwelling units.
3. Where 50 percent or more of the design heating load is served using perimeter convective heating, radiant ceiling panels, or both.
4. Individual gas boilers with input capacity less than 300,000 Btu/h (87 kW) shall not be included in the calculations of the total system input or total system efficiency.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the hydrocarbon resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first (“bottom-up inorganic recovery”) case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second (“top-down inorganic recovery”) case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third (“organic recovery”) case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into fuels”, https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will decrease the cost of construction.
This code change can decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into fuels”, https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

Proposal # 922

CED1-154-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.11.6 Heat recovery for space conditioning in healthcare facilities. Where heating water is used for space heating, a condenser heat recovery system shall be installed provided that all of the following are true:

1. The building is a Group I-2, Condition 2 occupancy.
2. The total design chilled water capacity for the Group I-2,Condition 2 occupancy, either air cooled or water cooled, required at cooling design conditions exceeds 3,600,000 Btu/h (1100 kw) of cooling.
3. Simultaneous heating and cooling occurs above 60°F (16°C) outdoor air temperature.

The required heat recovery system shall have a cooling capacity that is not less than 7 percent of the total design chilled water capacity of the Group I-2, Condition 2 occupancy at peak design conditions.

Exceptions:

1. Buildings that provide 60 percent or more of their reheat energy from ~~on-site~~ renewable energy or site-recovered energy.
2. Buildings in Climate Zones 5C, 6B, 7 and 8.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the hydrocarbon resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first ("bottom-up inorganic recovery") case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second ("top-down inorganic recovery") case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third ("organic recovery") case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will decrease the cost of construction.
This code change can decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), "Process for the extraction of fats and oils", https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), "Stanford researchers create new catalyst that can turn carbon dioxide into fuels", https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), "Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts", *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

Proposal # 924

CED1-156-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.3.2 HVAC equipment performance requirements. Equipment shall meet the minimum efficiency requirements of Tables C403.3.2(1) through C403.3.2(16) when tested and rated in accordance with the applicable test procedure. Plate-type liquid-to-liquid heat exchangers shall meet the minimum requirements of AHRI 400. The efficiency shall be verified through certification under an approved certification program or, where a certification program does not exist, the equipment efficiency ratings shall be supported by data furnished by the manufacturer. Where multiple rating conditions or performance requirements are provided, the equipment shall satisfy all stated requirements. Where components, such as indoor or outdoor coils, from different manufacturers are used, calculations and supporting data shall be furnished by the designer that demonstrates that the combined efficiency of the specified components meets the requirements herein. Efficiency values and metrics in tables shall be equal to the values and metrics shown in ASHRAE 90.1-2022.

ASHRAE

ASHRAE
180 Technology Parkway NW
Peachtree Corners, GA 30092

90.1—~~2019~~ 2022: Energy Standard for Buildings Except Low-rise Residential Buildings

Reason: ASHRAE 90.1-2022 will be published by November 2022 with updated mechanical efficiency tables. This change is a "marker" to have the IECC update its tables to be aligned with the updated values and metrics approved for ASHRAE 90.1-2022.

Cost Impact: The code change proposal will increase the cost of construction.
For buildings that use equipment where the efficiency values in the IECC are increased to match the values in ASHRAE 90.1-2022.

Where the efficiency values and metrics are the same in IECC 2021/2024 and ASHRAE 90.1-2022, there is no increase in the cost of construction.

Workgroup Recommendation

Proposal # 854

CED1-157-22

Proponents: Nicholas O'Neil, representing NEEA (noneil@energy350.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C403.3.2(6) GAS- AND OIL-FIRED BOILERS—MINIMUM EFFICIENCY REQUIREMENTS~~[i]~~

Portions of table not shown remain unchanged.

EQUIPMENT TYPE[b]	SUBCATEGORY OR RATING CONDITION	SIZE CATEGORY (INPUT)	~~MINIMUM EFFICIENCY~~	MINIMUM EFFICIENCY ~~AS OF 3/2/2022~~	TEST PROCEDURE[a]
Boilers, hot water	Gas fired	< 300,000 Btu/h[g, h] for applications outside US	~~82% AFUE~~	84~~2~~% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~80% E_t[d]~~	84~~0~~% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h [b]	~~82% E_c[c]~~	85~~2~~% E_c[c]	
		> 10,000,000 Btu/h [b]		82% E_c[c]	
	Oil fired[f]	< 300,000 Btu/h[g,h] for applications outside US	~~84% AFUE~~	86~~4~~% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~82% E_t[d]~~	87~~2~~% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h [b]	~~84% E_c[c]~~	88~~4~~% E_c[c]	
		> 10,000,000 Btu/h [b]		84% E_c[c]	
Boilers, steam	Gas fired	< 300,000 Btu/h[g] for applications outside US	~~80% AFUE~~	82~~0~~% AFUE	DOE 10 CFR 430 Appendix N
	Gas fired~~—all, except natural draft~~	≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~79% E_t[d]~~	81~~79~~% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h [b]	~~79% E_t[d]~~	82~~79~~% E_t[d]	
		> 10,000,000 Btu/h [b]		79% E_t[d,i]	
	~~Gas fired—natural draft~~	~~≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]~~	~~77% E_t[d]~~	~~79% E_t[d]~~	
		~~> 2,500,000 Btu/h[b]~~	~~77% E_t[d]~~	~~79% E_t[d]~~	
	Oil fired[f]	< 300,000 Btu/h[g] for applications outside US	~~82% AFUE~~	85~~2~~% AFUE	DOE 10 CFR 430 Appendix N
		≥ 300,000 Btu/h and ≤ 2,500,000 Btu/h[e]	~~81% E_t[d]~~	84~~1~~% E_t[d]	DOE 10 CFR 431.86
		> 2,500,000 Btu/h and ≤ 10,000,000 Btu/h [b]	~~81% E_t[d]~~	85~~1~~% E_t[d]	
		> 10,000,000 Btu/h [b]		81% E_t[d]	

For SI: 1 British thermal unit per hour = 0.2931 W.

a. Chapter 6 contains a complete specification of the referenced standards, which include test procedures, including the reference year version of the test procedure.

b. These requirements apply to boilers with rated input of 8,000,000 Btu/h or less that are not packaged boilers and to all packaged boilers. Minimum efficiency requirements for boilers cover all capacities of packaged boilers.

c. E_c = Combustion efficiency (100 percent less flue losses).

d. E_t = Thermal efficiency.

e. Maximum capacity—minimum and maximum ratings as provided for and allowed by the unit's controls.

f. Includes oil-fired (residual).

g. Boilers shall not be equipped with a constant burning pilot light.

h. A boiler not equipped with a tankless domestic water-heating coil shall be equipped with an automatic means for adjusting the temperature of the water such that an incremental change in inferred heat load produces a corresponding incremental change in the temperature of the water supplied.

~~i. This table is a replica of ASHRAE 90.1 Table 6.8.1-6 Gas- and Oil-Fired Boilers—Minimum Efficiency Requirements.~~

i. Prior to March 2, 2022, for natural draft very large gas-fired steam commercial packaged boilers, a minimum thermal efficiency level of 77 percent is permitted and meets Federal commercial packaged boiler energy conservation standards

Reason: On January 10, 2020 DOE published new boiler efficiency requirements for boilers manufacturer after 1/20/2023. This proposal updates the table for the 2024 IECC, with updates based on US DOE final rulemakings and removing values in effect for equipment installed before 3/2/2022. It also removes the reference to ASHRAE table under footnote i which may no longer apply until ASHRAE updates tables to reflect the proposed DOE rulemaking.
Finally, it removes the separate natural draft and non-natural draft commercial boiler categories as the new DOE rule does not differentiate efficiency requirements based on this technology. The one exception is for very large gas-fired boilers manufacturer prior to March 2022 which can have a 77% Et instead of 79% Et. Hence, a footnote is added to mark this single adjustment and shortens the table to avoid confusion.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This update simply aligns federal requirements with the efficiency tables listed in the IECC so they are up to date. These are DOE minimum efficiency standards and therefore no increase or decrease in cost is expected.

Bibliography: Energy Conservation Standards for Residential Boilers - Final Rule, US Department of Energy, Washington DC, January 10, 2020

https://www.ecfr.gov/current/title-10/chapter-II/subchapter-D/part-431/subpart-E/subject-group-ECFRe1ae92ed608f22e/section-431.87
Energy Conservation Standards for Residential Boilers - Final Rule, US Department of Energy, Washington DC, January 15, 2016 (as published in the US Federal Register, 81 Fed. Reg. 2320)

Workgroup Recommendation

Proposal # 666

CED1-158-22

Proponents: Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Michael Rosenberg, representing Pacific Northwest National Laboratory (michael.rosenberg@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.3.4 Boilers. Boiler Systems shall comply with the following:

1. Combustion air positive shut-off shall be provided on all newly installed boiler systems that comply with one or more of the following ~~as follows~~:

   1.1 ~~All boiler systems with an~~ The total input capacity is no less than ~~of~~ 2,500,000 Btu/h (732 kW) and ~~above~~ one or more of ~~in which~~ the boiler s ~~is~~ are designed to operate with a nonpositive vent static pressure.

   1.2 Any stack serving the ~~All~~ boiler system~~s~~ is connected to ~~where one stack serves~~ two or more boilers with a total combined input capacity ~~per stack~~ of not less than 2,500,000 Btu/h (732 kW).

2. Each newly installed boiler or boiler system with a ~~Boiler system~~ combustion air fan~~s with~~ motor~~s~~ 10 horsepower (7.46 kW) or larger shall comply with ~~meet~~ one of the following ~~for newly installed boilers~~:

   2.1 The fan motor shall be variable speed, or

   2.2 The fan motor shall include controls that limit the fan motor demand to no more than 30 percent of the total design wattage at 50 percent of design air volume.

Reason: This proposal is editorial and recommends alternative language to reduce ambiguity.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is editorial and does not impact the cost effectiveness of the requirement.

Workgroup Recommendation

Proposal # 664

CED1-159-22

Proponents: Greg Johnson, representing Johnson & Associates Consulting Services (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

C403.3.4.1 Boiler oxygen concentration controls. Newly installed boilers with an input capacity of 5,000,000 Btu/h (1465 kW) and steady state full-load less than 90 percent shall maintain stack-gas oxygen concentrations not greater than the values specified in Table C403.3.4.1. Combustion air volume shall be controlled with respect to measured flue gas oxygen concentration. The use of a common gas and combustion air control linkage or jack shaft is prohibited.

Revise as follows:

TABLE C403.3.4.1 BOILER OXYGEN CONCENTRATIONS

Boiler System Application	Minimum stack-gas oxygen concentration[a]
≤ 10% of the boiler system capacity is used for process applications at design conditions	5%
Process boilers	3%

a. Concentration levels measured by volume on a dry basis over firing rates of 20 to 100 percent.

Exception: These concentration limits do not apply where 50 percent or more of the boiler system capacity serves Group R-2 occupancies.

Reason: It is unclear to what the exception applies; C403.3.4.1 Boiler oxygen concentration controls? Table C403.3.4.1? Tables should not have exceptions. Something needs fixing.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Probably editorial.

Workgroup Recommendation

Proposal # 899

CED1-160-21

Proponents: Mike Moore, representing Broan-NuTone (mmoore@statorllc.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.4.6.2 All other ~~HVAC~~ heating and cooling systems. Thermostats for ~~HVAC~~ heating and cooling systems shall be provided with a demand responsive control that complies with one of the following:

1. Certified OpenADR 2.0a VEN, as specified under Clause 11, Conformance
2. Certified OpenADR 2.0b VEN, as specified under Clause 11, Conformance
3. Certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls
4. IEC 62746-10-1
5. The communication protocol required by a controlling entity, such as a utility or service provider, to participate in an automated demand response program
6. The physical configuration and communication protocol of CTA 2045-A or CTA 2045-B.

C403.4.2.3 Optimum start and stop. Optimum start and stop controls shall be provided for each ~~HVAC~~ heating and cooling system with direct control of individual zones. The optimum start controls shall be configured to automatically adjust the daily start time of the ~~HVAC~~ heating and cooling system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy. . The optimum stop controls shall be configured to reduce the ~~HVAC~~ heating and cooling system's heating temperature setpoint and increase the cooling temperature setpoint by not less than 2°F (1.11ºC) before scheduled unoccupied periods based on the thermal lag and acceptable drift in space temperature that is within comfort limits.

Exception: Dwelling units and sleeping units are not required to have optimum start controls.

C403.4.7 ~~HVAC~~ Heating and cooling system controls for operable openings to the outdoors . All doors from a conditioned space to the outdoors and all other operable openings from a conditioned space to the out-doors that are larger than 40 square feet (3.7 m^2) when fully open, shall have automatic controls interlocked with the heating and cooling system. The controls shall be configured to do the following within 5 minutes of opening:

1. Disable mechanical heating to the zone or reset the space heating temperature setpoint to 55°F (12.7°C) or less.
2. Disable mechanical cooling to the zone or reset the space cooling temperature setpoint to 90°F (32°C) or more. Mechanical cooling can remain enabled if the outdoor air temperature is below the space temperature.

Exceptions:

1. Building entrances with automatic closing devices.
2. Emergency exits with an automatic alarm that sounds when open.
3. Operable openings and doors serving enclosed spaces without a thermostat or ~~HVAC~~ heating or cooling temperature sensor.
4. Separately zoned areas associated with the preparation of food that contain appliances that contribute to the ~~HVAC~~ heating or cooling loads of a restaurant or similar type of occupancy.
5. Warehouses that utilize operable openings for the function of the occupancy where approved by the *code official*.
6. The first entrance doors where located in the exterior wall and are part of a vestibule system.
7. Operable openings into spaces served by radiant heating and cooling systems.
8. Alterations where walls would have to be opened solely for the purpose of meeting this requirement and where approved.
9. Doors served by air curtains meeting the requirements of Section C402.6.6.

Reason: Section C403.4 is entitled, "Heating and cooling system controls." As noted in the text within this charging section to subsection C403.4.6, the entire section is only applicable to controls for heating and cooling systems. A careful read of the subsections also supports the conclusion that the section only applies to controls for heating and cooling systems. To ensure that the terms in the section align with the meaning, please replace references to "HVAC" (i.e., heating, ventilation and cooling) with "heating and cooling."

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is an editorial clarification with no bearing on cost.

Workgroup Recommendation

Proposal # 623

CED1-161-22

Proponents: Reid Hart, rep. Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**); Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Ellen Franconi, representing Pacific Northwest National Laboratory (ellen.franconi@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.4.6 Demand responsive controls. Buildings shall be provided with *demand responsive controls* capable of executing the following actions in response to a demand response signal:

1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Where a *demand response signal* is not available the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by direct digital control including, but not limited to, an energy management system, the system shall be capable of *demand responsive control* and capable of adjusting all thermal set-points to comply. The demand responsive controls shall comply with either Section C403.4.6.1 or Section C403.4.6.2

Exceptions:

1. Group I occupancies
2. Group H occupancies
3. Controls serving data center systems
4. Occupancies or applications requiring precision in indoor temperature control as approved by the code official
5. Controls that serve only fossil fuel equipment
6. Buildings that comply with Load Management measure G02 in Section C406.3.3

C406.3.3 G02 HVAC Load Management. Automatic load management controls shall be configured as follows:

1. Where electric cooling is in use ~~to~~ controls shall gradually increase the cooling setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective cooling capacity to 60% of installed capacity during the peak period.
2. Where electric heating is in use ~~to~~ controls shall gradually decrease the heating setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective heating capacity to 60% of installed capacity during the peak period.
3. Where HVAC systems ~~are~~ serve ~~ing~~ multiple zones and have less than 70 percent outdoor air required, include controls that provide excess outdoor air preceding the peak period and reduce outdoor air by at least 30 percent during the peak period, in accordance with ASHRAE Standard 62.1 Section 6.2.5.2 Short Term Conditions or provisions for *approved* engineering analysis in the International Mechanical Code Section 403.3.1.1, Outdoor Airflow Rate.

Exception: Single zone air conditioners and heat pumps that comply with the requirements of C403.4.6.1 shall be deemed to meet the control requirements of this section.

Credits achieved for measure G02 shall be calculated as follows:

1. Where a *demand response signal* is not available for the *building* from a controlling entity or *demand responsive controls* are not required by Section C403.4.6, the full value of the G02 credits in Tables C406.3(1) through C406.3(9) shall be achieved.
2. Where a *demand response signal* is available for the *building* from a controlling entity and *demand responsive controls* are required by Section C403.4.6, 50 percent of the G02 credits in Tables C406.3(1) through C406.3(9) shall be achieved.

Reason: Providing an exception to HVAC demand response in Section C403.4.6 is appropriate where buildings comply with energy credit G02 in Section C406.3.3. G02 provides a generally superior method of control including gradually ramping temperature setpoints, ventilation deferment, and options for capacity reduction rather than temperature control. Further, G02 is not restricted to only open ADR methods, but can work with local building demand monitoring or a scheduled peak approach in smaller buildings. Including an exception for C403.4.6 also avoids the perception that a building must comply with both (possibly conflicting) requirements, as measures in C406 are chosen by the building designer to meet a required credit level.
To coordinate with C403.4.6 requirements, where an openADR demand response signal is available from the serving utility, the credits are reduced by half.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
In some cases the cost of construction is reduced, as the exception allows clear compliance with either requirement and not both.

Workgroup Recommendation

Proposal # 661

CED1-162-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.4.6 Demand responsive controls. Buildings shall be provided with demand responsive controls capable of executing the following actions in response to a demand response signal:

1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Where a demand response signal is not available the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by direct digital control including, but not limited to, an energy management system, the system shall be capable of demand responsive control and capable of adjusting all thermal set-points to comply. The demand responsive controls shall comply with either Section C403.4.6.1 or Section C403.4.6.2

Exceptions:

1. Group I occupancies
2. Group H occupancies
<u>3.</u> <u>Group R-2 occupancies</u>
~~3~~ <u>4</u>. Controls serving data center systems
~~4~~ <u>5</u>. Occupancies or applications requiring precision in indoor temperature control as approved by the code official
~~5~~ <u>6</u>. Controls that serve only fossil fuel equipment

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	13	7	11	6	8	9	6	1	24	8	9	30	15	5	32	28	31	36
E03	Envelope leak reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	7	7	9	65	16	1	73	43	52	26
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	1	7	7	6	8
E05	Add Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	1	14	12	13	13
E06	Improve Fenestration	C406.2.1.6	7	7	4	6	9	11	13	3	1	22	5	10	27	18	7	41	33	22	21
H01	HVAC Performance	C406.2.2.1	20	19	16	17	14	13	11	11	5	13	10	8	15	12	7	18	14	17	19
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	3	1	1	6	2	3	10	5	2	14	10	13	16
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	3	1	1	1	1	1	1	1	1	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	10	8	22	20	25	16	17	32	21	24	17	23	27	16	21	24	18	18
H05	DOAS/fan control	C406.2.2.5	32	31	27	28	23	23	28	21	12	42	24	24	56	36	19	73	54	70	79
W01	SHW preheat recovery	C406.2.3.1a	61	63	74	74	85	88	101	100	121	103	109	122	102	111	130	93	106	99	96
W02	Heat pump water heater	C406.2.3.1b	50	52	62	61	72	74	86	85	104	88	94	106	88	96	112	81	92	87	84
W03	Efficient gas water heater	C406.2.3.1c	38	39	46	46	53	55	63	62	76	64	68	76	64	69	81	58	66	62	60
W04	SHW pipe insulation	C406.2.3.2	7	7	8	7	8	8	8	9	10	8	9	9	7	8	9	6	7	6	6
W05	Point of use water heaters	C406.2.3.3a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3b	3	3	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	3	2
W07	SHW heat trace system	C406.2.3.3c	12	12	13	13	14	15	15	15	18	14	15	16	13	14	16	11	13	11	10
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	45	46	55	54	63	65	74	73	89	75	80	89	74	81	95	68	77	72	70
W10	Shower heat recovery	C406.2.3.6	15	16	19	19	22	23	26	26	32	27	29	32	27	29	34	25	28	27	26
P01	Energy monitoring	C406.2.4	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
X01	Demand Responsive Space Conditioning (R-2)	C406.2.X	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	4	4	4	4	3	4	3	2	3	2	1	1	2	1	1	1	1
L04	Increase daylight area	C406.2.5.4	5	5	5	5	5	5	4	4	4	4	4	3	3	4	3	2	3	3	2
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	4	6	8	3	5	4	3
L06	Light power reduction	C406.2.5.7	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	4	5	5	4	4	5	4	4	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	15	15	17	16	17	18	17	18	20	16	17	18	15	16	18	13	15	13	12
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	2	2	1	2	2	1	1	2	1	3	2	3	3

CED345

a. "x" indicates credit is not available for that measure.

Add new text as follows:

C406.2.X Demand Responsive Space Conditioning for R-2 Occupancies. R-2 occupancies claiming credit for demand responsive space conditioning controls shall comply with demand response control requirements of Section 403.4.6.

Reason: This measure should be addressed through utility programs to ensure that the demand response controls are fully compatible with the programs' requirements at the time of program implementation. Demand response programs are not available universally and not all renters or owners will decide to opt in to participate where these programs are offered – in these cases the more expensive controls will become a "stranded asset."
This proposal adds an exception for R-2 occupancies and also adds demand response controls as an optional practice in Section C406 for credit.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction at R-2 occupancies.

Workgroup Recommendation

Proposal # 678

CED1-164-22

Proponents: Shannon Corcoran, representing American Gas Association (corcoransm@att.net); Renee Lani, representing American Public Gas Association (rlani@apga.org); Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.4.6 Demand responsive controls. Buildings shall be provided with demand responsive controls capable of executing the following actions in response to a demand response signal:

1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Where a demand response signal is not available the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by direct digital control including, but not limited to, an energy management system, the system shall be capable of demand responsive control and capable of adjusting all thermal set-points to comply. The demand responsive controls shall comply with either Section C403.4.6.1 or Section C403.4.6.2

Exceptions:

1. Group I occupancies
2. Group H occupancies
3. Controls serving data center systems
4. Occupancies or applications requiring precision in indoor temperature control as approved by the code official
5. Controls that serve only ~~fossil~~ fuel gas or fuel oil equipment

Reason: The term "fossil fuel" is an undefined term and should not be used in the IECC. In place of "fossil fuel", the terms "fuel gas or fuel oil" should be used. These terms are defined in the International Fuel Gas Code/National Fuel Gas Code or NFPA 31 respectively, and the terminology should be consistent amongst the various model codes.
There are 24 instances throughout the document where "fossil fuel" is used and should be changed to "fuel gas or fuel oil."

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal does not change the cost of construction.

Workgroup Recommendation

Proposal # 857

CED1-165-22

Proponents: Thomas Nagy, representing enVerid Systems (tnagy@enverid.com)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

C403.7.1 Demand control ventilation. Demand control ventilation (DCV) shall be provided for the following:

1. Spaces with ventilation provided by single-zone systems where an air-side economizer is provided in accordance with Section C403.5.
2. Spaces larger than 250 square feet (23.2 m^2) in climate zones 5A, 6, 7, and 8 and spaces larger than 500 square feet (46.5 m^2) in other climate zones which have a design occupant load of 15 people or greater per 1,000 square feet (93 m^2) of floor area, as established in Table 403.3.1.1 of the International Mechanical Code, and are served by systems with one or more of the following:

    2.1 An air-side economizer.

    2.2 Automatic modulating control of the outdoor air damper.

    2.3 A design outdoor airflow greater than 3,000 cfm (1416 L/s)

Exceptions:

1. Spaces served by systems with energy recovery in accordance with Section C403.7.4.2 and that have a floor area less than:

    1.1 6000 square feet (2600 m^2) in climate zone 3C.

    1.2 2000 square feet (190 m^2) in climate zones 1A, 3B, and 4B.

    1.3 1000 square feet (90 m^2) in climate zones 2A, 2B, 3A, 4A, 4C, 5 and 6.

    1.4 400 square feet (40 m^2) in climate zones 7 and 8.

2. Multiple-zone systems without direct digital control of individual zones communicating with a central control panel.
3. Spaces served by multiple-zone systems with a system design outdoor airflow less than 750 cfm (354 L/s).
4. Spaces where more than 75 percent of the space design outdoor airflow is required for makeup air that is exhausted from the space or transfer air that is required for makeup air that is exhausted from other spaces.
5. Spaces with one of the following occupancy classifications as defined in Table 403.3.1.1 of the *International Mechanical Code*: correctional cells, education laboratories, barber, beauty and nail salons, and bowling alley seating areas.
6. Spaces using air cleaning in compliance with the ASHRAE 62.1 Indoor Air Quality Procedure.

Reason: There is a contradiction with ASHRAE Standard 62.1-2019 when it comes to using DCV. In section 6.2.6.1 of ASHRAE 62.1-2019 there is an exception that states the following: “CO_2-based DCV shall not be applied in zone with indoor sources of CO_2 other than occupants, or with CO_2 removal mechanisms, such as gaseous air cleaners.” The reason for this is that using air cleaners with CO_2 scrubbing in conjunction with the Indoor Air Quality Procedure (IAQP) will allow for a lower OA minimum than the typical prescriptive OA minimum used with the ventilation rate procedure (VRP). If DCV was then used to lower the outside airflow further, that may lead to higher levels of other volatile organic compounds, above the acceptable limits.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal will neither increase nor decrease the cost of construction.

Bibliography: ASHRAE 62.1-2019, page 25

Workgroup Recommendation

Proposal # 862

CED1-166-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.7.2 Parking garage ventilation systems. Ventilation systems employed in enclosed parking garages ~~used for storing or handling automobiles operating under their own power~~ shall comply with Section 404.1 of the *International Mechanical Code* and the following: ~~meet all of the following~~:

1. Separate ventilation systems and control systems shall be provided for each parking garage section.
2. Control systems for each parking garage section shall ~~automatically detect and control contaminant levels in accordance with the *International Mechanical Code*, and~~ shall be capable of and configured to reduce fan airflow to not less than 0.05 cfm per square foot [0.00025 m^3 /(s • m^2)] of the floor area served and not more than 20 percent ~~or less~~ of the design capacity.
3. The ventilation system for each parking garage section shall have controls and devices that result in fan motor demand of no more than 30 percent of design wattage at 50 percent of the design airflow.

Exception: Garage ventilation systems serving a single parking garage section having a total ventilation system motor nameplate horsepower (ventilation system motor nameplate kilowatt) not exceeding 5 hp (3.7 kW) at fan system design conditions and where the parking garage section has no mechanical cooling or mechanical heating.

Nothing in this section shall be construed to require more than one parking garage section in any parking structure.

PARKING GARAGE SECTION. A part of an enclosed parking garage that is separated from all other parts of the garage by full-height solid walls or operable openings that are intended to remain closed during normal operation and where vehicles cannot pass to other parts of the garage. A parking garage can have one or more parking garage sections and parking garage sections can include multiple floors. ~~It may include multiple floors if there are ramps to allow vehicles to pass between the floors~~.

Reason: C403.7.2, as drafted, eliminates the distinction between enclosed and open parking garages. This would require ventilation systems even in garage systems open to exterior atmosphere. Further, the proposal does not clearly correlate with the International Mechanical Code.
The proposed resolution directs users to the IMC for pollutant detection and control. It also specifies the minimum standby ventilation rate required by the IMC of 0.05 cfm per square foot of the floor area served. This better correlates with IMC.

The proposed resolution also clarifies that an enclosed parking garage may have only one section, which was clearly stated in the foreword to ASHRAE 90.1-2019 Addendum d.

Several editorial improvements are suggested.

On cost justification: It simply is not adequate to say something is cost effective because of the opinion of the ASHRAE 90.1 committee. If it existed, the proponents of CECPI-6-21 - the original code change - should provide the same data and calculations that the 90.1 committee relied upon when it decided to publish Addendum d to ASHRAE 90.1-2019. Note that cost-effectiveness was not actually calculated for Addendum d. Instead, the foreword to Addendum d stated this:

"*Cost effectiveness is assured by the LCCA done for VAV systems, variable-flow chilled-water pumps, and cooling tower fans, which have the same 5 hp threshold yet operate fewer hours and/or much less turndown than garage ventilation fans.*"

In other words, the rationale for CECPI-6-21 relied upon cost justification that was not done.

The original proponents of CECPI-6-21 should do their own arithmetic and show the consensus committee the numbers.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Some costs may be avoided through clearer language.

Bibliography:
https://www.ashrae.org/file%20library/technical%20resources/standards%20and%20guidelines/standards%20addenda/90_1_2019_d_20210104.pdf

Workgroup Recommendation

CED1-167-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com); Armin Rudd, representing self, Principal (arudd@absystems.us)

2024 International Energy Conservation Code [CE Project]

C403.7.4 Energy recovery systems. Energy recovery ventilation systems shall be provided as specified in either Section C403.7.4.1 or C403.7.4.2, as applicable.

Revise as follows:

C403.7.4.1 Nontransient dwelling units. Nontransient dwelling units shall be provided with outdoor air energy recovery ventilation systems with an *enthalpy recovery ratio* of not less than 50 percent at cooling design condition and not less than 60 percent at heating design condition.

Exceptions:

1. Nontransient dwelling units in Climate Zone 3C.
2. Nontransient dwelling units with not more than 500 square feet (46 m^2) of *conditioned floor area* in Climate Zones 0, 1, 2, 3, 4C and 5C ~~and either adjoin an open-ended corridor or do not adjoin a corridor.~~.
~~3.~~ ~~Nontransient dwelling units with not more than 500 square feet (46 m^2) of conditioned floor area that are located in Climate Zones 1A, 2B, 3B, and 3C.~~
~~4.~~ 3. *Enthalpy recovery ratio* requirements at heating design condition in Climate Zones 0, 1 and 2.
~~5.~~ 4. *Enthalpy recovery ratio* requirements at cooling design condition in Climate Zones 4, 5, 6, 7 and 8.

Reason: “Corridor” is not defined in Chapter 2 Definitions and adds a restriction that is not supported by the cost-effectiveness analysis provided. The cost-effectiveness analysis provided with this change had significant issues that must be addressed before the proposal can go forward. The proponent hand-picked the most favorable set of inputs and design assumptions possible to help justify the proposal. A more representative and evenhanded analysis will significantly change the results. We are prepared to review the analysis with the proponent in detail. This change applies only to very small apartments - 500 sqft or less - the most affordable type of housing. Just a few issues are mentioned below:

o The baseline case used for comparing the proposal assumes a balanced system without HRV/ERV. This is the most favorable point of comparison and a system that is not commonly used in practice. Section 403 of the IMC allows other ventilation options that are commonly used in buildings. This assumption by the proponent significantly overestimates the energy savings from installing HRV/ERV and significantly underestimates the incremental costs.

o One hour of labor for installing HRV/ERV significantly underestimates the level of effort that would be needed.

o The proponent does not explain the indoor ERV duct connections or ventilation air distribution strategy. These assumptions make a significant difference in energy use and construction costs and must be disclosed so that reviewers can evaluate this aspect of the analysis. These design choices also can make HRV/ERV unacceptable to the occupant.

o The proponent removes independent bathroom fan exhausts and combines ducting of all bathroom exhausts with the ERV. This strategy will not be acceptable to many designers and occupants. In addition, the analysis did not account for a needed boost in capacity when bathrooms are being used.

Cost Impact: The code change proposal will decrease the cost of construction.
This change will restore the exception for very small dwelling units (500 sqft and less) and will decrease the cost of construction for the most affordable type of housing -- small apartment units.

Workgroup Recommendation

Proposal # 679

CED1-168-22

Proponents: Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov); Michael Rosenberg, representing Pacific Northwest National Laboratory (michael.rosenberg@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.7.8 Occupied standby controls. Occupied-standby controls, in accordance with C403.7.8.1 and C403.7.8.2, shall be ~~are~~ required for each zone of a system that complies with the following: ~~zones and systems serving zones where all spaces served by the zone are required to have occupant sensor lighting controls by Section C405.2.1 and are an ASHRAE Standard 62.1 occupancy category where the ASHRAE Standard 62.1 Ventilation Rate Procedure allows the ventilation air to be reduced to zero when the space is in occupied-standby mode.~~

1. All spaces served by the zone are required to have occupant sensor lighting controls in accordance with C405.2.1.
2. ASHRAE Standard 62.1 Ventilation Rate Procedure allows the ventilation air to be reduced to zero in all spaces served by the zone during occupied standby mode.

Spaces meeting these criteria include:

1. Post-secondary classrooms/lecture/training rooms
2. Conference/meeting/multipurpose rooms
3. Lounges/breakrooms
4. Enclosed offices
5. Open plan office areas
6. Corridors

C403.7.8.1 Occupied Standby Zone Controls. ~~For zones meeting the occupied-standby control criteria, within~~ Within five (5) minutes of all ~~rooms~~ spaces in that zone entering occupied-standby mode, the zone control shall operate as follows:

1. Active heating set point shall be setback ~~at least~~ by no less than 1°F (0.55°C).
2. Active cooling set point shall be setup ~~at least~~ by no less than 1°F(0.55°C).
3. All airflow supplied to the zone shall be shut off whenever the space temperature is between the active heating and cooling set points.

Exception: Multiple zone systems without automatic zone flow control dampers.

C403.7.8.2 Occupied Standby System Controls. Multiple zone systems that can automatically reset the effective minimum outdoor air setpoint ~~and that serve zones with occupied-standby zone controls~~ shall reset the effective minimum outdoor air set-point based on a zone outdoor air requirement of zero for all zones in occupied-standby mode. Sequences of operation for system outside air reset shall comply with an approved method.

Reason: This proposal is editorial and recommends alternative language to reduce ambiguity.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is editorial and does not impact cost effectiveness.

Workgroup Recommendation

Proposal # 665

CED1-169-22

Proponents: Laura Petrillo-Groh, representing AHRI (lpetrillo-groh@ahrinet.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.8.1 **Allowable** **Fan power.** ~~For each fan system serving an occupied space or other enclosed space that includes one or more fans or fan arrays with fan electrical input power greater than 1 kW, fan system electrical input power determined per Section C403.8.1.2 at the fan system design airflow shall not be greater than the limit is calculated in accordance with Section C403.8.1.1. This section does not apply to fans service heat rejection equipment.~~
Each HVAC system having a total fan system motor nameplate horsepower exceeding 5 hp (3.7 kW) at fansystem design conditions shall not exceed the allowable fan system motor nameplate hp (Option 1) or fan system bhp (Option 2) shown in Table C403.8.1(1). This includes supply fans, exhaust fans, return/relief fans, and fan-powered terminal units associated with systems providing heating or cooling capability. Single-zone variable air volume systems shall comply with the constant volume fan power limitation.

Exceptions:

1. Hospital, vivarium and laboratory systems that utilize flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall be permitted to use variable volume fan power limitation.
2. Individual exhaust fans with motor nameplate horsepower of 1 hp (0.746 kW) or less are exempt from the allowable fan horsepower requirement.

~~TABLE C403.8.1(1) SUPPLY FAN POWER ALLOWANCES (W/CFM)~~

~~Multi-Zone VAV Fan System Airflow (cfm)[a]~~	~~All Other Fan Systems Airflow (cfm)~~					
~~Air system Component~~	~~<5,000~~	~~5,000 to <10,000~~	~~≥10,000~~	~~<5,000~~	~~5,000 to <10,000~~	~~≥10,000~~
~~W/cfm~~						
~~Supply System Base Allowance for each fan system~~	~~0.413~~	~~0.472~~	~~0.480~~	~~0.243~~	~~0.267~~	~~0.248~~
~~Particle filtration (select all that apply)~~						
~~Filter not higher than MERV 12~~	~~0.094~~	~~0.079~~	~~0.073~~	~~0.097~~	~~0.084~~	~~0.075~~
~~MERV 13 to MERV 16 filter~~	~~0.210~~	~~0.177~~	~~0.165~~	~~0.217~~	~~0.185~~	~~0.168~~
~~HEPA filter~~	~~0.347~~	~~0.292~~	~~0.277~~	~~0.357~~	~~0.304~~	~~0.278~~
~~Heating (select all that apply)~~						
~~Hydronic heating coil (central)~~	~~0.047~~	~~0.050~~	~~0.055~~	~~0.049~~	~~0.053~~	~~0.057~~
~~Electric heat~~	~~0.047~~	~~0.050~~	~~0.055~~	~~0.049~~	~~0.042~~	~~0.038~~
~~Gas or oil furnace <90% Et or <90% AFUE~~	~~0.071~~	~~0.060~~	~~0.073~~	~~0.061~~	~~0.063~~	~~0.075~~
~~Gas or oil furnace ≥ 90% Et or ≥90% AFUE~~	~~0.117~~	~~0.099~~	~~0.092~~	~~0.122~~	~~0.104~~	~~0.094~~
~~Cooling and dehumidification (select all that apply)~~						
~~Hydronic/DX cooling coil, or heat pump coil (wet) [Healthcare facilities can select twice]~~	~~0.141~~	~~0.118~~	~~0.110~~	~~0.146~~	~~0.125~~	~~0.112~~
~~Fluid economizer coil~~	~~0.141~~	~~0.118~~	~~0.110~~	~~0.146~~	~~0.125~~	~~0.112~~
~~Desiccant system-solid or liquid~~	~~0.164~~	~~0.138~~	~~0.128~~	~~0.170~~	~~0.145~~	~~0.131~~
~~Hot gas reheat coil~~	~~0.047~~	~~0.040~~	~~0.037~~	~~0.049~~	~~0.042~~	~~0.038~~
~~Series energy recovery~~	~~0.141~~	~~0.118~~	~~0.110~~	~~0.146~~	~~0.125~~	~~0.112~~
~~Evaporative humidifier/cooler in series with a cooling coil. Value shown is allowed W/cfm per 1.0 in. wg. Determine pressure loss (in. wg.) at the lesser of 400 fpm or maximum velocity allowed by the manufacturer. [Calculation required[b]]~~	~~0.233~~	~~0.196~~	~~0.184~~	~~0.241~~	~~0.205~~	~~0.186~~
~~Energy recovery~~						
~~Enthalpy Recovery Ratio ≥0.50 and <0.55~~	~~0.141~~	~~0.118~~	~~0.110~~	~~0.146~~	~~0.125~~	~~0.112~~
~~Enthalpy Recovery Ratio ≥0.55 and <0.60~~	~~0.166~~	~~0.140~~	~~0.130~~	~~0.172~~	~~0.147~~	~~0.133~~
~~Enthalpy Recovery Ratio ≥0.60 and <0.65~~	~~0.191~~	~~0.161~~	~~0.151~~	~~0.198~~	~~0.169~~	~~0.153~~
~~Enthalpy Recovery Ratio ≥0.65 and <0.70~~	~~0.217~~	~~0.182~~	~~0.171~~	~~0.224~~	~~0.191~~	~~0.173~~
~~Enthalpy Recovery Ratio ≥0.70 and <0.75~~	~~0.242~~	~~0.204~~	~~0.191~~	~~0.250~~	~~0.213~~	~~0.193~~
~~Enthalpy Recovery Ratio ≥0.75 and <0.80~~	~~0.267~~	~~0.225~~	~~0.212~~	~~0.276~~	~~0.235~~	~~0.213~~
~~Enthalpy Recovery Ratio ≥0.80~~	~~0.292~~	~~0.246~~	~~0.232~~	~~0.301~~	~~0.257~~	~~0.234~~
~~Run-around liquid or refrigerant coils~~	~~0.141~~	~~0.118~~	~~0.110~~	~~0.146~~	~~0.125~~	~~0.112~~
~~Gas-phase filtration~~						
~~Gas-phase filtration~~	~~0.233~~	~~0.196~~	~~0.184~~	~~0.241~~	~~0.205~~	~~0.186~~
~~Other~~						
~~Economizer return damper~~	~~0.049~~	~~0.042~~	~~0.038~~	~~0.049~~	~~0.043~~	~~0.039~~
~~100% Outdoor air system[c]~~	~~0.000~~	~~0.000~~	~~0.000~~	~~0.073~~	~~0.104~~	~~0.112~~
~~Low-turndown single-zone VAV fan systems[d]~~	~~0.000~~	~~0.000~~	~~0.000~~	~~0.073~~	~~0.104~~	~~0.094~~
~~Air blender~~	~~0.047~~	~~0.040~~	~~0.037~~	~~0.049~~	~~0.042~~	~~0.038~~
~~Sound attenuation section [fans serving spaces with design background noise goals below NC35]~~	~~0.035~~	~~0.030~~	~~0.027~~	~~0.036~~	~~0.032~~	~~0.029~~
~~Deducation for systems that feed a terminal unit or fan coil with a fan with electrical input power <1kWe~~	~~-0.500~~	~~-0.500~~	~~-0.500~~	~~-0.100~~	~~-0.100~~	~~-0.100~~

a. ~~See section C408.3.1.1 for requirements for a Multi-Zone VAV system.~~

~~b. Power allowances require further calculation. Multiply the actual pressure drop of the device or component by the fan power allowance in Table C403.8.1(2).~~

~~c. The 100 percent outdoor air system must serve 3 or more HVAC zones.~~

~~d. A low-turndown single-zone VAV fan system must be capable of and configured to reduce airflow to 50 percent of design airflow and use no more than 30 percent of the design wattage at that airflow. No more than 10 percent of the design load served by the equipment shall have fixed loads.~~

~~e. The deduction of 0.500 W/cfm is a default value for multizone VAV fan systems. If the terminal unit or fan coil manufacturer can demonstrate that the share of the unit's fan power required to move the fan system's air is less than 0.500 W/cfm, that value may be used. The W/cfm shall be calculated by dividing the power required to operate the terminal unit's fan at fan system design conditions by the airflow of the terminal unit at those conditions.~~

~~TABLE C403.8.1(2) EXHAUST, RETURN, RELIEF, TRANSFER FAN SYSTEM POWER ALLOWANCES (W/CFM)~~

~~Mult-Zone VAV Fan System airflow[a] (cfm)~~			~~All Other Fan Systems Airflow (cfm)~~			
~~Air System Component~~	~~<5,000~~	~~5,000 TO <10,000~~	~~≥10,000~~	~~<5,000~~	~~5,000 to <10,000~~	~~≥10,000~~
~~W/cfm~~						
~~Exhaust, Return, Relief, and Transfer System Base Allowance for each *fan system*~~	~~0.231~~	~~0.256~~	~~0.248~~	~~0.194~~	~~0.192~~	~~0.200~~
~~Particle filtration~~						
~~Filter (any MERV value)[b]~~	~~0.049~~	~~0.042~~	~~0.038~~	~~0.049~~	~~0.043~~	~~0.039~~
~~Energy recovery~~						
~~Enthalpy Recovery Ratio ≥ 0.50 and <0.55~~	~~0.146~~	~~0.125~~	~~0.112~~	~~0.146~~	~~0.128~~	~~0.114~~
~~Enthalpy Recovery Ratio ≥0.55 and <0.60~~	~~0.173~~	~~0.148~~	~~0.133~~	~~0.173~~	~~0.150~~	~~0.135~~
~~Enthalpy Recovery Ratio≥0.60 and <0.65~~	~~0.199~~	~~0.170~~	~~0.153~~	~~0.199~~	~~0.173~~	~~0.155~~
~~Enthalpy Recovery Ratio ≥0.65 and <0.70~~	~~0.225~~	~~0.192~~	~~0.173~~	~~0.226~~	~~0.196~~	~~0.176~~
~~Enthalpy Recovery Ratio ≥0.70 and <0.75~~	~~0.250~~	~~0.214~~	~~0.193~~	~~0.252~~	~~0.218~~	~~0.196~~
~~Enthalpy Recovery Ratio ≥0.75 and <0.80~~	~~0.276~~	~~0.236~~	~~0.213~~	~~0.277~~	~~0.240~~	~~0.216~~
~~Enthalpy Recovery Ratio ≥0.8~~	~~0.302~~	~~0.258~~	~~0.234~~	~~0.303~~	~~0.263~~	~~0.236~~
~~Run-around liquid or refrigerant coils~~	~~0.146~~	~~0.125~~	~~0.112~~	~~0.146~~	~~0.128~~	~~0.114~~
~~Special exhaust and return system requirements (select all that apply)~~						
~~Return or exhaust systems required to be fully ducted by code or accreditation standards~~	~~0.122~~	~~0.105~~	~~0.094~~	~~0.122~~	~~0.107~~	~~0.096~~
~~Return and/or exhaust airflow control devices required by code or accreditation standards to maintain pressure relationships between spaces~~	~~0.122~~	~~0.105~~	~~0.094~~	~~0.122~~	~~0.107~~	~~0.096~~
~~Laboratory and vivarium exhaust systems in high-rise buildings for vertical duct exceeding 75 feet. Value shown is allowed W/cfm per 0.25 inch wg for each 100 feet exceeding 75 feet. [Calculation required[c]]~~	~~0.061~~	~~0.053~~	~~0.047~~	~~0.061~~	~~0.054~~	~~0.048~~
~~Exhaust system serving fume hoods~~	~~0.085~~	~~0.074~~	~~0.066~~	~~0.085~~	~~0.075~~	~~0.067~~
~~Biosafety cabinet. Value shown is allowed W/cfm per 1.0 inch wg air pressure drop [Calculation required[c]]~~	~~0.241~~	~~0.206~~	~~0.186~~	~~0.242~~	~~0.210~~	~~0.188~~
~~Exhaust filters, scrubbers, or other exhaust treatment required by code or standard. Value shown is allowed W/cfm per 1.0 inch wg air pressure drop. [Calculation required[c]]~~	~~0.241~~	~~0.206~~	~~0.186~~	~~0.242~~	~~0.210~~	~~0.188~~
~~Other~~						
~~Sound attenuation section (fans serving spaces with design background noise goals below NC35)~~	~~0.036~~	~~0.032~~	~~0.029~~	~~0.036~~	~~0.032~~	~~0.029~~

~~a. See Section C408.3.1.1 for requirements for a Multi-Zone VAV System.~~

~~b. Particle filter pressure loss can only be counted once per fan system.~~

~~c. Power allowances require further calculation. Multiply the actual pressure drop of the device or component by the fan power allowance in Table C403.8.1(2).~~

~~TABLE C403.8.1(3) FAN POWER LIMIT ALTITUDE CORRECTION FACTOR~~

~~Altitude (ft)~~	~~Correction factor~~
~~<3,000~~	~~1.000~~
~~≥3,000 and <4,000~~	~~0.896~~
~~≥4,000 and <5,000~~	~~0.864~~
~~≥5,000 and <6,000~~	~~0.832~~
~~≥6,000~~	~~0.801~~

~~TABLE C403.8.1(4) DEFAULT VALUES FOR FAN ELECTRICAL INPUT POWER BASED ON MOTOR NAMEPLATE HP[a, b]~~

~~Motor Nameplate Horsepower~~	~~Variable-Speed Drive (kW)~~	~~Without Variable-Speed Drive (kW)~~
~~<1~~	~~0.96~~	~~0.89~~
~~≥1 and <1.5~~	~~1.38~~	~~1.29~~
~~≥1.5 and <2~~	~~1.84~~	~~1.72~~
~~≥2 and <3~~	~~2.73~~	~~2.57~~
~~≥3 and <5~~	~~4.38~~	~~4.17~~
~~≥5 and <7.5~~	~~6.43~~	~~6.15~~
~~≥7.5 and <10~~	~~8.46~~	~~8.13~~
~~≥10 and <15~~	~~12.47~~	~~12.03~~
~~≥15 and <20~~	~~16.55~~	~~16.04~~
~~≥20 and <25~~	~~20.58~~	~~19.92~~
~~≥25 and <30~~	~~24.59~~	~~23.77~~
~~≥30 and <40~~	~~32.74~~	~~31.70~~
~~≥40 and <50~~	~~40.71~~	~~39.46~~
~~≥50 and <60~~	~~48.50~~	~~47.10~~
~~≥60 and <75~~	~~60.45~~	~~58.87~~
~~≥75 and <100~~	~~80.40~~	~~78.17~~

~~a. This table cannot be used for Motor Nameplate Horsepower values greater than 100.~~

~~b. This table is to be used only with motors with a service factor ≤1.15. If the service factor is not provided, this table may not be used.~~

~~**C403.8.1.1 Determining Fan Power Limit.** The maximum allowed fan system electrical input power, shall be determined in accordance with the following steps 1 through 5:~~

1. ~~The fan system's classification shall be determined. A fan system is considered to be multizone VAV where it meets the following requirements; fan systems that do not meet the following requirements shall be classified as other fans:~~

   ~~1.1 The fan system shall serve three or more HVAC zones and airflow to each shall be individually controlled based on heating, cooling and/or ventilation requirements.~~

   ~~1.2 The sum of the minimum airflows for each HVAC zone shall be not greater than 40 percent of the fan system design conditions.~~

   ~~**Exception:** Hospital, vivarium, and laboratory systems that use flow control devices on exhaust or return to maintain space pressure relationships necessary for occupant health and safety or environmental control shall use the multizone VAV fan power allowances.~~

2. ~~Determine the fan system airflow and choose the applicable table(s) for fan power allowance.~~

   ~~2.1 For single-cabinet fan systems, use the fan system airflow and the power allowances in both Table C403.8.1(1) and Table C403.8.1(2).~~

   ~~2.2 For supply-only fan systems, use the fan system airflow and power allowances in Table C403.8.1(1).~~

   ~~2.3 For relief fan systems, use the design relief airflow and the power allowances in Table C403.8.1(2).~~

   ~~2.4 For exhaust, return and transfer fan systems, use the fan system airflow and the power allowances in Table C403.8.1(2).~~

   ~~2.5 For complex fan systems and DOAS with energy recovery fan systems, separately calculate the fan power allowance for the supply and return/exhaust systems and sum them. For the supply airflow at the fan system design conditions, and the power allowances in Table C403.8.1(1). For the return/exhaust airflow, use return or exhaust airflow at the fan system design conditions, and the power allowances in Table C403.8.1(2).~~

3. ~~For each fan system determine the components included in the fan system and sum the fan power allowances of those components. All fan systems shall include the System Base Allowance. If, for a given component, only a portion of the fan system airflow passes through the component, calculate the fan power allowance for the com-ponent per equation 4-7:~~

~~(Equation 4-7)~~

$$FPA_{adj} = (Q_{comp} / Q_{sys}) * FPA_{comp}$$

~~FPA_{adj} = The corrected fan power allowance for the component in w/cfm~~
~~Q_{comp} = The airflow through component in cfm~~
~~Qsys = The fan system airflow in cfm~~
~~FPA_{comp} = The fan power allowance of the component from Table C403.8.1(1) or Table C403.8.1(2)~~

4. ~~Multiply the fan system airflow by the sum of the fan power allowances for the fan system, then divide by 1000 to convert to KW.~~

~~(Equation 4-8)~~

$$FPL = (Q_{sys} * FPA_{sum})/1000$$

~~FPL = The fan power limit in KW~~
~~Q_{sys} = The fan system airflow in cflm (L/s)~~
~~FPA_{sum} = The sum of the fan power allowance for the system in W/cfm~~
~~1000 = The conversion from W to kW~~

5. ~~For building sites at elevations greater than 3,000 feet (900 m), multiply the fan power limit by the correction factor from Table C408.3.1(3).~~

~~(Equation 4-9)~~

$$FPL_{alt} = FPL * C_{alt}$$

~~FPL_{alt} = The adjusted fan power limit in KW.~~
~~FPL = The fan power limit in KW calculated in step 4.~~
~~C_{alt} = The altitude correction factor from Table C408.3.1(3)~~

~~C403.8.1.2 Determining Fan System Electrical Input Power.~~ ~~The fan system electrical input power is the sum of the fan electrical input power of each fan or fan array in-cluded in the fan system other than fans with fan electrical input power ≤ 1 kW. If variable speed drives are used their efficiency losses shall be included. Fan system input power shall be calculated with mid-life filter pressure drop, which is the mean of the clean filter pressure drop and design final filter pressure drop. The fan electrical input power for each fan or fan array shall be determined using one of the following methods. There is no requirement to use the same method for all fans in a fan system:~~

1. ~~Use the default fan electrical input power in Table C408.3.1(4) for one or more of the fans. This method cannot be used for complex fan systems.~~
2. ~~Use the fan electrical input power at fan system design conditions provided by the manufacturer of the fan, fan array, or equipment that includes the fan or fan array, calculated per a test procedure included in 10 CFR Part 430, 10 CFR Part 431, ANSI/AMCA Standard 210, ASHRAE 51 AHRI Standard 430, AHRI Standard 440, or ISO 5801.~~
3. ~~Use the fan electrical input power provided by the manufacturer, calculated at fan system design conditions per one of the methods listed in section 5.3 of ANSI/AMCA 208.~~
4. ~~Use the fan nameplate electrical input power.~~

~~C403.8.2 Motor nameplate horsepower.~~ ~~For each fan, the fan brake horsepower (bhp) shall be indicated on the construction documents and the selected motor shall be not larger than the first available motor size greater than the following:~~

1. ~~For fans less than 6 bhp (4476 W), 1.5 times the fan brake horsepower.~~
2. ~~For fans 6 bhp (4476 W) and larger, 1.3 times the fan brake horsepower.~~

Exceptions:

1. ~~Fans equipped with electronic speed control devices to vary the fan airflow as a function of load.~~
2. ~~Fans with a fan nameplate electrical input power of less than 0.89 kW.~~
3. ~~Systems complying with Section C403.8.1 fan system motor nameplate hp (Option 1).~~

4. ~~Fans with motor nameplate horsepower less than 1 hp (746 W).~~

~~**C403.8.3 Fan efficiency.** Each fan and fan array shall have a fan energy index (FEI) of not less than 1.00 at the design point of operation, as determined in accordance with AMCA 208 by an *approved* independent testing laboratory and labeled by the manufacturer. Each fan and fan array used for a variable-air-volume system shall have an FEI of not less than 0.95 at the design point of operation, as determined in accordance with AMCA 208 by an approved independent testing laboratory and labeled by the manufacturer. The FEI for fan arrays shall be calculated in accordance with AMCA 208 Annex C.~~

~~**Exceptions:** The following fans are not required to have a fan energy index~~:

1. ~~Fans that are not embedded fans with motor nameplate horsepower of less than 1.0 hp (0.75 kW) or with a nameplate electrical input power of less than 0.89 kW.~~
2. ~~Embedded fans that have a motor nameplate horsepower of 5 hp (3.7 kW) or less, or with a fan system electrical input power of 4.1 kW or less.~~
3. ~~Multiple fans operated in series or parallel as the functional equivalent of a single fan that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less or with a fan system electrical input power of 4.1 kW or less.~~
4. ~~Fans that are part of equipment covered in Section C403.3.2.~~
5. ~~Fans included in an equipment package certified by an *approved agency* for air or energy performance.~~
6. ~~Ceiling fans, which are defined as nonportable devices suspended from a ceiling or overhead structure for circulating air via the rotation of the blades.~~
7. ~~Fans used for moving gases at temperatures above 482°F (250°C).~~
8. ~~Fans used for operation in explosive atmospheres.~~
9. ~~Reversible fans used for tunnel ventilation.~~
10. ~~Fans that are intended to operate only during emergency conditions.~~
11. ~~Fans outside the scope of AMCA 208.~~

~~**C403.8.4 Fractional hp fan motors**. Motors for fans that are not less than $^1/_{12}$ hp (0.062 kW) and are less than 1 hp (0.746 kW) shall be electronically commutated motors or shall have a minimum motor efficiency of 70 percent, rated in accordance with DOE 10 CFR 431. These motors shall have the means to adjust motor speed for either balancing or remote control. The use of belt-driven fans to sheave adjustments for airflow balancing instead of a varying motor speed shall be permitted.~~

~~**Exceptions:** The following motors are not required to comply with this section~~

1. ~~Motors in the airstream within fan coils and terminal units that only provide heating to the space served.~~
2. ~~Motors in space-conditioning equipment that comply with Section C403.3.2 or Sections C403.8.1. through C403.8.3.~~
3. ~~Motors that comply with Section C405.8.~~

~~**C403.8.5 Low-capacity ventilation fans**. Mechanical ventilation system fans with motors less than $^1/_{12}$ hp (0.062 kW) in capacity shall meet the efficacy requirements of Table C403.8.5 at one or more rating points. Airflow shall be tested in accordance with the test procedure referenced by Table C403.8.5 and listed. The airflow shall be reported in the product listing or on the label. Fan efficacy shall be reported in the product listing or shall be derived from the input power and airflow values reported in the product listing or on the label. Fan efficacy for fully ducted HRV, ERV, balanced, and in-line fans shall be determined at a static pressure not less than 0.2 inch w.c. (49.85 Pa). Fan efficacy for ducted range hoods, bathroom, and utility room fans shall be determined at a static pressure not less than 0.1 inch w.c. (24.91 Pa).~~

Exceptions:

1. ~~Where ventilation fans are a component of a listed heating or cooling appliance.~~
2. ~~Dryer exhaust duct power ventilators, domestic range hoods and domestic range booster fans that operate intermittently.~~
3. ~~Fans in radon mitigation systems.~~
4. ~~Fans not covered within the scope of the test methods referenced in Table C403.8.5.~~
5. ~~Ceiling fans regulated under 10 CFR 430 Appendix U.~~

~~TABLE C403.8.5 LOW-CAPACITY VENTILATION FAN EFFICACY[a]~~

~~SYSTEM TYPE~~	~~AIRFLOW RATE (CFM)~~	~~MINIMUM EFFICACY (CFM/WATT)~~	~~TEST PROCEDURE~~
~~Balanced ventilation system without heat or energy recovery~~	~~Any~~	~~1.2[a]~~	~~ASHRAE Standard 51 (ANSI/AMCA Standard 210)~~
~~HRV, ERV~~	~~Any~~	~~1.2~~	~~CAN/CSA 439-18~~
~~Range hood~~	~~Any~~	~~2.8~~	~~ASHRAE 51 (ANSI/AMCA Standard 210)~~
~~In-line supply or exhaust fan~~	~~Any~~	~~3.8~~	
~~Other exhaust fan~~	~~≤90~~	~~2.8~~	
	~~≥90 and <200~~	~~3.5~~	
	~~≥200~~	~~4.0~~	

For SI: 1 cfm/ft = 0.47 L/s.

a. ~~For balanced systems, HRVs, and ERVs, determine the efficacy as the outdoor airflow divided by the total fan power.~~

~~C403.8.6 Fan control.~~ ~~Controls shall be provided for fans in accordance with Section C403.8.6.1 and as required for specific systems provided in Section C403.~~

~~C403.8.6.1 Fan airflow control.~~ ~~Each cooling system listed in Table C403.8.6.1 shall be designed to vary the indoor fan airflow as a function of load and shall comply with the following requirements:~~

1. ~~Direct expansion (DX) and chilled water cooling units that control the capacity of the mechanical cooling directly based on space temperature shall have not fewer than two stages of fan control. Low or minimum speed shall not be greater than 66 percent of full speed. At low or minimum speed, the fan system shall draw not more than 40 percent of the fan power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.~~
2. ~~Other units including DX cooling units and chilled water units that control the space temperature by modulating the airflow to the space shall have modulating fan control. Minimum speed shall be not greater than 50 percent of full speed. At minimum speed the fan system shall draw not more than 30 percent of the power at full fan speed. Low or minimum speed shall be used during periods of low cooling load and ventilation-only operation.~~
3. ~~Units that include an air-side economizer in accordance with Section C403.5 shall have not fewer than two speeds of fan control during economizer operation.~~

Exceptions:

1. ~~Modulating fan control is not required for chilled water and evaporative cooling units with fan motors of less than 1 hp (0.746 kW) where the units are not used to provide *ventilation air* and the indoor fan cycles with the load.~~
2. ~~Where the volume of outdoor air required to comply with the ventilation requirements of the *International Mechanical Code* at low speed exceeds the air that would be delivered at the speed defined in Section C403.8.6, the minimum speed shall be selected to provide the required *ventilation air*.~~

~~**TABLE C403.8.6.1 COOLING SYSTEMS**~~

~~COOLING SYSTEM TYPE~~	~~FAN MOTOR SIZE~~	~~MECHANICAL COOLING CAPACITY~~
~~DX cooling~~	~~Any~~	~~≥ 65,000 Btu/h~~
~~Chilled water and evaporative cooling~~	~~≥ 1/4 hp~~	~~Any~~

~~For SI: 1 British thermal unit per hour = 0.2931 W; 1 hp = 0.746 kW.~~

Reason: AHRI is concerned that the most recent 90.1 addendum (ISC) includes corrections that are present in IECC Public Draft 1. The 90.1 ISC also received additional comments. Until this major proposal has been fully vetted and has had issued resolved through the 90.1 process, it is not yet ready to be adopted into code.
AHRI Recommendation: Reintroduce proposal (completely harmonized with 90.1) after the 90.1 addendum has been finalized.

Cost Impact: The code change proposal will decrease the cost of construction.
Changes to Section C403.8.1 as included in the Public Draft 1 would increase the cost of construction. Reverting to the lanuaguage in the 2021 IECC would reduce the cost, by comparison.

Workgroup Recommendation

Proposal # 894

CED1-170-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com); Alex Smith, representing NAHB (asmith@nahb.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C404.10 Demand responsive water heating. Electric storage water heaters with a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with demand responsive controls in accordance with Table C404.10 or another equivalent approved standard.
Exceptions:

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
3. Water heaters that use 3-phase electric power.

<u>4</u> <u>Water heaters in R-2 occupancies.</u>

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	13	7	11	6	8	9	6	1	24	8	9	30	15	5	32	28	31	36
E03	Envelope leak reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	7	7	9	65	16	1	73	43	52	26
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	1	7	7	6	8
E05	Add Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	1	14	12	13	13
E06	Improve Fenestration	C406.2.1.6	7	7	4	6	9	11	13	3	1	22	5	10	27	18	7	41	33	22	21
H01	HVAC Performance	C406.2.2.1	20	19	16	17	14	13	11	11	5	13	10	8	15	12	7	18	14	17	19
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	3	1	1	6	2	3	10	5	2	14	10	13	16
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	3	1	1	1	1	1	1	1	1	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	10	8	22	20	25	16	17	32	21	24	17	23	27	16	21	24	18	18
H05	DOAS/fan control	C406.2.2.5	32	31	27	28	23	23	28	21	12	42	24	24	56	36	19	73	54	70	79
W01	SHW preheat recovery	C406.2.3.1a	61	63	74	74	85	88	101	100	121	103	109	122	102	111	130	93	106	99	96
W02	Heat pump water heater	C406.2.3.1b	50	52	62	61	72	74	86	85	104	88	94	106	88	96	112	81	92	87	84
W03	Efficient gas water heater	C406.2.3.1c	38	39	46	46	53	55	63	62	76	64	68	76	64	69	81	58	66	62	60
W04	SHW pipe insulation	C406.2.3.2	7	7	8	7	8	8	8	9	10	8	9	9	7	8	9	6	7	6	6
W05	Point of use water heaters	C406.2.3.3a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3b	3	3	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	3	2
W07	SHW heat trace system	C406.2.3.3c	12	12	13	13	14	15	15	15	18	14	15	16	13	14	16	11	13	11	10
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	45	46	55	54	63	65	74	73	89	75	80	89	74	81	95	68	77	72	70
W10	Shower heat recovery	C406.2.3.6	15	16	19	19	22	23	26	26	32	27	29	32	27	29	34	25	28	27	26
P01	Energy monitoring	C406.2.4	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
X01	Demand Response Water Heater (R-2)	C406.2.X	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD	TBD
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	4	4	4	4	3	4	3	2	3	2	1	1	2	1	1	1	1
L04	Increase daylight area	C406.2.5.4	5	5	5	5	5	5	4	4	4	4	4	3	3	4	3	2	3	3	2
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	4	6	8	3	5	4	3
L06	Light power reduction	C406.2.5.7	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	4	5	5	4	4	5	4	4	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	15	15	17	16	17	18	17	18	20	16	17	18	15	16	18	13	15	13	12
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	2	2	1	2	2	1	1	2	1	3	2	3	3

a. "x" indicates credit is not available for that measure.

Add new text as follows:

C406.2.X Demand Response Water Heating for R-2 Occupancies. For R-2 occupancies, electric storage water heaters with a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with demand responsive controls in accordance with Table C404.10 or another equivalent *approved* standard.

Reason: This measure should be addressed through utility programs to ensure that the demand response controls are fully compatible with the programs' requirements at the time of program implementation. Demand response programs are not available universally and not all renters or owners will decide to opt in to participate where these programs are offered – in these cases the more expensive controls will become a "stranded asset."
Mandating demand responsive water heaters in R-2 buildings is overreach with the potential for unintended consequences where many occupants utilize the same hot water source such as can be found in congregate living facilities, boarding houses, convents, dormitories, and fraternities and sororities. This is particularly true given the low threshold for compliance of 40 gallons. That's only sufficient to serve about 4 residents, or a two-bedroom dwelling unit and certainly not congregate living.

It is also important to understand that where people live in greater densities, with varying ownership and tenancy structures, like R-2 occupancies, there are a broader range of occupant needs than found in other 'commercial' buildings, meaning there is already more distributed demand among occupants for energy using services than in other building occupancies. (It is important to remember that because of increased density, R-2 buildings use less energy per capita than other living options – both within the building and often in related transportation impacts).

The installation of these demand responsive controls for electric equipment in residential applications is better achieved through utility incentives that encourage people without other specific and personal disqualifying considerations to opt into available local demand response programs. Market based solutions will hasten the adoption of these provisions and the use of electric powered water heaters far faster than mandates that incent the use of combustion equipment. If the utility needs the capacity afforded by demand response it can purchase it from the owners of the systems within residential occupancies and provide or incent optimal controls at that time. This is not an issue of infrastructure buried in walls or floors.

This proposal adds an exception for Group R occupancies and also adds demand response controls as an optional practice in Section C406 for credit.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction for R-2 occupancies.

Workgroup Recommendation

Proposal # 680

CED1-171-22

Proponents: Bruce Swiecicki, representing National Propane Gas Association (bswiecicki@npga.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C404.8.3 Covers. Outdoor heated pools and outdoor permanent spas shall be provided with a vapor-retardant cover or other *approved* vapor-retardant means.

> **Exception:** Where more than 75 percent of the energy for heating, computed over an operating season of not fewer than 3 calendar months, is from a heat pump or an ~~on-site~~ renewable energy system, covers or other vapor-retardant means shall not be required.

Reason: In a related proposal, the definition of Renewable Energy Resources is proposed to be modified to be more inclusive of the hydrocarbon resources available to the world. The ultimate determining factor is shaping up to be the source energy carbon intensity of all energy sources and therefore, no resources should be disallowed by the code. Decisions on which energy sources to employ for any building should ultimately be determined based on the performance attributes of the energy source.
This proposal is based on extensive research that has been done and is ongoing, as well as the terminology currently found in the regulations promulgated by the U.S. Environmental Protection Agency[1]. Recent work regarding the recycling of plastics into useable forms of energy has demonstrated processes that can be used to help rid the world of an environmental scourge[2], or the use of clean hydrogen to convert captured carbon dioxide into propane and other hydrocarbons[3],[4].

The remainder of this statement is attributable to Dr. Thomas M. Ortiz, Ph.D. P.E., Director, Codes and Standards for the National Propane Gas Association.

All notions of renewability rely on circularity, the regeneration of raw materials from existing finished products in a way that allows for replenishment of those materials on the timescale of a human lifetime.

Naturally occurring hydrocarbons are generated chemically via the decomposition of organic material. Hydrocarbons can also be recovered from the chemical decomposition of polymers (plastics) and the synthesis of hydrogen and carbon dioxide. Renewable hydrocarbons result where the chemical processes which produce hydrocarbons consume preexisting feedstocks of any of the above types (organic, polymer, or hydrogen), of hydrocarbon, in one of three circular economic cycles.

Each circular, renewable hydrocarbon cycle can begin with an initial quantity of naturally (geologically) produced hydrocarbon feedstock. Imagine a gas well from which a quantity of propane can be isolated cryogenically in a processing plant. This propane can be burned as fuel, processed in a petrochemical plant into plastics, or used to produce organic materials[5]. From this point, three paths can be traversed.

In the first (“bottom-up inorganic recovery”) case, propane burned as fuel generates carbon dioxide as a byproduct. This carbon dioxide can be captured, either immediately at the point of combustion, or later via direct air capture of carbon dioxide. The captured carbon is then blended with clean (renewable) hydrogen in a synthesis reaction that results in new propane[6]. This propane can subsequently be burned, and its carbon dioxide byproduct recaptured, beginning the cycle again.

In the second (“top-down inorganic recovery”) case, propane is processed into plastics, the latter which eventually reach the end of their economically useful life. These plastics are decomposed in a catalytic reactor into new propane[7], which can either be burned or else reprocessed in petrochemical plants into fresh plastics, beginning the cycle again. It is immaterial whether the propane generated during each period are burned as fuel or processed into plastics; either product may be recovered and replenished.

The third (“organic recovery”) case involves industrial decomposition of renewable organic materials (e.g. wood, crops, fats, oils) into small chain hydrocarbons. Propane generated via industrial organic decomposition can likewise be burned or processed into plastics, and—as described above—regenerated into fresh propane using either the circular top-down or bottom-up inorganic processes.

Thus, we see that hydrocarbons may indeed be renewable and can be generated in a variety of equivalently circular processes. There is no distinction chemically, functionally, or from a carbon accounting perspective, among the renewable hydrocarbons generated via the available inorganic or organic recovery processes. Such hydrocarbons are therefore a legitimately renewable fuel source

[1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M

[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into fuels”, https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Cost Impact: The code change proposal will decrease the cost of construction.
This code change proposal can decrease the cost of construction.

Bibliography: [1] 40 CFR Part 80 Subpart M: https://www.ecfr.gov/current/title-40/chapter-I/subchapter-C/part-80/subpart-M
[2] CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[3]CSA Group: https://www.csagroup.org/article/research/defining-recycling-in-the-context-of-plastics/

[4] https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/

[5] U.S. Patent 540563A (1995), “Process for the extraction of fats and oils”, https://patents.google.com/patent/US5405633A/en

[6] Stanford News (2019), “Stanford researchers create new catalyst that can turn carbon dioxide into fuels”, https://news.stanford.edu/2019/10/17/new-catalyst-helps-turn-carbon-dioxide-fuel/ .

[7] Guido Zichittella, Amani M. Ebrahim, Jie Zhu, Anna E. Brenner, Griffin Drake, Gregg T. Beckham, Simon R. Bare, Julie E. Rorrer, and Yuriy Román-Leshkov (2022), “Hydrogenolysis of Polyethylene and Polypropylene into Propane over Cobalt-Based Catalysts”, *JACS Au Article ASAP*, DOI: 10.1021/jacsau.2c00402 .

Workgroup Recommendation

Proposal # 926

CED1-172-22

Proponents: Reid Hart, rep. Pacific Northwest National Laboratory (reid.hart.pe@gmail.com); Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	**Energy Credit Measure**	**Section**	**Climate Zone**																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
W09	SHW ~~distribution sizing~~	C406.2.3.5	~~45~~	~~46~~	~~55~~	~~54~~	~~63~~	~~65~~	~~74~~	~~73~~	~~89~~	~~75~~	~~80~~	~~89~~	~~74~~	~~81~~	~~95~~	~~68~~	~~77~~	~~72~~	~~70~~
W09	SHW flow reduction	C406.2.3.5	22	22	27	26	31	32	37	37	45	38	40	45	38	41	48	35	39	37	36

a. "x" indicates credit is not available for that measure.

TABLE 406.2(3) BASE ENERGY CREDITS FOR GROUP R-1 OCCUPANICES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																	
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
W09	SHW flow reduction	C406.2.3.5	~~13~~	~~14~~	~~16~~	~~16~~	~~18~~	~~20~~	~~22~~	~~22~~	~~23~~	~~25~~	~~25~~	~~28~~	~~27~~	~~26~~	~~29~~	~~26~~	~~27~~	~~26~~	~~25~~
W09	SHW flow reduction	C406.2.3.5	6	7	8	8	9	10	11	11	12	13	13	14	14	13	15	13	14	14	13

a. "x" indicates credit is not available for that measure.

TABLE C406.2.3.4 Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water

Plumbing Fixture	Maximum Flow Rate
Faucet for private lavatory,[a] hand sinks, or bar sinks	~~1.50~~ 1.2 gpm at 60 psi (~~0.095 L/s~~ 4.5 L/m at 410 kPa)
Faucet for residential kitchen sink [a,b, c]	1.8 gpm at 60 psi ~~0.11 L/s~~ 6.8 L/m at 410 kPa)
Shower head (including hand-held shower spray) [a, b, d]	~~2.0~~ 1.8 gpm at 80 psi (~~0.13 L/s~~ 6.8 L/m at 550 kPa)

a. Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)- (p).

b. Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.

c. Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (~~0.14 L/s~~ 8.3 L/m at 410 kPa) and must default to the maximum flow rate listed.

d. When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.

Reason: The uniform pluming code recently lowered the flow limit for showerheads from 2.5 to 2.0 gpm (9.5 to 7.6 L/m). To maintain a savings for this energy credit measure, the limit for measure W09 is reduced to 1.8 gpm (6.8 L/m). In addition, other residential fixture flow is reduced to 1.2 gpm (4.5 L/m) This aligns with appliance standards in California, Colorado, Washington and possibly other jurisdictions. In addition, the maximum flow for residential lavatory fixtures is reduced to 1.2 gpm (4.5 L/m), aligning with those jurisdictions.
The energy impact was reanalyzed with the new differentials between base and improved, with the energy credits being cut in half.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The lower flow fixtures are readily available nationally, and there is not a cost increase related to flow. The primary cost driver for these finish pluming fixtures is related to finish and other parameters.

Workgroup Recommendation

Proposal # 655

CED1-173-22

Proponents: Reid Hart, rep. Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**); Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.2.2.5 H05 Dedicated Outdoor Air System. Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:

1. Zone controls shall cycle the heating/cooling unit fans off when not providing required heating and cooling or shall limit fan power to 0.12 watts/cfm of zone ~~outdoor~~ supply air.
2. Outdoor air shall be supplied by an independent ventilation system designed to provide no more than ~~110~~ 130 percent of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code*.

   Exception: Outdoor airflow is permitted to increase during emergency or economizer operation implemented as described in item 4.
3. The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65 percent or more at heating design conditions in climate zones 3 through 8 and an *enthalpy recovery ratio* of 65 percent or more at cooling design conditions in climate zones 0, 1, 2, 3A, 3B, 4A, 4B, 5A, and 6A. In"A" climate zones, energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on sensible *energy recovery ratio*. Where energy recovery effectiveness is less than the 65 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.
4. Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode. partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:

   4.1. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).

   4.2. The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.
5. Ventilation systems providing mechanical dehumidification shall use recovered energy for reheat within the limits of item 4. This shall not limit the use of latent energy recovery for dehumidification.

Where only a portion of the building is permitted to be served by constant air volume units or theenthalpy recovery ratio or sensible *energy recovery ratio* is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:

(Equation 4-20)

$$EC_{DOAS} = EC_{BASE} \times FLOOR_{CAV} \times ERE_{ADJ}$$

Where:

EC_{DOAS}= Energy credits achieved for H05 ~~H06~~

EC_{base}= H05 ~~H06~~ base energy credits in Section C406.2
$FLOOR_{CAV}$= Fraction of whole project gross conditioned fl oor area not required to have variable speed or multi-speed fan airflow control in accordance with Section C403.8.6.
ERE_{adj}= The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating *enthalpy recovery ratio* or *sensible energy recovery ratio* where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.

Reason: Three minor changes are made to energy credit measure H05 (DOAS) to allow for flexibility.

1. The reference to heating/cooling supply fan operation during ventilation only mode of 0.12 W/cfm is changed from outdoor air to supply air. This is intended to allow continuous operation of destratification convective cooling fans or VRF cassette fans at low speed when heating or cooling is not active.
2. The maximum normal operation outdoor air is increased from 110% to 130% of the IMC minimum outdoor air required to allow for LEED indoor air quality points.
3. An exception for increased economizer operation of the DOAS system is added along with an allowance for emergency outdoor air flushing of spaces. An increased airflow economizer approach can save energy two ways: 1) using cool outdoor air instead of mechanical cooling, and 2) oversizing the ductwork for economizer operation resulting in reduced fan energy during normal operation.

In addition, there are editorial corrections in the formula symbols section.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The changes allow for optional additional controls or increased ductwork sizing that are not required. This measure is not a requirement of the code as it is one of multiple additional energy credit options that can be selected to meet C406 requirements.

Workgroup Recommendation

Proposal # 657

CED1-174-22

Proponents: Reid Hart, rep. Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.2.3.2 Water-heating distribution temperature maintenance. A project is allowed to claim energy credits from only one of the following SHW distribution temperature maintenance measures.

1. **W04: Service Hot Water Piping Insulation Increase.** Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hotwater source to the fixture shutoff. Where no more than 50 percent of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.
2. **W05 Point of use water heaters.** Credits are available for office or school buildings larger than 5000 square feet ~~10,000 ft^2~~ (~~930~~ 460 m^2) where service water heating systems meet the following requirements:

   2.1. Fixtures requiring hot water shall be supplied from a local ~~ized source of hot~~ water heater with no recirculating system or heat trace piping.

   Exception: Commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping where water heaters are located not more than 50 lineal feet (15 m) from the furthest fixture served.

   2.2. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C404.4.1. ~~C403.12.3 without e~~

   Exceptions:
   1. Piping at locations where a vertical support of the piping is installed.
   2. Where piping passes through a framing member if insulation requires increasing the size of the framing member.

   2.3. The water volume in the piping from the water heater to the termination of ~~the~~ any individual fixture ~~supply pipe~~ shall be limited as follows:

   ~~2.1~~ 2.3.1. Non-residential Public lavator y faucets that are available for use by members of the general public ~~ies~~: not more than 2 oz (60 mL)

   ~~2.2~~ 2.3.2. All other plumbing fixtures or appliances: not more than ~~0.25 gallons~~ 16 oz (~~0.95~~ 0.5 L)

   ~~**Exception:** Where all remotely located hot water uses meet the requirements for measure W05, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.~~

3. **W06 Thermostatic balancing valves.** Credits are available where service water heating is provided centrally and distributed throughout the building. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 115°F (46°C).
4. **W07 Heat trace system.** Credits are available for projects with gross floor area greater than 10,000 square feet (930 m^2) and a central water-heating system. The energy credits achieved shall be from Tables C406.1.2(1) through C406.1.2(9). This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

Reason: The changes are primarily editorial and for purposes of clarification. Two substantial changes include:

- Reducing the size of building where the credit is allowed, allowing for more applicability.
- Reducing the volume of fluid in the piping to other fixtures to 16 ounces. With 3/8" supply piping, a 3 or 4 floor stack of restrooms with 4 lavatories on each floor can be effectively served while allowing timely delivery of hot water to the fixtures.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The measure can be selected from a number of options, so this measure (W05) is not specifically required by the code.

Workgroup Recommendation

CED1-175-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.3 Renewable and Load Management Credits ~~achieved~~ Achieved. Renewable energy and load management measures shall achieve credits as follows:
~~installed in the building that comply with Sections C406.3.1 through C406.3.8 shall achieve the credits listed for the occupancy group in Tables C406.3(1) through C406.3(9) or where calculations are required in Sections C406.3 to determine credits or modify the table credits, the credits achieved shall be based upon the Section C406.3 calculations.~~

1. **General measure requirements.** Credits are achieved for measures installed in the *building* that comply with Sections C406.3.1 through C406.3.8

2. **Achieved credits** are determined as follows:

2.1. Measure credits achieved shall be determined in one of two ways, depending on the measure:

2.1.1 ~~1~~ The measure credit shall be the base ~~energy~~ credit listed by occupancy group and climate zone for the measure in Tables C406.3(1) through C406.3(9) where no adjustment factor or formula is shown in the description of the measure in Section C406.3.

2.1.2 ~~2~~ The measure credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the description of the measure in Section C406.3. Where adjustments are applied, each measure energy credit shall be rounded to the nearest whole number.

2.2 Load management and renewable credits achieved for the project shall be the sum of credits for individual measures included in the project. Credits are available for the measures listed in this Section.

2.3 Where a project contains multiple building use groups, credits achieved for each building use group shall be summed and then weighted by the ~~gross~~ floor area of each building use group to determine the weighted average project energy credits achieved.

3. **Load management control requirements**. The load management measures in Sections C406.3.2 (G01) through C406.3.7 (G06) require load management control sequences that are capable of and configured to automatically provide the load management operation specified based on indication of a peak period related to high short-term electric prices, grid condition, or peak building load. Such a peak period shall, where possible, be initiated by a *demand response signal* from the controlling entity, such as a utility or service operator. When communications are disabled or unavailable, all *demand responsive controls* shall continue backup demand response based on a local schedule or building demand monitoring. The local building schedule shall be adjustable without programming and reflect the electric rate peak period dates and times. The load management control sequences shall be activated for peak period control by either:

3.1 ~~1.~~ A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification, or

3.2 ~~2.~~ A device certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls, or

3.3 The physical configuration and communication protocol of CTA 2045-A or CTA 2045-B, or

3.4 For air conditioners and heat pumps with two or more stages of control and cooling capacity of less than 65,000 Btu/h (19 kW), thermostats with a demand responsive control that complies with the communication and performance requirements of AHRI 1380, or

3.5 ~~3~~. A device that complies with IEC 62726-10-1, an international standard for the open automated demand response system interface between the appliance, system, or energy management system and the controlling entity, or

3.6 ~~4~~. An interface that complies with the communication protocol required by a controlling entity, to participate in an automated demand response program, or

3.7 ~~5~~. Where the controlling entity does not have a *demand response* *signal* ~~program or protocol~~ available for the building type and size, local ~~demand response~~ load management control shall be provided based on either:

3.7.1 ~~5.1~~ Building demand management controls that monitor building electrical demand and initiate controls to minimize monthly or peak time period demand charges, or,

3.7.2 ~~5.2~~ Where buildings are less than 25,000 gross square feet, a local building schedule that reflects the electric rate peak period dates and times. In this case a binary input to the control system shall be provided that activates the demand response sequence.

Reason: The proposed changes provide structure and clarification while reducing redundancy. There is no change in requirements.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The changes are editorial for clarification and do not change any requirements.

Workgroup Recommendation

Proposal # 672

CED1-176-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.3.7 G06 SWH Energy Storage. Where SHW is heated by electricity, automatic load management controls <u>that</u> comply with ANSI/CTA-2045-B shall preheat stored SHW before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:

1. Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.
2. Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1. ~~Where heat pump water heating is used, the credits achieved shall be 1/3 of the credits in Tables C406.3(1) through C406.3(9).~~

<u>Credits achieved for measure G06 shall be calculated as follows:</u>

1. <u>Where a controlling entity does not make a *demand response signal* available to the *building* or where water heaters are not required to have *demand responsive controls* by Section C404.10, credits shall be the full value listed in Tables C406.3(1) through C406.3(9).</u>
2. <u>Where a controlling entity does make a *demand response signal* available to the *building* and where water heaters are not required to have *demand responsive controls* by Section C404.10, credits shall be 50 percent of the value listed in Tables C406.3(1) through C406.3(9).</u>
3. <u>Where heat pump water heating is used, the credits achieved shall be 33 percent of the credits calculated in item 1 or 2.</u>

Reason: The credit adjustments added here account for the difference between a capability being required in the base code and full implementation though the credit measure. Full credit is given here when either the base code requirement does not apply or there is not a demand response program available. Half credit is given when there is a demand response program and the base code requires compatible demand response controls.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The changes here are in response to base code changes and allow for partial credit when there is a capability requirement in the base code that is fully implemented here.

Workgroup Recommendation

Proposal # 699

CED1-177-22

Proponents: Aaron McEwin, representing Industry Professional (amcewin@jordanskala.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C408.2 Mechanical systems and service water-heating systems commissioning and completion requirements. Prior to the final mechanical and plumbing inspections, the *registered design professional or approved agency* shall provide evidence of mechanical systems *commissioning* and completion in accordance with the provisions of this section.
Construction document notes shall clearly indicate provisions for *commissioning* and completion requirements in accordance with this section and are permitted to refer to specifications for further requirements. Copies of all documentation shall be given to the owner or owner's authorized agent and made available to the *code official* upon request in accordance with Sections C408.2.4 and C408.2.5.

Exceptions: The following systems are exempt:

1. Buildings with less than 10,000 square feet (929 m2) and ~~Mechanical systems and service water-heating systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW)~~ combined heating, cooling, and service water-heating ~~and space-heating~~ capacity of less than 960,000 Btu/h (280kW).

~~2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.~~

2. Dwelling units and sleeping units served on of the following systems:

   2.1. Simple unitary or packaged HVAC equipment listed in Table C403.3.2(1), Table C403.3.2(2), Table C403.3.2(4), Table C403.3.2(5) each serving one zone and controlled by a single thermostat in the zone served.

   2.2 Two-pipe heating systems serving one or more zones, where no cooling system is installed.

Reason: Under the 2012 IECC, the referenced section referred to "Simple" Systems. In the 2015 IECC, the definition of "Simple" system was removed and only the "Economizer" section was provided. The "Economizer" Section was referenced and did not make since from a commissioning stand point since economizers generally have complex controls that activate mechanical dampers based on a control input (i.e. dry bulb, enthalpy, etc.).
This change gets back to the original intent of less complex systems that serve individual dwelling units and sleeping units do not need to be commissioned.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This clarifies the original intent of the commissioning section prior to the removal of the "Simple" system section of the code.

A: It is the opinion of staff that Exception 2 of Section C408.2 only applies to packaged and split systems serving individual sleeping units and dwelling units. Subject to the approval of the Code Official, it is reasonable to determine that the intent of Exception 2 of Section C408.2 in the 2015 IECC is to exempt HVAC systems that serve individual sleeping units and dwelling units from the commissioning requirement when the systems are packaged or split systems. Exception 2 Section C408.2 of the 2015 IECC states the following.

"Systems included in Section C403.3 that serve individual dwelling units and sleeping units."

Note that Section C403.3 of the 2015 IECC is an economizer provision and does not provide specific language for dwelling units and sleeping units.

In the 2012 IECC Exception 2 of Section C408.2 had similar language. It stated the following.

"Systems included in Section C403.3 that serve dwelling units and sleeping units in hotels, motels, boarding houses or similar units."

Section C403.3 of the 2012 IECC stated the following.

"**C403.3 Simple HVAC systems and equipment (Prescriptive).** This section applies to buildings served by unitary or packaged HVAC equipment listed in Tables C403.2.3(1) through C403.2.3(8), each serving one zone and controlled by a single thermostat in the zone served. It also applies to two-pipe heating systems serving one or more zones, where no cooling system is installed."

In the 2012 IECC the intent of Exception 2 of Section C408.2 was to exempt the dwelling units and sleeping units described when they were served by simple HVAC systems that met the criteria of Section C403.3 (Simple HVAC systems). Exception 2 of Section C408.2 of the 2012 IECC was brought into the code through Public Comment 4 of the code change proposal EC147-09/10. EC147-09/10 was approved as modified with several public comments, including Public Comment 4. A portion of the reason statement for Public Comment 4 stated the following.

"… An exception was also placed in the requirements that will exempt systems installed in hotel/motel and high-rise residential that meet the simple building definition in Section 503.3. This will, for example, exempt packaged terminal heat pump (PTHP) systems commonly used in hotel/motel sleeping rooms that are intermittently occupied and where there may be additional costs of commissioning multiple small systems."

During the 2015 code development cycle Sections C403.3 of the 2012 IECC and C403.4 of the 2012 IECC were modified to, among other things, remove the distinction between simple and complex HVAC systems to make the 2015 IECC more user-friendly. In the process Section C403.3.1 of the 2012 IECC (Economizers) was renumbered to Section C403.3 of the 2015 IECC (Economizers).

Attached Files

- **C408.2 Clarification.pdf**
  https://energy.cdpaccess.com/proposal/775/1463/files/download/348/

Workgroup Recommendation

Proposal # 775

CED1-178-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

CHAPTER 4 [CE]
COMMERCIAL ENERGY EFFICIENCY

Revise as follows:

~~SECTION 409 CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO~~ . [Delete in their entirety Section 409, Appendix CE "Required HVAC TSPR" and associated definitions used solely in this section.]

~~**C409.1 Purpose.** Section 409 establishes criteria for demonstrating compliance with the requirements of C403.1.1, HVAC total system performance ratio (HVAC TSPR)~~

~~**C409.2 Scope.** Section C409 applies to new HVAC systems that serve buildings in Section C403.1.3.1 and are not excluded from using HVAC TSPR by Section C403.1.3. All applicable HVAC systems shall comply with Section C409.~~

~~**C409.3 Core & Shell / Initial Build-Out, and Future System Construction Analysis.** Where the building permit applies to only a portion of the HVAC system in a *building* and the remaining components will be designed under a future building permit or were previously installed, the future or previously installed components shall be modeled as follows:~~

1. ~~Where the HVAC zones that do not include HVAC systems in the current permit will be or are served by independent systems, then the block including those zones shall not be included in the model.~~
2. ~~Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.~~
3. ~~Where the zone equipment in the permit receives HVAC services from previously installed systems that are not in the permit, the previously installed systems shall be modeled with equipment matching the certified value of what is installed or equipment that meets the requirements of Section C403.~~
4. ~~Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.~~

~~**C409.4 HVAC TSPR Compliance.** Systems allowed to use HVAC TSPR in accordance with Section C403.1.3 shall comply with all of the following:~~

1. ~~Systems shall meet the applicable provisions of Section C403.1.3.3 and Sections within Section C403 that are listed in Table C407.2~~
2. ~~The HVAC TSPR of the proposed design shall be greater than or equal to the HVAC TSPR of the standard reference design divided by the mechanical performance factor (MPF)using Equation 4-33.~~

~~(Equation 4-33)~~

~~TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.~~
~~TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.~~
~~MPF = Mechanical Performance Factor from Table C409.4 based on climate zone and building use type~~

~~Where a building has multiple building use types, MPF shall be area weighted using Equation 4-34~~

~~(Equation 4-34)~~

~~MPF1, MPF2 through MPFn= Mechanical Performance Factors from Table C409.4 based on climate zone and building use types 1,2, through n~~
~~A1, A2 through An= Conditioned floor areas for building use types 1, 2, through n~~

~~TABLE C409.4 Mechanical Performance Factors~~

Climate Zone: Building type	Occupancy Group	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Office (small and medium)[a]	B	0.72	0.715	0.70	0.705	0.685	0.65	0.71	0.68	0.645	0.805	0.70	0.78	0.845	0.765	0.805	0.865	0.835	0.875	0.895
Office (Large)[a]	B	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.81	0.77	0.67	0.76	0.63	0.71	0.72	0.63	0.73	0.71	0.71	0.71
Retail	M	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.51	0.40	0.45	0.57	0.68	0.46	0.68	0.67	0.50	0.45	0.44	0.38
Hotel/Motel	R-1	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.45	0.59	0.52	0.38	0.47	0.51	0.35	0.38	0.31	0.26
Multi-family/Dormitory	R-2	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.72	0.55	0.53	0.50	0.44	0.54	0.47	0.38	0.55	0.50	0.51	0.47
School/Education and Libraries	E (A-3)	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.67	0.73	0.72	0.68	0.82	0.73	0.61	0.89	0.80	0.83	0.77

~~a. Large office gross conditioned floor area >150,000 ft^2 (14,000 m^2) or > 5 floors; all other offices are small or medium~~

~~C409.4.1 HVAC TSPR.~~ ~~HVAC TSPR is calculated according to Equation 4-35.~~

~~(Equation 4-35)~~

~~Building HVAC system energy = Sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps, and heat rejection in thousands of Btus~~
~~Heating and cooling load = Sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus~~

~~C409.5 General.~~ ~~Projects shall comply with the requirements of this Section when calculating compliance using HVAC Total System Performance Ratio.~~

~~C409.5.1 Simulation Program.~~ ~~Simulation tools used to calculate HVAC TSPR of the Standard Reference Design shall comply with the following:~~

1. ~~The simulation program shall calculate the HVAC TSPR based only on the input for the proposed design and the requirements of Section 409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the standard reference design.~~
2. ~~Performance analysis tools meeting the applicable subsections of Section 409 and tested according to ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140, shall be permitted to be approved. The required tests shall include building thermal envelope and fabric load test (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verifi-cation test (Section 5.5), along with the associated reporting (Section 6). Tools are permitted to be approved based on meeting a specified threshold for a jurisdiction. The code official shall be permitted to approve tools for a specified application or limited scope.~~
3. ~~The test results and modeler reports shall be posted on a publicly available website and shall include the test re-sults of the simulation programs and input files used for generating the results along with the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.~~
4. ~~The simulation program shall have the ability to explicitly model part-load performance curves or other part-load adjustment methods based on manufacturer's part-load performance data for mechanical equipment.~~

~~C409.5.2 Climatic Data.~~ ~~C409.5.2 The simulation program shall perform the simulation using hourly values of climatic data, such as temperature and humidity, using TMY3 data for the site as specified here: https://buildingenergyscore.energy.gov/resources~~

~~C409.5.3 Documentation.~~ ~~Documentation conforming to the provisions of this section shall be provided to the~~ ~~*code official.*~~

~~C409.5.3.1 Compliance Report.~~ ~~Building permit submittals shall include:~~

1. ~~A report produced by the simulation software that includes the following:~~

   1.1 ~~Address of the building.~~

   1.2 ~~Name of individual completing the compliance report.~~

   1.3 ~~Name and version of the compliance software tool~~

   1.4 ~~The dimensions, floor heights and number of floors for each block.~~

   1.5 ~~By block, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for each fenestration component.~~

   1.6 ~~By block or by surface for each block, the fenestration area.~~

   1.7 ~~By block, a list of the HVAC equipment simulated in the proposed design including the equipment type, fuel type, equipment efficiencies and system controls.~~

   1.8 ~~Annual site HVAC energy use by end use for the proposed and baseline building.~~

   1.9 ~~Annual sum of heating and cooling loads for the baseline building.~~

   1.10 ~~The HVAC total system performance ratio for both the standard reference design and the proposed design.~~

2. ~~A mapping of the actual building HVAC component characteristics and those simulated in the proposed design showing how individual pieces of HVAC equipment identified above have been combined into average inputs as required by Section C409.6.1.10 including:~~

   2.1 ~~Fans~~

   2.2 ~~Hydronic pumps~~

   2.3 ~~Air handlers~~

   2.4 ~~Packaged cooling equipment~~

   2.5 ~~Furnaces~~

   2.6 ~~Heat pumps~~

   2.7 ~~Boilers~~

   2.8 ~~Chillers~~

   2.9 ~~Heat rejection equipment (open and closed-circuit cooling towers; dry coolers)~~

   2.10 ~~Electric resistance coils~~

   2.11 ~~Condensing units~~

   2.12 ~~Motors for fans and pumps~~

   2.13 ~~Energy recovery devices~~

3. ~~For each piece of equipment identified above include the following as applicable:~~

   ~~3.1 Equipment name or tag consistent with that found on the design documents.~~

   ~~3.2 Rated Efficiency level.~~

   ~~3.3 Rated Capacity.~~

   ~~3.4 Where not provided by the simulation program report in item a, documention of the calculation of any weighted equipment efficiencies input into the program.~~

   ~~3.5 Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm or W/gpm).~~

4. ~~Floor plan of the building identifying:~~

   4.1 ~~How portions of the buildings are assigned to the simulated blocks.~~

   4.2 ~~Areas of the building that are not covered under the requirements of Section C403.1.1.~~

~~**C409.6 Calculation Procedures.** Except as specified by this Section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques~~

~~**C409.6.1 Simulation of the proposed building design.** The proposed design shall be configured and analyzed as specified in this section.~~

~~**C409.6.1.1 Block Geometry.** The geometry of buildings shall be configured using one or more blocks. Each block shall define attributes including block dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent blocks. Where actual building shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:~~

1. ~~The conditioned floor area and volume of each block shall match the proposed design within 10 percent.~~
2. ~~The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.~~
3. ~~The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.~~
4. ~~The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.~~

~~The creation of additional blocks may be necessary to meet these requirements. A more complex zoning of the building shall be allowed where all thermal zones in the reference and proposed model are the same and rules related to block geometry and HVAC system assignment to blocks are met with appropriate assignment to thermal zones.~~

~~**Exception:** Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.~~

~~**C409.6.1.1.1 Number of Blocks.** One or more blocks may be required per building based on the following restrictions:~~

1. ~~Each *block* can have only one occupancy type (multifamily *dwelling unit*, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single *block* shall be created for each unique use type.~~
2. ~~Each block can be served by only one type of HVAC system. Therefore, a single block shall be created for each unique HVAC system and use type combination. Multiple HVAC units of the same type may be represented in one block. Table D601.10.2 provides directions for combining multiple HVAC units or components of the same type into a single block.~~
3. ~~Each block can have a single definition of floor to floor or floor to ceiling heights. Where floor heights differ by more than two feet, unique blocks should be created for the floors with varying heights.~~
4. ~~Each block can include either above grade or below grade floors. For buildings with both above grade and below grade floors, separate blocks should be created for each. For buildings with floors partially above grade and partially below grade, if the total wall area of the floor(s) in consideration is greater than or equal to 50 percent above grade, then it should be simulated as a completely above grade block, otherwise it should be simulated as a below grade block.~~
5. ~~Each wall on a façade of a block shall have similar vertical fenestration. The product of the proposed design U-factor times the area of windows (UA) on each façade of a given floor cannot differ by more than 15 percent of the average UA for that façade in each block. The product of the proposed design SHGC times the area of windows (SHGCA) on each façade of a given floor cannot differ by more than 15 percent of the average SHGCA for that façade in each block. If either of these conditions are not met, additional blocks shall be created consisting of floors with similar fenestration.~~
6. ~~For a building model with multiple blocks, the blocks should be configured together to have the same adjacencies as the actual building design.~~

~~**C409.6.1.2 Thermal Zoning.** Each floor in a block shall be modeled as a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone. Below grade floors shall be modeled as a single thermal block. If any façade in the block is less than 45 feet in length, there shall only be a single thermal zone per floor. Otherwise each floor shall be modeled with five thermal zones. A perimeter zone shall be created extending from each façade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each floor shall be modeled as a core zone with no exterior walls.~~

~~**C409.6.1.3 Occupancy.** Building occupancies modeled in the standard reference design and the proposed design shall comply with the following requirements.~~

~~**C409.6.1.3.1 Occupancy Type.** The occupancy type for each block shall be consistent with the building area type as determined in accordance with Section C405.4.2.1. Portions of the building that are building area types other than multifamily dwelling unit, multifamily common area, office, school (education), library, or retail shall not be included in the simulation. Surfaces adjacent to such building portions shall be modeled as adiabatic in the simulation program.~~

~~**C409.6.1.3.2 Occupancy schedule, density, and heat gain.** The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.~~

~~**C409.6.1.4 Envelope Components.** Building envelope components modeled in the standard reference design and the proposed design shall comply with the requirements of this Section.~~

~~**C409.6.1.4.1 Roofs.** Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single block, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.70 and emittance at 0.90.~~

~~**C409.6.1.4.2 Above grade walls.** Walls will be modeled as steel frame construction. The U-factor and area of above grade walls shall be modeled~~

~~as in the proposed design. If different wall constructions exist on the façade of a block an area-weighted U-factor shall be used.~~

~~**C409.6.1.4.3 Below grade walls.** The C-factor and area of below grade walls shall be modeled as in the proposed design. If different slab on grade floor constructions exist in a block, an area-weighted C- factor shall be used.~~

~~**C409.6.1.4.4 Above grade exterior floors.** Exterior floors shall be modeled as steel frame. The U-factor and area of floors shall be modeled as in the proposed design. If different wall constructions exist in the block an area-weighted U-factor shall be used.~~

~~**C409.6.1.4.5 Slab on grade floors.** The F-factor and area of slab on grade floors shall be modeled as in the proposed design. If different below grade wall constructions exist in a block, an area-weighted F- factor shall be used.~~

~~**C409.6.1.4.6 Vertical Fenestration.**~~ The window area and area weighted U-factor and SHGC shall be modeled for each façade based on the proposed design. Each exterior surface in a block must comply with Section C409.6.1.1.1 item 5. Windows will be combined into a single window centered on each façade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade, area weighted average for each shall be input by the user.

~~**C409.6.1.4.7 Skylights.** The skylight area and area weighted U-factor and SHGC shall be modeled for each floor based the proposed design. Skylights will be combined into a single skylight centered on the roof of each zone based on the area input by the user.~~

~~**C409.6.1.4.8 Exterior Shading.** Permanent window overhangs shall be modeled. When windows with and without overhangs or windows with different overhang projection factors exist on a façade, window width weighted projection factors shall be input by the user as follows:~~

~~**C409.6.1.5 Lighting.** Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for multifamily, office, retail, library, or school. The lighting schedule shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.~~

~~**C409.6.1.6 Miscellaneous equipment.** The miscellaneous equipment schedule and power shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.~~

~~**Exceptions:**~~

1. ~~Multifamily dwelling units shall have a miscellaneous load density of 0.42 W/ft^2~~
2. ~~Multifamily common areas shall have a miscellaneous load density of 0 W/ft^2~~

~~**C409.6.1.7 Elevators.** Elevators shall not be modeled.~~

~~**C409.6.1.8 Service water heating equipment.** Service water heating shall not be modeled.~~

~~**C409.6.1.9 On-site renewable energy systems.** On-site Renewable Energy Systems shall not be modeled.~~

~~**C409.6.1.10 HVAC equipment.** HVAC systems shall meet the requirements of Section C403 Mechanical Systems.~~

~~**C409.6.1.10.1 Supported HVAC systems.** At a minimum, the HVAC systems shown in Table CD105.2.10.1 shall be supported by the simulation program.~~

~~**TABLE C409.6.1.10.1 PROPOSED BUILDING HVAC SYSTEMS SUPPORTED BY HVAC TSPR SIMULATION SOFTWARE**~~

~~System No.~~	~~System Name~~
~~1~~	~~Packaged Terminal Air Conditioner (with electric or hydronic heat)~~
~~2~~	~~Packaged Terminal Air Heat Pump~~
~~3~~	~~Packaged Single Zone Gas Furnace[a] and/or air-cooled Air Conditioner (includes split systems[b])~~
~~4~~	~~Packaged Single Zone Heat Pump (air to air only)(includes split systems[b] and electric or gas supplemental heat)~~
~~5~~	~~Variable Refrigerant Flow (air cooled only)~~
~~6~~	~~Variable Refrigerant Flow (air cooled only)~~
~~7~~	~~Water Source Heat Pump (Water Loop), water-source *Variable Refrigerant Flow System*, or water-source air conditioner~~
~~8~~	~~Ground Source Heat Pump~~
~~9~~	~~Packaged Variable Air Volume (DX cooling)[a]~~
~~10~~	~~Variable Air Volume (hydronic cooling)[a]~~
~~11~~	~~Variable Air Volume with Fan Powered Terminal Units~~
~~12~~	~~Dedicated Outdoor Air System (in conjunction with systems 1-8)~~

a. ~~Reheat or primary heat may be electric, hydronic, or gas furnace~~

b. ~~Condensing units with DX air handlers are modeled as package furnace with air conditioners or heat pumps~~

~~**C409.6.1.10.2 Proposed building HVAC system simulation.** The HVAC systems shall be modeled as in the proposed design at design conditions unless otherwise stated with clarifications and simplifications as described in Tables C409.6.1.10.2(1) and C409.6.1.10.2(2). System parameters not described in the following sections shall be simulated to meet the minimum requirements of Section C403. All zones within a block shall be served by the same HVAC system type as described in Section C409.6.1.1.1 item 2. Heat loss from ducts and pipes shall not be modeled. Table C409.6.1.10.2(1) Proposed Building System Parameters are based on input of full-load equipment efficiencies with adjustment using part-load curves integrated in the simulation program. Where other approaches to part-load adjustment are used, it is permitted for specific input parameter to vary. The simulation program shall model part-load HVAC equipment performance using either:~~

1. ~~Full-load efficiency adjusted for fan power input that is modeled separately and typical part-load performance adjustments for the proposed equipment.~~
2. ~~Part-load adjustments based on input of both full-load and part-load metrics, or~~
3. ~~Equipment-specific adjustments based on performance data provided by the equipment manufacturer for the proposed equipment.~~

~~Where multiple system components serve a block, average values weighed by the appropriate metric as described in this section shall be used.~~

1. ~~Where multiple fan systems serve a single block, fan power shall be based on weighted average using the design supply air cfm~~
2. ~~Where multiple cooling systems serve a single block, COP shall be based on a weighted average using cooling capacity. DX coils shall be entered as multi-stage if more than 50 percent of coil capacity serving the block is multi-stage with staged controls.~~
3. ~~Where multiple heating systems serve a single block, thermal efficiency or heating COP shall be based on a weighted average using heating capacity.~~
4. ~~Where multiple boilers or chillers serve a heating water or chilled water loop, efficiency shall be based on a weighted average for using heating or cooling capacity.~~
5. ~~When multiple cooling towers serving a condenser water loop are combined, the cooling tower efficiency, cooling tower design approach and design range are based on a weighted average of the design water flow rate through each cooling tower.~~
6. ~~Where multiple pumps serve a heating water, chilled water or condenser water loop, pump power shall be based on a weighted average for using design water flow rate.~~
7. ~~When multiple system types with and without economizers are combined, the economizer maximum outside air fraction of the combined system shall be based on weighted average of 100 percent supply air for systems with economizers and design outdoor air for systems without economizers.~~
8. ~~Multiple systems with and without ERVs cannot be combined.~~
9. ~~Systems with and without supply air temperature reset cannot be combined.~~
10. ~~Systems with different fan control (constant volume, multi-speed or VAV) for supply fans cannot be combined.~~

~~TABLE C409.6.1.10.2(1) PROPOSED BUILDING SYSTEM PARAMETERS~~

~~Category~~	~~Parameter~~	~~Fixed or User Defined~~	~~Required~~	Applicable Systems
~~HVAC System Type~~	~~System Type~~	~~User Defined~~	~~Selected from Table C409.6.1.10.1~~	All
~~System Sizing~~	~~Design Day Information~~	~~Fixed~~	~~99.6% heating design and 1% dry-bulb and 1% wet-bulb cooling design~~	All
	~~Zone Coil Capacity~~	~~Fixed~~	~~Sizing factors used are 1.25 for heating equipment and 1.15 for cooling equipment~~	All
	~~Supply Airflow~~	~~Fixed~~	~~Based on a supply-air-to-room-air temperature set-point difference of 20°F(11.11°C) or~~	1-11
		~~Fixed~~	~~Equal to required outdoor air ventilation~~	12
~~Outdoor Ventilation Air~~	~~Portion of supply air with proposed Filter ≥MERV 13~~	~~User defined~~	~~Percentage of supply air flow subject to higher filtration (Adjusts baseline Fan Power higher. Prorated)~~	All
	~~Outdoor Ventilation Air Flow Rate~~	~~Fixed~~	~~As specified in ASHRAE Standard 90.1 Normative Appendix C, adjusted for proposed DCV control~~	All
	~~Outdoor Ventilation Supply Air Flow Rate Adjustments~~	~~Fixed~~	~~Based on ASHRAE Standard 62.1 Section 6.2.4.3 System Ventilation Efficiency (Evs) is 0.75~~	9-11
		~~Fixed~~	~~System Ventilation Efficiency (Evs) is 1.0~~	1-8, 12
		~~Fixed~~	~~Basis is 1.0 Zone Air Distribution Effectiveness~~	All
~~System Operation~~	~~Space temperature set points~~	~~Fixed~~	~~As specified in ASHRAE Standard 90.1 Normative Appendix C, except -multifamily which shall use 68°F(20°C) heating and 76°F(24.4°C) cooling setpoints. -hotel/motel that shall be 70°F(21.1°C) heating and 72°F(22.2°C) cooling~~	1-11
	~~Fan Operation – Occupied~~	~~User defined~~	~~Runs continuously during occupied hours or cycles to meet load. Multispeed fans reduce airflow related to thermal loads.~~	1-11
	~~Fan Operation – Occupied~~	~~Fixed~~	~~Fan runs continuously during occupied hours~~	12
	~~Fan Operation – Night Cycle~~	~~Fixed~~	~~Fan cycles on to meet setback temperatures~~	1-11
~~Packaged Equipment Efficiency~~	~~DX Cooling Efficiency~~	~~User defined~~	~~Cooling COP without fan energy calculated in accordance with Section C409.6.1.10.2~~	1, 2, 3, 4, 5,7, 8, 9, 11,12
	~~DX Coil Number of Stages~~	~~User defined~~	~~Single Stage or Multistage~~	3, 4, 9, 10, 11, 12
	~~Heat Pump Efficiency~~	~~User defined~~	~~Heating COP without fan energy calculated in accordance with Section C409.6.1.10.2~~	2, 4, 5, 7, 8, 12
	~~Furnace Efficiency~~	~~User defined~~	~~Furnace thermal efficiency~~	3, 9, 11, 12
~~Heat Pump Supplemental Heat~~	~~Heat Source~~	~~User defined~~	~~Electric resistance or gas furnace~~	2, 4, 7, 8, 12
	~~Control~~	~~Fixed~~	~~Supplemental electric heat locked out above 40°F(4°C) OAT. Runs as needed in conjunction with compressor between 40°F(4°C) and 0°F(-17.8°C). Gas heat operates in place of the heat pump when the heat pump cannot meet load.~~	2, 4, 7, 8, 12
~~System Fan Power and Controls~~	~~Part-load Fan Controls -Constant Volume -Two Speed or three speed -VAV~~	~~User defined~~	~~Static pressure reset included for VAV.~~	1-8 (CAV, two or three speed), 9, 10, 11 (VAV), 12 (CAV and VAV)
	~~Design Fan Power (W/cfm)~~	~~User defined~~	~~Input electric power for all fans required to operate at fan system design conditions divided by the supply airflow rate This is a "wire to air" value including all drive, motor efficiency and other losses.~~	All

	~~Low-speed and medium speed fan power~~	~~User defined~~	~~Low speed input electric power for all fans required to operate at low-speed conditions divided by the low speed supply airflow rate. This is a "wire to air" value including all drive, motor efficiency and other losses. Also provide medium speed values for three-speed fans.~~	1-8
~~Variable Air Volume Systems~~	~~Supply Air Temperature (SAT) Controls~~	~~User defined~~	~~If not SAT reset then constant at 55°F(12.8°C).Options for reset based on outside air temperature (OAT) or warmest zone.~~ ~~If warmest zone, then the user can specify the minimum and maximum temperatures.~~ ~~If OAT reset, SAT is reset higher to 60°F(15.6°C) at outdoor low of 50°F(10°C). SAT is 55°F(12.8°C) at outdoor high of 70°F(21.1°C).~~	9, 10, 11
	~~Minimum Terminal Unit airflow percentage~~	~~User defined~~	~~Average minimum terminal unit airflow percentage for block weighted by cfm or minimum required for outdoor air ventilation, whichever is higher.~~	9, 10, 11
	~~Terminal Unit Heating Source~~	~~User defined~~	~~Electric or hydronic~~	9, 10, 11
	~~Dual set point minimum VAV damper position~~	~~User defined~~	~~Heating maximum airflow fraction~~	9, 10
	~~Fan Powered Terminal Unit (FPTU) Type~~	~~User defined~~	~~Series or parallel FPTU~~	11
	~~Parallel FPTU Fan~~	~~Fixed~~	~~Sized for 50% peak primary air at 0.35 W/cfm~~	11
	~~Series FPTU Fan~~	~~Fixed~~	~~Sized for 50% peak primary air at 0.35 W/cfm~~	11
~~Economizer~~	~~Economizer Presence~~	~~User defined~~	~~Yes or No~~	3, 4, 5, 6, 9, 10, 11
	~~Economizer Control Type~~	~~Fixed~~	~~Lockout on Differential dry-bulb temperature (OAT>RAT) in 6A, 5A, All B & C climate zones; fixed enthalpy>28 Btu/lb (47kJ/kg) or fixed dry-bulb OAT>75°F(24°C) in 0A to 4A climate zones~~	3, 4, 5, 6, 9, 10, 11
~~Energy Recovery~~	~~Sensible Effectiveness~~	~~User defined~~	~~Heat exchanger sensible effectiveness at design heating and cooling conditions~~	3, 4, 9, 10, 11, 12
	~~Latent Effectiveness~~	~~User defined~~	~~Heat exchanger latent effectiveness at design heating and cooling conditions~~	3, 4, 9, 10, 11, 12
	~~Economizer Bypass~~	~~User defined~~	~~If ERV is bypassed or wheel rotation is slowed during economizer conditions (Yes/No)~~	3, 4, 9, 10, 11, 12
	~~Economizer Bypass active~~	~~Fixed~~	~~If there is a bypass, it will be active between 45°F(7.2°C) and 75°F(23.9°C) outside air temperature.~~	3, 4, 9, 10, 11, 12
	~~Bypass SAT Setpoint~~	~~User defined~~	~~If bypass, target supply air temperature~~	3, 4, 9, 10, 11, 12
	~~Fan Power Reduction during Bypass (W/cfm)~~	~~User defined~~	~~If ERV system include bypass, static pressure set point and variable speed fan, fan power can be reduced during economizer conditions~~	3, 4, 9, 10, 11, 12
~~Demand Controlled Ventilation~~	~~DCV Application on/off~~	~~User defined~~	~~Percent of block floor area under occupied standby controls, ON/OFF only with occupancy sensor and no variable control~~	3, 4, 9, 10, 11, 12
	~~DCV Application CO2~~	~~User defined~~	~~Percentage of block floor area under variable DCV control (CO2); may include both variable and ON/OFF control~~	3, 4, 9, 10, 11, 12
~~DOAS~~	~~DOAS Fan Power W/cfm~~	~~User defined~~	~~Fan electrical input power in W/cfm of supply airflow~~	12
	~~DOAS Supplemental Heating and Cooling~~	~~User defined~~	~~Heating source, cooling source, energy recovery and respective efficiencies~~	12
	~~Maximum SAT Set point (Cooling)~~	~~User defined~~	~~SAT set point if DOAS includes supplemental cooling~~	12

	~~Minimum SAT Set point (Heating)~~	~~User defined~~	~~SAT set point if DOAS includes supplemental heating~~	12
~~Heating plant~~	~~Boiler Efficiency~~	~~User defined~~	~~Boiler thermal efficiency~~	1, 6, 7, 9, 10, 11, 12
	~~Heating Water Loop Configuration~~	~~User defined~~	~~Constant flow primary only; Variable flow primary only; Constant flow primary – variable flow secondary, Variable flow primary and secondary~~	1, 6, 7, 9, 10, 11, 12
	~~Heating Water Primary Pump Power (W/gpm)~~	~~User defined~~	~~Heating water primary pump input W/gpm heating water flow~~	1, 6, 7, 9, 10, 11, 12
	~~Heating Water Secondary Pump Power (W/gpm)~~	~~User defined~~	~~Heating water secondary pump input W/gpm heating water flow (if primary/secondary)~~	1, 6, 7, 9, 10, 11, 12
	~~Heating Water Loop Temperature~~	~~User defined~~	~~Heating water supply and return temperatures, °F(°C)~~	1, 6, 9, 10,11
	~~Heating Water Loop Supply Temperature Reset~~	~~Fixed~~	~~Reset HWS by 27.3% of design delta-T (HWS-70°F(21.1°C) Space Heating temperature set point) between 20°F(-6.7°C) and 50°F(10°C) OAT~~	1, 6, 7, 9, 10, 11, 12
	~~Boiler type~~	~~Fixed~~	~~Non-condensing boiler where input thermal efficiency is less than 86%; Condensing boiler otherwise~~	1, 6, 7, 9, 10, 11, 12
~~Chilled Water Plant~~	~~Chiller Compressor Type~~	~~User defined~~	~~Screw/Scroll, Centrifugal or Reciprocating~~	6, 10, 11, 12
	~~Chiller Condenser Type~~	~~User defined~~	~~Air cooled or water cooled~~	6, 10, 11, 12
	~~Chiller Full Load Efficiency~~	~~User defined~~	~~Chiller COP~~	6, 10, 11, 12
	~~Chilled Water Loop Configuration~~	~~User defined~~	~~Variable flow primary only, constant flow primary – variable flow secondary, variable flow primary and secondary~~	6, 10, 11,12
	~~Chilled Water Primary Pump Power (W/gpm)~~	~~User defined~~	~~Primary pump input W/gpm chilled water flow~~	6, 10, 11,12
	~~Chilled Water Secondary Pump Power (W/gpm)~~	~~User defined~~	~~Secondary Pump input W/gpm chilled water flow (if primary/secondary)~~	6, 10, 11,12
	~~Chilled Water Temperature Reset Included~~	~~User defined~~	~~Yes/No~~	6, 10, 11,12
~~Chilled Water Plant (cont.)~~	~~Chilled Water Temperature Reset Schedule (if included)~~	~~Fixed~~	~~Outdoor air reset: CHW supply temperature of 44°F(6.7°C) at 80°F(26.7°C) outdoor air dry bulb and above, CHW supply temperature of 54°F(12.2°C) at 60°F(15.6°C) outdoor air dry bulb temperature and below, ramped linearly between~~	6, 10, 11,12
	~~Condenser Water Pump Power (W/gpm)~~	~~User defined~~	~~Pump input W/gpm condenser water flow~~	6, 7, 8, ,10, 11, 12
	~~Condenser Water Pump Control~~	~~User defined~~	~~Constant speed or variable speed~~	6, 7, 8, 10, 11,12
	~~Heat Rejection Equipment Efficiency~~	~~User defined~~	~~gpm/hp tower fan~~	6, 7, 10, 11, 12
	~~Heat Rejection Fan Control~~	~~User defined~~	~~Constant or variable speed~~	6, 7, 10, 11, 12
	~~Heat Rejection Approach and Range~~	~~User defined~~	~~Design cooling tower approach and range temperature~~	6, 7, 10, 11, 12

~~Heat Pump Loop~~	~~Loop flow and Heat Pump Control Valve~~	~~Fixed~~	~~Two position Valve with VFD on Pump. Loop flow at 3 gpm/ton~~	7, 8
	~~Heat Pump Loop minimum and maximum temperature control~~	~~User defined~~	~~User input: restrict to minimum 20°F(11.1°C) and maximum 40°F(22.2°C) temperature difference~~	7
~~GLHP Well Field~~	~~-~~	~~Fixed~~	~~Bore depth = 250 ft(76 m)~~ ~~Bore length 200 ft/ton (1.5 m/kW) for the greater of cooling or heating load~~ ~~Bore spacing = 15 ft(4.6 m) Bore diameter = 5 in (127 mm)~~ ~~¾" (19 mm)Polyethylene pipe~~ ~~Ground and grout conductivity =~~ ~~4.8 Btu-in/h-ft2-°F (0.69 W/(mK))~~	8

a. ~~Part load fan power and pump power modified in accordance with Table C409.6.1.10.2(2)~~

~~TABLE C409.6.1.10.2(2)~~ FAN AND PUMP POWER CURVE COEFFICIENTS

~~Equation Term~~	~~Fan Power Coefficients~~	~~Pump Power Coefficients~~	
~~VSD + SP reset~~	~~Ride Pump Curve~~	~~VSD + DP/valve reset~~	
~~b~~	~~0.0408~~	~~0~~	~~0~~
~~x~~	~~0.088~~	~~3.2485~~	~~0.0205~~
~~x^2~~	~~-0.0729~~	~~-4.7443~~	~~0.4101~~
~~x^3~~	~~0.9437~~	~~2.5295~~	~~0.5753~~

~~**C409.6.1.10.3 Demand Control Ventilation.** Demand Controlled Ventilation (DCV) shall be modeled using a simplified approach that adjusts the design outdoor supply air flow rate based on the floor area of the building that is covered by DCV. The simplified method shall accommodate both variable DCV and on/off DCV, giving on/off DCV on third the effective floor control area of variable DCV. Outdoor air reduction coefficients shall be as stated in Table C409.6.1.10.3.~~

Exception: On/off DCV shall receive full effective area adjustment for R-1 and R-2 occupancies.

~~TABLE C409.6.1.10.3~~ DCV OUTDOOR AIR REDUCTION CURVE COEFFICIENTS

~~Equation term~~	~~DCV OSA reduction (y) as a function of effective DCV control floor area (x)~~			
~~Office~~	~~School~~	~~Hotel; Motel; Multi-Family; Dormitory~~	~~Retail~~	
~~b~~	~~0~~	~~0~~	~~0~~	~~0~~
~~x~~	~~0.4053~~	~~0.2676~~	~~0.5882~~	~~0.4623~~
~~x^2~~	~~-0.8489~~	~~0.7753~~	~~-1.0712~~	~~-0.848~~
~~x^3~~	~~1.0092~~	~~-1.5165~~	~~1.3565~~	~~1.1925~~
~~x^4~~	~~-0.4168~~	~~0.7136~~	~~-0.6379~~	~~-0.5895~~

~~**C409.6.2 Simulation of the standard reference design.** The *standard reference design* shall be configured and analyzed as specified in this section.~~

~~**C409.6.2.1 Utility Rates.** Same as proposed design.~~

~~**C409.6.2.2 Blocks.** Same as proposed design.~~

~~**C409.6.2.3 Thermal zoning.** Same as proposed design.~~

~~**C409.6.2.4 Occupancy type, schedule, density, and heat gain.** Same as proposed design.~~

~~**C409.6.2.5 Envelope components.** Same as proposed design~~

~~**C409.6.2.6 Lighting.** Same as proposed design.~~

~~**C409.6.2.7 Miscellaneous equipment.** Same as proposed design.~~

~~**C409.6.2.8 Elevators.** Not modeled. Same as proposed design.~~

~~**C409.6.2.9 Service water heating equipment.** Not modeled. Same as proposed design.~~

~~**C409.6.2.10 On-site renewable energy systems.** Not modeled. Same as proposed design.~~

~~**C409.6.2.11 HVAC equipment.** The reference building design HVAC equipment consists of separate space conditioning systems as described in Table C409.6.2.11(1) through Table C409.6.2.11(3) for the appropriate building use types. In these tables, 'Warm' refers to climate zones 0 to 2 and 3A and 'Gold' refers to climate zones 3B, 3C, and 4 to 8.~~

~~TABLE C409.6.2.11(1) REFERENCE BUILDING DESIGN HVAC COMPLEX SYSTEMS~~

~~Building Type Parameter~~	~~Large Office (warm)~~	~~Large Office (cold)~~	~~School (warm)~~	~~School (cold)~~
~~System Type~~	~~VAV/ RH~~ ~~Water-cooled Chiller/~~ ~~Electric Reheat (PIU)~~	~~VAV/ RH~~ ~~Water-cooled Chiller/~~ ~~Gas Boiler~~	~~VAV/ RH~~ ~~Water-cooled Chiller/~~ ~~Electric Reheat (PIU)~~	~~VAV/ RH~~ ~~Water-cooled Chiller/~~ ~~Gas Boiler~~
~~Fan control~~	~~VSD (No SP Reset)~~	~~VSD (No SP Reset)~~	~~VSD (No SP Reset)~~	~~VSD (No SP Reset)~~
~~Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13~~	~~1.165 (2.468)~~	~~1.165 (2.468)~~	~~1.165 (2.468)~~	~~1.165 (2.468)~~
~~Main fan power (W/CFM (W·s/L) proposed < MERV13~~	~~1.066 (2.259)~~	~~1.066 (2.259)~~	~~1.066 (2.259)~~	~~1.066 (2.259)~~
~~Zonal fan power (W/CFM (W·s/L))~~	~~0.35 (0.75)~~	~~NA~~	~~0.35 (0.75)~~	~~NA~~
~~Minimum zone airflow fraction~~	~~1.5* Voz~~	~~1.5* Voz~~	~~1.2* Voz~~	~~1.2* Voz~~
~~Heat/cool sizing factor~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~
~~Outdoor air economizer~~	~~No~~	~~Yes except 4A~~	~~No~~	~~Yes except 4A~~
~~Occupied OSA (= proposed)~~	~~Sum(Voz)/0.75~~	~~Sum(Voz)/0.75~~	~~Sum(Voz)/0.65~~	~~Sum(Voz)/0.65~~
~~Energy recovery ventilator efficiency ERR~~ ~~(Enthalpy Recovery Ratio)~~ ~~ERV bypass SAT set point~~	~~NA~~	~~NA~~	~~50%~~ ~~No Bypass~~	~~50%~~ ~~60°F(15.6 °C)except 4A~~
~~DCV~~	~~No~~	~~No~~	~~No~~	~~No~~
~~Cooling Source~~	~~(2) Water-cooled Centrifugal Chillers~~	~~(2) Water-cooled Centrifugal Chillers~~	~~(2) Water- Cooled Screw Chillers~~	~~(2) Water- Cooled Screw Chillers~~
~~Cooling COP (net of fan)~~	~~Path B for profile~~	~~Path B for profile~~	~~Path B for profile~~	~~Path B for profile~~
~~Heating source (reheat)~~	~~Electric resistance~~	~~Gas Boiler~~	~~Electric resistance~~	~~Gas Boiler~~
~~Furnace or boiler efficiency~~	~~1.0~~	~~75% Et~~	~~1.0~~	~~80% Et~~
~~Condenser heat rejection~~	~~Axial Fan Open Circuit Cooling Tower~~			
~~Cooling tower efficiency (gpm/fan-hp (L/s-fan-kW))~~	~~38.2 (3.23)~~	~~38.2 (3.23)~~	~~38.2 (3.23)~~	~~38.2 (3.23)~~
~~Tower turndown (> 300 ton (1060 kW))~~	~~50%~~	~~50%~~	~~50%~~	~~50%~~
~~Pump (constant flow/variable flow)~~	~~Constant Flow; 10°F (5.6°C) range~~	~~Constant Flow; 10°F (5.6°C) range~~	~~Constant Flow; 10°F (5.6°C) range~~	~~Constant Flow; 10°F (5.6°C) range~~
~~Tower approach~~	~~25.72 – (0.24 x WB), where WB WB is the 0.4% evaporation design wet-bulb temperature (°F)~~			
~~Cooling condenser pump power (W/gpm (W·s/L))~~	~~19 (300)~~	~~19 (300)~~	~~19 (300)~~	~~19 (300)~~
~~Cooling primary pump power (W/gpm (W·s/L))~~	~~9 (142)~~	~~9 (142)~~	~~9 (142)~~	~~9 (142)~~
~~Cooling secondary pump power (W/gpm (W·s/L))~~	~~13 (205)~~	~~13 (205)~~	~~13 (205)~~	~~13 (205)~~
~~Cooling coil chilled water delta-T, °F (°C)~~	~~12 (6.7)~~	~~12 (6.7)~~	~~12 (6.7)~~	~~12 (6.7)~~
~~Design chilled water supply temperature, °F (°C)~~	~~44 (6.7)~~	~~44 (6.7)~~	~~44 (6.7)~~	~~44 (6.7)~~
~~Chilled water supply temperature (CHWST)~~ ~~reset set point vs Outside Air Temperature OAT, °F (°C)~~	~~CHWST:~~ ~~44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)~~	~~CHWST:~~ ~~44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)~~	~~CHWST:~~ ~~44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)~~	~~CHWST:~~ ~~44-54/OAT 80-60 (6.7-12.2/ 26.7-15.6)~~
~~Building Type Parameter~~	~~Large Office (warm)~~	~~Large Office (cold)~~	~~School (warm)~~	~~School (cold)~~
~~CHW cooling loop pumping control~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~
~~Heating pump power (W/gpm~~	~~16.1 (254)~~	~~16.1 (254)~~	~~16.1 (254)~~	~~16.1 (254)~~

~~(W·s/L))~~	[illegible]	[illegible]	[illegible]	[illegible]
~~Heating oil HW dT. °F (°C)~~	~~50 (10)~~	~~50 (10)~~	~~50 (10)~~	~~50 (10)~~
~~Design Hot Water Supply Temperature (HWST). °F (°C)~~	~~180 (82.2)~~	~~180 (82.2)~~	~~180 (82.2)~~	~~180 (82.2)~~
~~HWST reset set point vs OAT, °F (°C)~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~
~~Heat loop pumping control~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~

~~TABLE C409.6.2.11(2) TSPR REFERENCE BUILDING DESIGN HVAC SIMPLE SYSTEMS~~

~~Building Type Parameter~~	~~Building Type~~					
	~~Medium Office (warm)~~	~~Medium Office (cold)~~	~~Small Office (warm)~~	~~Small Office (cold)~~	~~Retail (warm)~~	~~Retail (cold)~~
~~System type~~	~~Package VAV - Electric Reheat~~	~~Package VAV - Hydronic Reheat~~	~~PSZ-HP~~	~~PSZ-AC~~	~~PSZ-HP~~	~~PSZ-AC~~
~~Fan Control~~	~~VSD (No SP Reset)~~	~~VSD (No SP Reset)~~	~~Constant Volume~~	~~Constant Volume~~	~~Constant Volume~~	~~Constant Volume~~
~~Main fan power (W/CFM (W·s/L)) proposed ≥ MERV13~~	~~1.285 (2.723)~~	~~1.285 (2.723)~~	~~0.916 (1.941)~~	~~0.916 (1.941)~~	~~0.899 (1.905)~~	~~0.899 (1.905)~~
~~Main fan power (W/CFM (W·s/L)) proposed < MERV13~~	~~1.176 (2.492)~~	~~1.176 (2.492)~~	~~0.850 (1.808)~~	~~0.850 (1.808)~~	~~0.835 (1.801)~~	~~0.835 (1.801)~~
~~Zonal fan power (W/CFM (W·s/L))~~	~~0.35 (0.75)~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Minimum zone airflow fraction~~	~~30%~~	~~30%~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Heat/cool sizing factor~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~
~~Supplemental heating availability~~	~~NA~~	~~NA~~	~~<40°F (<4.4°C) OAT~~	~~NA~~	~~<40°F (<4.4°C) OAT~~	~~NA~~
~~Outdoor air economizer~~	~~No~~	~~Yes except 4A~~	~~No~~	~~Yes except 4A~~	~~No~~	~~Yes except 4A~~
~~Occupied OSA source~~	~~Packaged unit, occupied damper, all building use types~~					
~~Energy recovery ventilator~~	~~No~~	~~No~~	~~No~~	~~No~~	~~No~~	~~No~~
~~DCV~~	~~No~~	~~No~~	~~No~~	~~No~~	~~No~~	~~No~~
~~Cooling source~~	~~DX, multi-stage~~	~~DX, multi-stage~~	~~DX, 1 stage (heat pump)~~	~~DX, single stage~~	~~DX, 1 stage (heat pump)~~	~~DX, single stage~~
~~Cooling COP (net of fan)~~	~~3.40~~	~~3.40~~	~~3.00~~	~~3.00~~	~~3.40~~	~~3.50~~
~~Heating source~~	~~Electric resistance~~	~~Gas Boiler~~	~~Heat Pump~~	~~Furnace~~	~~Heat Pump~~	~~Furnace~~
~~Heating COP (net of fan) / furnace or boiler efficiency~~	~~1.0~~	~~75% Et~~	~~3.40~~	~~80% Et~~	~~3.40~~	~~80% Et~~

~~TABLE C409.6.2.11(3)~~ TSPR REFERENCE BUILDING DESIGN HVAC SIMPLE SYSTEMS

~~**C409.7 Target Design HVAC Systems.** Target system descriptions described in Tables C409.7(1) through C409.7(3) are provided as reference for Section C403.1.1 Exception 10. The target systems are used for developing MPF values and do not need to be programmed into TSPR software.~~

~~TABLE C409.7(1) TARGET BUILDING DESIGN CRITERIA HVAC COMPLEX SYSTEMS~~

~~Parameter~~	~~Building Type~~			
	~~Large office (warm)~~	~~Large office (cold)~~	~~School (warm)~~	School (cold)
~~System type~~	~~VAV/RH~~	~~VAV/RH~~	~~VAV/RH~~	VAV/RH
	~~Water-cooled chiller/~~	~~Water-cooled chiller/~~	~~Water-cooled chiller/~~	Water-cooled chiller/
	~~Electric Reheat (PIU)~~	~~Gas boiler~~	~~Electric Reheat (PIU)~~	Gas boiler
~~Fan Control~~	~~VSD (No SP Reset)~~	~~VSD (No SP Reset)~~	~~VSD (No SP Reset)~~	VSD (No SP Reset)
~~Main fan power (W/CFM (W·s/L) Proposed ≥ MERV13~~	~~1.127 (2.388)~~	~~1.127 (2.388)~~	~~1.127 (2.388)~~	1.127 (2.388)
~~Zonal fan power (W/CFM (W·s/L))~~	~~0.35 (0.75)~~	~~NA~~	~~0.35 (0.75)~~	NA
~~Minimum zone airflow fraction~~	~~1.5* Voz~~	~~1.5* Voz~~	~~1.2* Voz~~	1.2* Voz
~~Heat/cool sizing factor~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	1.25/1.15
~~Outdoor air economizer~~	~~Yes except 0-1~~	~~Yes~~	~~Yes except 0-1~~	Yes
~~Occupied OSA (= proposed)~~	~~Sum(Voz)/0.75~~	~~Sum(Voz)/0.75~~	~~Sum(Voz)/0.65~~	Sum(Voz)/0.65
~~Energy recovery ventilator efficiency ERR~~	~~NA~~	~~NA~~	~~50%~~	50%
~~(Enthalpy Recovery Ratio)~~			~~No bypass~~	60°F(15.6°C) except 4A
~~ERV bypass SAT set point~~			~~-~~	-
~~DCV~~	~~Yes~~	~~Yes~~	~~Yes~~	Yes
~~% Area Variable Control~~	~~15%~~	~~15%~~	~~70%~~	70%
~~% Area On/Off Control~~	~~65%~~	~~65%~~	~~20%~~	20%
~~Cooling Source~~	~~(2) Water-cooled centrif chillers~~	~~(2) Water-cooled centrif chillers~~	~~(2) Water-cooled screw chillers~~	(2) Water-cooled screw chillers
~~Cooling COP (net of fan)~~	~~ASHRAE 90.1 Appendix G, Table G3.5.3~~	~~ASHRAE 90.1 Appendix G, Table G3.5.3~~	~~ASHRAE 90.1 Appendix G, Table G3.5.3~~	ASHRAE 90.1 Appendix G, Table G3.5.3
~~Heating source (reheat)~~	~~Electric resistance~~	~~Gas boiler~~	~~Electric resistance~~	Gas boiler
~~Furnace or boiler efficiency~~	~~1.0~~	~~90% Et~~	~~1.0~~	90% Et
~~Condenser heat rejection~~	~~Cooling Tower~~	~~Cooling Tower~~	~~Cooling Tower~~	Cooling Tower
~~Cooling tower efficiency (gpm/hp (L/s·kW)) — See G3.1.3.11~~	~~40.2 (3.40)~~	~~40.2 (3.40)~~	~~40.2 (3.40)~~	40.2 (3.40)
~~Tower turndown (> 300 ton (1060 kW))~~	~~50%~~	~~50%~~	~~50%~~	50%
~~Pump (constant flow/variable flow)~~	~~Constant Flow; 10°F (5.6°C) range~~	~~Constant Flow; 10°F (5.6°C) range~~	~~Constant Flow; 10°F (5.6°C) range~~	Constant Flow; 10°F (5.6°C) range
~~Tower approach~~	~~ASHRAE 90.1 Appendix G, Table G3.1.3.11~~	~~ASHRAE 90.1 Appendix G, Table G3.1.3.11~~	~~ASHRAE 90.1 Appendix G, Table G3.1.3.11~~	ASHRAE 90.1 Appendix G, Table G3.1.3.11
~~Cooling condenser pump power (W/gpm (W·s/L))~~	~~19 (300)~~	~~19 (300)~~	~~19 (300)~~	19 (300)
~~Cooling primary pump power (W/gpm (W·s/L))~~	~~9 (142)~~	~~9 (142)~~	~~9 (142)~~	9 (142)
~~Cooling secondary pump power (W/gpm (W·s/L))~~	~~13 (205)~~	~~13 (205)~~	~~13 (205)~~	13 (205)
~~Cooling coil chilled water delta-T, °F (°C)~~	~~18 (10)~~	~~18 (10)~~	~~18 (10)~~	18 (10)
~~Design chilled water supply temperature, °F (°C)~~	~~42 (5.56)~~	~~42 (5.56)~~	~~42 (5.56)~~	42 (5.56)
~~Chilled water supply temperature (CHWST)reset set point vs OAT, °F (°C)~~	~~CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)~~	~~CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)~~	~~CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)~~	CHWS 44-54/OAT 80-60 (6.7-12.2)/26.7-15.6)
~~CHW cooling loop pumping control~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	2-way Valves & pump VSD
~~Heating pump power (W/gpm (W·s/L))~~	~~16.1 (254)~~	~~16.1 (254)~~	~~19 (254)~~	19 (254)
~~Heating HW dT, °F (°C)~~	~~50 (27.78)~~	~~20 (11.11)~~	~~50 (27.78)~~	20 (11.11)

~~Design HWST. °F (°C)~~	~~180 (82)~~	~~140 (60)~~	~~180 (82)~~	140 (60)
~~Hot water supply temperature (HWST) range vs outside air temperature (OAT) range~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)
~~Heat loop pumping control~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	~~2-way Valves & pump VSD~~	2-way Valves & pump VSD

~~TABLE C409.7(2) TARGET BUILDING DESIGN CRITERIA HVAC SIMPLE SYSTEMS~~

~~Parameter~~	~~Building type~~					
	~~Medium office (warm)~~	~~Medium office (cold)~~	~~Small office (warm)~~	~~Small office (cold)~~	~~Retail (warm)~~	~~Retail (cold)~~
~~System type~~	~~Package VAV - Electric Reheat~~	~~Package VAV - Hydronic Reheat~~	~~PSZ-HP~~	~~PSZ-AC~~	~~PSZ-HP~~	~~PSZ-AC~~
~~Fan control~~	~~VSD (with SP Reset)~~	~~VSD (with SP Reset)~~	~~Constant volume~~	~~Constant volume~~	~~2-speed~~	~~2-speed~~
~~Main fan power (W/CFM (W·s/L))proposed ≥ MERV13~~	~~0.634 (1.343)~~	~~0.634 (1.343)~~	~~0.486 (1.03)~~	~~0.486 (1.03)~~	~~0.585 (1.245)~~	~~0.585 (1.245)~~
~~Zonal fan power (W/CFM (W·s/L))~~	~~0.35 (5.53)~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Minimum zone airflow fraction~~	~~1.5* Voz~~	~~1.5* Voz~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Heat/cool sizing factor~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~
~~Supplemental heating availability~~	~~NA~~	~~NA~~	~~<40°F (<4.4°C) OAT~~	~~NA~~	~~<40°F (<4.4°C) OAT~~	~~NA~~
~~Outdoor air economizer~~	~~Yes except 0-1~~	~~Yes~~	~~Yes except 0-1~~	~~Yes~~	~~Yes except 0-1~~	~~Yes~~
~~Occupied OSA source~~	~~Packaged unit, occupied damper, all building use types~~					
~~Energy recovery ventilator~~	~~No~~	~~No~~	~~No~~	~~No~~	~~Yes, in 0A, 1A, 2A, 3A~~	~~Yes all A, 6,7,8 CZ~~
~~ERR~~					~~50%~~	~~50%~~
~~DCV~~	~~Yes~~	~~Yes~~	~~No~~	~~No~~	~~Yes~~	~~Yes~~
~~% Area Variable Control~~	~~15%~~	~~15%~~			~~80%~~	~~80%~~
~~% Area On/Off Control~~	~~65%~~	~~65%~~			~~0%~~	~~0%~~
~~Cooling source~~	~~DX, multi-stage~~	~~DX, multi-stage~~	~~DX, 1 stage (heat pump)~~	~~DX, single stage~~	~~DX, 2 stage (heat pump)~~	~~DX, 2 stage~~
~~Cooling COP (net of fan)~~	~~3.83~~	~~3.83~~	~~3.82~~	~~3.8248~~	~~3.765~~	~~3.765~~
~~Heating source~~	~~Electric resistance~~	~~Gas boiler~~	~~Heat pump~~	~~Furnace~~	~~Heat pump~~	~~Furnace~~
~~Heating COP (net of fan) / furnace or boiler efficiency~~	~~100%~~	~~8 1% E_t~~	~~3.81~~	~~81% E_t~~	~~3.536~~	~~81% E_t~~
~~Heating coil HW dT. °F (°C)~~	~~NA~~	~~20 (11.11)~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Design HWST. °F (°C)~~	~~NA~~	~~140 (60)~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~HWST reset set point vs OAT, °F (°C)~~	~~NA~~	~~HWST: 180-150/OAT 20-50 (82-65.6/ -6.7-10)~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Heat loop pumping control~~	~~NA~~	~~2-way Valves & ride pump curve~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~
~~Heating pump power (W/gpm (W·s/L))~~	~~NA~~	~~16.1~~	~~NA~~	~~NA~~	~~NA~~	~~NA~~

Delete without substitution:

~~TABLE C409.7(3) TARGET BUILDING DESIGN CRITERIA HVAC SIMPLE SYSTEMS~~

~~Parameter~~	~~Building Type~~			
	~~Hotel (warm)~~	~~Hotel (cold)~~	~~Multifamily (warm)~~	~~Multifamily (cold)~~
~~System type~~	~~PTHP~~	~~PTAC with Hydronic Boiler~~	~~Split HP~~	~~Split AC~~
~~Fan control~~	~~Cycling~~	~~Cycling~~	~~Cycling~~	~~Cycling~~
~~Main fan power (W/CFM (W·s/L))~~	~~0.300 (0.638)~~	~~0.300 (0.638)~~	~~0.246 (0.523)~~	~~0.271 (0.576)~~
~~Heat/cool sizing factor~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~	~~1.25/1.15~~
~~Supplemental heating availability~~	~~<40°F (<4.4°C)~~	~~NA~~	~~<40°F (<4.4°C)~~	~~NA~~
~~Outdoor air economizer~~	~~Only CZ 2, 3~~	~~No~~	~~No~~	~~No~~
~~Occupied OSA source~~	~~DOAS~~	~~DOAS~~	~~DOAS~~	~~DOAS except 3C~~
~~Energy recovery ventilator~~	~~NA~~	~~NA~~	~~Yes~~	~~Yes except 3C~~
~~ERR~~	~~NA~~	~~NA~~	~~60%~~	~~60%~~
~~DCV~~	~~Yes~~	~~Yes~~		
~~% Area Variable Control~~	~~70%~~	~~70%~~	~~No~~	~~No~~
~~% Area Variable Control~~	~~0%~~	~~0%~~		
~~Cooling source~~	~~DX, 1stage (heat pump)~~	~~DX, 1 stage~~	~~DX, 1stage (heat pump)~~	~~DX, 1 stage~~
~~Cooling COP (net of fan)~~	~~3.83~~	~~3.83~~	~~3.823~~	~~3.6504~~
~~Heating source~~	~~Heat pump~~	~~(2) Hydronic boiler~~	~~Heat pump~~	~~Furnace~~
~~Heating COP (net of fan) / furnace or boiler efficiency~~	~~3.44~~	~~81%~~ $\cancel{E_t}$	~~3.86~~	~~80% AFUE~~
~~Heating pump power (W/gpm (W·s/L))~~	~~NA~~	~~16.1~~	~~NA~~	~~NA~~
~~Heating coil heating water delta-T, °F (°C)~~	~~NA~~	~~20 (11.11)~~	~~NA~~	~~NA~~
~~Design HWST, °F (°C)~~	~~NA~~	~~140 (60)~~	~~NA~~	~~NA~~
~~HWST reset set point vs OAT, °F (°C)~~	~~NA~~	~~HWST: 180-150/OAT 20-50 (82-65.6/-6.7-10)~~	~~NA~~	~~NA~~
~~Heat loop pumping control~~	~~NA~~	~~2-way Valves & ride pump curve~~	~~NA~~	~~NA~~

Reason:

- The TSPR scheme proposed by the comment is *ad hoc* and not supported by analysis. The cost of construction associated with the proposal is not supported by examples or analysis that justify the conclusion that the scheme would address the primary objectives of using a TSPR approach in a building performance scheme.
- No relationship of the TSPR scheme to prescriptive requirements is established by the proponent, likely developing inconsistencies in stringency across the IECC when prescriptive versus performance paths are considered.
- The role of the U. S. Department of Energy (DOE) as a proponent of this and associated code changes relating to TSPR exceeds DOE's legal authority granted under the Energy Policy and Conservation Act (EPCA) to support development of building codes. Historically and lawfully, DOE's role in supporting building costs and standards has involved executing its specified legal responsibility to analysis energy code stringency for national adoption, support of analysis of proposals of other proponents during code cycles, participation in IECC code hearings to provide technical viewpoints and information to inform debate of the proposals of others, and other supporting activities. The emergence of DOE as a formal proponent for IECC code changes over-reaches this historical role and lacks the support of the legislative role of DOE.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed deletion of Section 409, and the Section as proposed, will neither increase nor decrease the cost of construction since no evidence of construction cost impacts were provided by the proponent.

Workgroup Recommendation

CED1-179-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

APPENDIX ~~CE~~
~~REQUIRED HVAC TSPR~~

~~CE101~~
~~General~~

~~**CE101.1 Required HVAC TSPR.** For jurisdictions who wish to adopt a stretch code or HVAC incentive system, make the following changes to Section C403.~~

~~**CE101.2 (Replace Section C4031 with the following)General.** Mechanical systems and equipment serving the building heating, cooling, ventilating, or refrigerating needs shall comply with one of the following:~~

1. Sections C403.1.1 and C403.2 through C403.14 and also comply with Section C403.1.3
2. Data Centers shall comply with C403.1.1, C403.1.2 and C403.6 through C403.14

~~**CE101.3 (Replace Section C40313 with the following)HVAC total system performance ratio (HVAC TSPR).** For systems serving buildings or portions of buildings of the following types:~~

1. ~~Office (including medical office) (occupancy group B),~~
2. ~~Retail (occupancy group M), library (occupancy group A-3),~~
3. ~~Education (occupancy group E), and~~
4. ~~Hotel/motel occupancies (occupancy group R-1) and~~
5. ~~The dwelling units and common areas within occupancy group R-2 multifamily buildings,~~

~~The HVAC total system performance ratio(HVACTSPR)of the proposed design HVAC systems shall be greater than or equal to the HVAC TSPR of the standard reference design divided by the applicable mechanical performance factor (MPF) fromTableC409.4. HVAC TSPR shall be calculated in accordance with Section C409, Calculation of HVAC Total System Performance Ratio.~~

~~**Exceptions:**~~

1. ~~Buildings with conditioned floor area less than 5,000 square feet.~~
2. ~~Alterations to existing buildings that do not substantially replace the entire HVAC system and are not serving initial build-out construction~~
3. ~~HVAC systems using district heating water, chilled water or steam.~~

4. ~~Portions of buildings served by systems using:~~

   ~~4.1 Small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or~~

   ~~4.2 Double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431~~

   ~~4.3 Packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr (3500 kW)~~

   ~~4.4 A common heating source serving both HVAC and service water heating equipment~~

   ~~4.5 HVAC systems not included in Table C409.5.2.10.1~~

   ~~4.6 HVAC systems included in table C409.5.2.10.1 with parameters in Table C409.5.2.10.2, not identified as applicable to that HVAC system type.~~

   ~~4.7 Underfloor air distribution and displacement ventilation HVAC systems.~~

   ~~4.8 Space conditioning systems that do not include mechanical cooling.~~

   ~~4.9 HVAC systems that provide recovered heat for service water heating~~

   ~~4.10 HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air and water cooled chillers on the same chilled water loop.~~

   ~~4.11 HVAC system served by heating water plants that include air to water or water to water heat pumps.~~

   ~~4.12 HVAC systems meeting or exceeding all the requirements of the applicable Target Design HVAC System described in Tables C409.5.4(1) through C409.5.4(3) ,~~

   ~~4.13 HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, data centers, and computer rooms.~~

   ~~4.14 Buildings or areas of medical office buildings that comply fully with ASHRAE Standard 170, including but not limited to surgical centers, or that are required by other applicable codes or standards to provide 24/7 air-handling unit operation~~

   ~~4.15 HVAC systems serving laboratories with fume hoods~~

   ~~4.16 Locker rooms with more than 2 showers~~

   ~~4.17 Natatoriums and rooms with saunas~~

   ~~4.18 Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h~~

   ~~4.19 Cafeterias and dining rooms~~

   ~~4.20 Areas of buildings with commercial refrigeration equipment exceeding 100 kW of power input.~~

~~TABLE CE101.3 Replace Table C409.4 with the following, this provides a 5% reduction in HVAC energy:~~

~~Climate Zone~~	~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~	
~~Building type~~	~~Occupancy Group~~																			
~~Office (small and medium)[a]~~	~~B~~	~~0.68~~	~~0.68~~	~~0.67~~	~~0.67~~	~~0.65~~	~~0.62~~	~~0.67~~	~~0.65~~	~~0.61~~	~~0.76~~	~~0.67~~	~~0.74~~	~~0.80~~	~~0.73~~	~~0.76~~	~~0.82~~	~~0.79~~	~~0.83~~	~~0.85~~
~~Office (Large)[a]~~	~~B~~	~~0.79~~	~~0.79~~	~~0.80~~	~~0.80~~	~~0.75~~	~~0.78~~	~~0.68~~	~~0.77~~	~~0.73~~	~~0.64~~	~~0.72~~	~~0.60~~	~~0.67~~	~~0.68~~	~~0.60~~	~~0.69~~	~~0.67~~	~~0.67~~	~~0.67~~
~~Retail~~	~~M~~	~~0.57~~	~~0.54~~	~~0.48~~	~~0.52~~	~~0.44~~	~~0.44~~	~~0.41~~	~~0.48~~	~~0.38~~	~~0.43~~	~~0.54~~	~~0.65~~	~~0.44~~	~~0.65~~	~~0.64~~	~~0.48~~	~~0.43~~	~~0.42~~	~~0.36~~
~~Hotel/Motel~~	~~R-1~~	~~0.59~~	~~0.59~~	~~0.60~~	~~0.60~~	~~0.59~~	~~0.65~~	~~0.58~~	~~0.67~~	~~0.69~~	~~0.43~~	~~0.56~~	~~0.49~~	~~0.36~~	~~0.45~~	~~0.48~~	~~0.33~~	~~0.36~~	~~0.29~~	~~0.25~~
~~Multi-Family/ Dormitory~~	~~R-2~~	~~0.61~~	~~0.60~~	~~0.64~~	~~0.60~~	~~0.62~~	~~0.61~~	~~0.56~~	~~0.68~~	~~0.52~~	~~0.50~~	~~0.48~~	~~0.42~~	~~0.51~~	~~0.45~~	~~0.36~~	~~0.52~~	~~0.48~~	~~0.48~~	~~0.45~~
~~School/ Education and Libraries~~	~~E(A-3)~~	~~0.78~~	~~0.77~~	~~0.76~~	~~0.75~~	~~0.71~~	~~0.68~~	~~0.67~~	~~0.68~~	~~0.64~~	~~0.69~~	~~0.68~~	~~0.65~~	~~0.78~~	~~0.69~~	~~0.58~~	~~0.85~~	~~0.76~~	~~0.79~~	~~0.73~~

a. large office (gross conditioned floor area >150,000 ft^2 (14,000 m^2) or > 5 floors); all other offices are small or medium

Reason:

- The TSPR scheme proposed by the comment is *ad hoc* and not supported by analysis. The cost of construction associated with the proposal is not supported by examples or analysis that justify the conclusion that the scheme would address the primary objectives of using a TSPR approach in a building performance scheme.
- No relationship of the TSPR scheme to prescriptive requirements is established by the proponent, likely developing inconsistencies in stringency across the IECC when prescriptive versus performance paths are considered.
- The role of the U. S. Department of Energy (DOE) as a proponent of this and associated code changes relating to TSPR exceeds DOE's legal authority granted under the Energy Policy and Conservation Act (EPCA) to support development of building codes. Historically and lawfully, DOE's role in supporting building costs and standards has involved executing its specified legal responsibility to analysis energy code stringency for national adoption, support of analysis of proposals of other proponents during code cycles, participation in IECC code hearings to provide technical viewpoints and information to inform debate of the proposals of others, and other supporting activities. The emergence of DOE as a formal proponent for IECC code changes over-reaches this historical role and lacks the support of the legislative role of DOE.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal would not affect construction costs if the TSPR coverage is not added to the IECC. Consequently, the Appendix will not alter construction costs either.

Workgroup Recommendation

Proposal # 908

CED1-180-22

Proponents: Laura Petrillo-Groh, representing AHRI (lpetrillo-groh@ahrinet.org); Vladimir Kochkin, representing NAHB (vkochkin@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

APPENDIX ~~CF~~
~~ENERGY CREDITS~~

~~CF101~~
~~GENERAL~~

~~**CF101.1 Purpose.** This purpose of this Appendix is to supplement the *International Energy Conservation Code* and requires projects to comply with Advanced Energy Credit Package requirements.~~

~~**CF101.2 Scope.** This Appendix applies to all buildings, in accordance with Section C406.1, required to comply with, either Section C406.1.1 or Section C406.1.3.~~

~~**CF102.1 Advanced Energy Credit Package requirements.** The requirements of this Section supercede the requirements of Section C406.1.1. Projects shall comply with measures from C406.2 to achieve the minimum number of required efficiency credits from Table CD102.1 based on building occupancy group and climate zone. Projects with multiple occupancies, unconditioned parking garages,*alterations*, and *buildings* with separate shell-and-core and build-out construction permits shall comply as follows:~~
~~Where a project contains multiple occupancies, credits in Table CD102.1 from each building occupancy shall be weighted by the gross fl oor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406 and Appendix CD.~~

~~**Exceptions:**~~

1. ~~Unconditioned parking garages that achieve 50 percent of the credits required for use groups S-1 and S-2 in Table CD102.1.~~
2. ~~Portions of buildings devoted to manufacturing or industrial use.~~

~~TABLE CF102.1 Energy Credit Requirements by Building Occupancy Group~~

~~Building Occupancy Groups~~	~~Climate Zone~~																		
	~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R-2, R-4, and I-1~~	~~179~~	~~174~~	~~188~~	~~197~~	~~200~~	~~200~~	~~200~~	~~200~~	~~200~~	~~200~~	~~200~~	~~200~~	~~193~~	~~200~~	~~200~~	~~200~~	~~200~~	~~200~~	~~200~~
~~I-2~~	~~78~~	~~75~~	~~73~~	~~71~~	~~80~~	~~90~~	~~100~~	~~85~~	~~90~~	~~97~~	~~83~~	~~90~~	~~99~~	~~90~~	~~96~~	~~107~~	~~106~~	~~130~~	~~117~~
~~R-1~~	~~106~~	~~100~~	~~110~~	~~105~~	~~109~~	~~122~~	~~123~~	~~125~~	~~131~~	~~137~~	~~129~~	~~136~~	~~157~~	~~139~~	~~147~~	~~171~~	~~158~~	~~180~~	~~176~~
~~B~~	~~114~~	~~110~~	~~112~~	~~115~~	~~108~~	~~107~~	~~116~~	~~111~~	~~114~~	~~126~~	~~118~~	~~123~~	~~135~~	~~125~~	~~125~~	~~152~~	~~142~~	~~153~~	~~141~~
~~A-2~~	~~83~~	~~81~~	~~82~~	~~82~~	~~86~~	~~86~~	~~108~~	~~91~~	~~97~~	~~126~~	~~99~~	~~111~~	~~147~~	~~117~~	~~113~~	~~160~~	~~143~~	~~163~~	~~151~~
~~M~~	~~113~~	~~113~~	~~121~~	~~118~~	~~123~~	~~127~~	~~116~~	~~116~~	~~133~~	~~109~~	~~100~~	~~92~~	~~99~~	~~134~~	~~125~~	~~171~~	~~146~~	~~150~~	~~137~~
~~E~~	~~91~~	~~95~~	~~91~~	~~100~~	~~96~~	~~100~~	~~105~~	~~104~~	~~101~~	~~113~~	~~110~~	~~110~~	~~120~~	~~117~~	~~122~~	~~131~~	~~132~~	~~126~~	~~131~~
~~S-1 and S-2~~	~~108~~	~~106~~	~~111~~	~~109~~	~~109~~	~~108~~	~~89~~	~~106~~	~~108~~	~~134~~	~~100~~	~~130~~	~~200~~	~~143~~	~~123~~	~~200~~	~~190~~	~~189~~	~~148~~
~~All Other~~	~~54~~	~~53~~	~~55~~	~~56~~	~~57~~	~~60~~	~~61~~	~~60~~	~~63~~	~~68~~	~~60~~	~~65~~	~~73~~	~~68~~	~~69~~	~~84~~	~~79~~	~~84~~	~~78~~

Reason: Appendices of IECC are intended to be ready for state adoption; however, Appendix CF is not. States and localities are expressly preempted from setting energy use regulations for products that DOE regulates, as Advanced Energy Credits almost certainly require.[1] No pathway for minimum efficiency products was included in the Technical Support Document for the base energy credits (Tables C406.1.1 and T406.1.2) (TSD for CEPI-193) therefore compliance with federal law cannot be confirmed for the base credits or the advance energy credits (Table CF102.1) by stakeholders.

PNNL developed a technical support document to accompany the ASHRAE 90.1 energy credit proposal (approved in 90.1-2022). (R. Hart, et al. 90.1 Energy Credits Analysis Documentation, PNNL-32516. January 2022.) The 90.1 technical support document (TSD) reviewed two demonstration packages--one to evaluate cost effectiveness and the other to show a reasonable package without using efficiency improvements for HVAC and SWH equipment subject to EPACT (42 USC § 6833) minimum federal efficiencies. While the credits and the baselines are not the same, in a recent presentation to SSPC 90.1 by R. Hart, the IECC base energy credit package was estimated to be 2.5% more stringent than the ASHRAE 90.1-2022 base goal of around 5% energy savings. In the TSD for CEPI-193, PNNL estimated that the advanced package of practical measures achieves an average of 16.8% energy cost savings. The calculated increase in CF102.1 over C406.1.1 (as proposed in public draft 1) is included in the table, below, and visually depicted in the figure, below, modified from the 90.1 TSD. (R. Hart, et al, 2021).

[1] *Air Conditioning, Heating & Refrigeration Inst. v. City of Albuquerque*, No. 08-633, 2008 WL 5586316, No. 08-633 at *6 (D. N.M. Oct. 3, 2008); *Nat'l Elec. Mfrs. Ass'n v. Calif. Energy Comm'n*, No. 2:17-CV-01625-KJM-AC, 2017 WL 6558134 at *5 (E.D. Ca. Dec. 21, 2017).

Average increase over C406.1.1 (in PD1)

	Average increase over C406.1.1 (in PD1)			
Building Occupancy Group	**0-2 CZ (Warm)**	**3-5 CZ (Moderate)**	**6-8 CZ (Cold)**	**Average of all CZ**
R-2, R-4, I-1	167%	129%	152%	150%
I-2	137%	151%	135%	141%
R-1	104%	62%	100%	89%
B	93%	73%	103%	89%
A-2	55%	52%	163%	90%
M	52%	61%	120%	77%
E	94%	76%	106%	92%
S-1 and S-2	121%	76%	103%	100%
Other	107%	87%	127%	107%
			Total average increase	**104%**

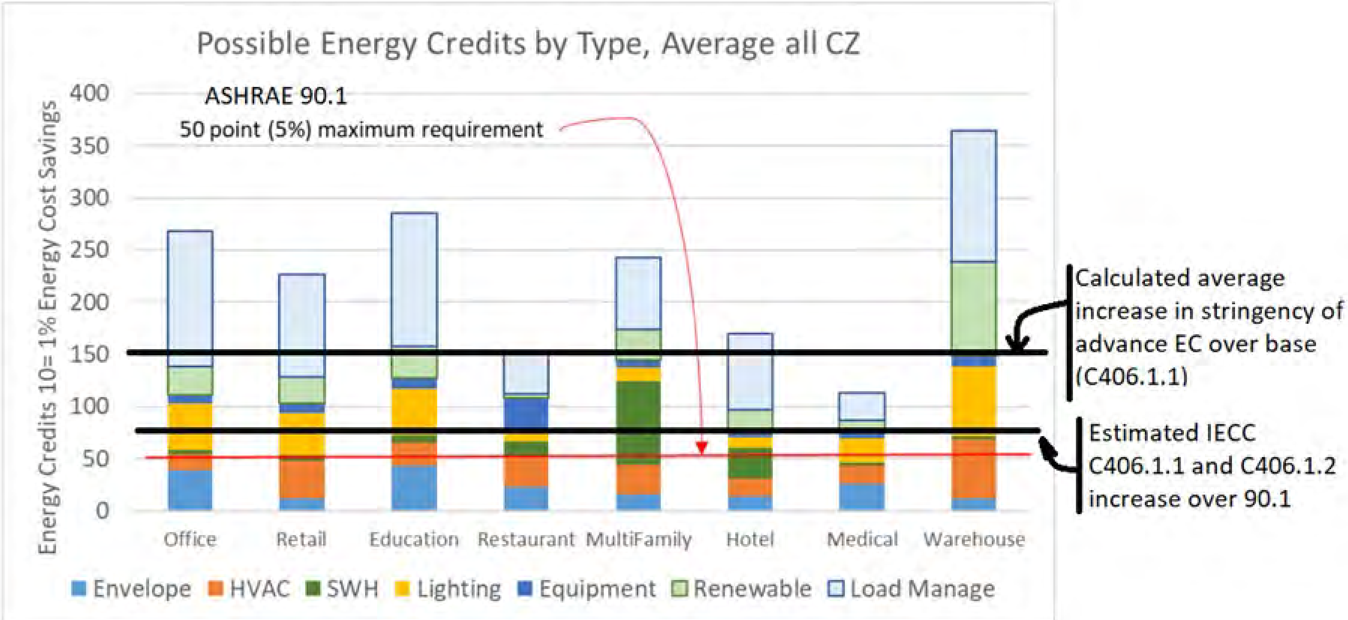

Figure 1. Potential Energy Credit Points by Building and Measure Type

It is not clear that the number of credits required in CF102.1 are even possible. AHRI has requested that PNNL analyze potential energy credit points by building and measure type for the IECC proposed base energy credits, advanced energy credits, and glide path.

Regarding the legal concerns with this proposal, states cannot adopt a building energy code effectively requiring the installation of federally covered products above federal minimum efficiencies. Until it is clear that the base package levels (and the advanced package) can be met with a cost-effective package with minimum efficiency equipment, AHRI has proposed deleting CF102.1 in entirety.

AHRI notes the energy code challenged in *AHRI v. City of Albuquerque* specifically included a compliance option that would have required HVAC systems and equipment and water heaters to meet efficiency standards that were more stringent than the specific standards DOE set under Energy Policy and Conservation Act (EPCA or The Act).[1] Thus, the court concluded those provisions were "preempted as a matter of law,"[2] and further ruled that the Albuquerque code was not saved by the fact that there were "viable, non-preempted options" for compliance.[3]

Building codes are not within the scope of EPCA's regulatory mandates, except where, as in *City of Albuquerque* and those building codes incorporate standards that directly regulate the efficiency of products covered by EPCA (as proposed here via energy credits embedded within the prescriptive pathway).[4] A state regulation does not need to directly prohibit the energy use of covered products to be preempted; state regulations "concerning" the energy efficiency or energy use of a product for which a standard is prescribed or established are sufficient. 42 U.S.C. § 6316(b)(2)(A).

The limited exception for building codes does not permit for states or localities to set efficiency requirements above the Federal minimum. **Congress was deliberate that states could not set back-door energy efficiency standards through building codes that would "expressly or effectively require the installation of covered products whose efficiencies exceed . . . the applicable Federal standard."**[5] The limited building code exception to preemption in EPCA permits states to create performance-based criteria, *so long as the efficiency minimums promulgated by DOE are not exceeded*. The law is unambiguous: "If a building code requires the installation of covered products with efficiencies exceeding both the applicable Federal standard … and the applicable standard of any State …that has been granted a waiver … such requirement of the building code shall not be applicable…." 42 U.S.C. § 6297 (f)(B).

No analysis has been provided that Tables CF102.1 can be met (and met cost effectively) with minimum efficiency EPCA-covered products and equipment. Therefore, at the levels in Public Draft q, these tables likely contravene the preemption provisions of EPCA by proposing an energy efficiency standard on a federally regulated product that exceed the Federal minimum. The Act specifies that only the Department of Energy can set energy standards for covered products. While the goal of advancing energy efficiency is laudable, federal law prohibits any regulation of covered products that conflict with existing federal energy regulation.

Lastly, the Energy Credit proposal was discussed in the Modeling Subcommittee. There are credits which involve subcommittees working directly with impacted equipment (for example, the HVACR and WH Subcommittee). Relevant subcommittees should be included in any discussion of proposed changes to Energy Credits.

[1] *Air Conditioning, Heating & Refrigeration Inst. v. City of* Albuquerque, 835 F.supp.2d 1133, 1133, 1139 (D. N.M. Sept. 30, 2010).

[2] *Id.* at 1137.

[3] *Id.* at 1136-37.

[4] EPCA's preemption provision includes an express, but very limited and narrowly drawn exception for building codes that include standards for covered products. Importantly, the focus of the exception remains on energy efficiency, *i.e.,* how a building code might affect "the ratio of useful output" or "the quantity of energy consumed" of products covered by EPCA.

[5] H.R. Rep. 100-11 at 26.

[6] *See* 42 U.S.C. § 6297(b).

[7] *See id.*; *see also Metro. Life Ins. Co. v. Massachusetts*, 471 U.S. 724, 739 (1985); *Nat'l Elec. Mfrs. Ass'n*, 2017 WL 6558134 at *5.

[1]

Air Conditioning, Heating & Refrigeration Inst. v. City of Albuquerque, No. 08-633, 2008 WL 5586316, No. 08-633 at *6 (D. N.M. Oct. 3, 2008); *Nat'l Elec. Mfrs. Ass'n v. Calif. Energy Comm'n*, No. 2:17-CV-01625-KJM-AC, 2017 WL 6558134 at *5 (E.D. Ca. Dec. 21, 2017).

[2] Id at 1133, 1139.

[3] *Id.* at 1137.

[4]*Id.* at 1136.

[5] EPCA's preemption provision includes an express, but very limited and narrowly drawn exception for building codes that include standards for covered products. Importantly, the focus of the exception remains on energy efficiency, *i.e.,* how a building code might affect "the ratio of useful output" or "the quantity of energy consumed" of products covered by EPCA. .

[6] *Id.* at 26.

Cost Impact: The code change proposal will decrease the cost of construction.
AHRI's code change proposal will decrease the cost of construction compared to the advanced energy credit proposal (Appendix CF) in public draft 1.

Workgroup Recommendation

Proposal # 880

CED1-181-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Add new definition as follows:

BIOMASS. Nonfossilized and biodegradable organic material originating from plants, animals and/or microorganisms, including products, by-products, residues and waste from agriculture, forestry and related industries as well as the nonfossilized and biodegradable organic fractions of industrial and municipal wastes, including gases and liquids recovered from the decomposition of nonfossilized and biodegradable organic material.

Reason: This definition was in the 2021 version of the IECC and needs to be re-inserted so that the IECC does not conflict with US federal law and policies, as well as the laws and policies of many states. Recent papers and federal executive orders highlight the federal and state laws and policies for biomass over the past 30+ years.
For example, this September 2022 paper "Forest Biomass Policies and Regulations in the United States of America" at https://www.fs.usda.gov/rm/pubs_journals/2022/rmrs_2022_page_dumroese_d001.pdf

On federal policies, the paper states: "The primary pieces of legislation considered as the over-arching umbrella to promote the increased use of bioenergy and woody biomass are the Biomass Research and Development Act of 2000, the Farm Bill of 2002, the Healthy Forest Restoration Act (HFRA) of 2003, the Energy Policy Act of 2005 (EPACT), the Energy Independence and Security Act of 2007 (EISA), and the Food Conservation and Energy Act of 2008 [14–16]."

On state policies, the paper says: "Becker and Lee [7] reviewed, classified, and integrated a database of legislation and policy instruments about woody biomass from all U.S. states. This database reports 388 policies, 95 tax incentives, 63 subsidies and grants, 129 rules and regulations, 67 education and consultation, and 33 financing and contracting instruments addressing state and local challenges using woody biomass and they provide support to overcome those challenges and promote forest management and create economic development opportunities."

In addition, the paper states: "In addition to the policies for biomass utilization, in 2013 there were 494 state laws in the U.S. that supported the use of forest biomass for heat and electricity production [21]. Within these state laws, there were 279 laws based on incentives (Tax incentives: 94 laws, project finance: 97 laws, and production incentives: 88 laws), 115 laws related to regulations (Consumption production standard: 73 laws, and connectivity standard: 42 laws), and 100 laws developed around information policies (dissemination: 85 laws, and research feasibility: 15 laws)."

Additionally, at the federal level, on September 12, 2022, President Biden issued the following Executive Order entitled "Executive Order on Advancing Biotechnology and Biomanufacturing Innovation for a Sustainable, Safe, and Secure American Bioeconomy" that can be accessed at: https://www.whitehouse.gov/briefing-room/presidential-actions/2022/09/12/executive-order-on-advancing-biotechnology-and-biomanufacturing-innovation-for-a-sustainable-safe-and-secure-american-bioeconomy/
Two of the key policies highlighted in the Executive Order are:

"(d) boost sustainable biomass production and create climate-smart incentives for American agricultural producers and forest landowners;

(e) expand market opportunities for bioenergy and biobased products and services;"

In addition, Section 13 of the Executive Order includes the following definition of biomass:
"(f) The term “biomass” means any material of biological origin that is available on a renewable or recurring basis. Examples of biomass include plants, trees, algae, and waste material such as crop residue, wood waste, animal waste and byproducts, food waste, and yard waste."

Therefore, the IECC should include a definition of biomass so that the energy code does not conflict with federal and state laws and policies.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This code change proposal only adds a definition to the code and has no construction cost impact.

Workgroup Recommendation

Proposal # 687

CED1-182-22

Proponents: Martha VanGeem, representing Masonry Alliance for Codes and Standards

2024 International Energy Conservation Code [CE Project]

Revise as follows:

<u>THERMAL</u> BLOCK. A generic concept used in energy simulation. It can include one or more thermal zones. It represents a whole building or portion of a building with the same use type served by the same HVAC system type.

Reason: This proposal is to change the new term "block" to "thermal block" in the definitions and leave the remainder of the definition the same. The term "block" is already used in the IECC with a lot of different meanings that are different from the one in this <u>new</u> definition of block in the current draft. The phrase "thermal block" is already used in C407 on simulations. So, I recommend that "thermal block" continue to be used in C407; and the sections in C407 that inserted the word "block" in this draft use the phrase "thermal block" or some other compound phrase in the next draft.

"Block" is already used in the IECC to mean many different things that are not defined: a concrete masonry unit, a thermal spacer block, something that gets in the way of sunlight, and as "blocking" (a type of framing).

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This is just a change in the definition for clarity throughout the standard.

Workgroup Recommendation

Proposal # 750

CED1-183-22

Proponents: Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.15.1 On-site renewable energy systems. *Buildings* shall install equipment for on-site renewable electricity generation with a direct current (DC) nameplate power rating of not less than ~~0.75~~ 0.50 W/ft^2 (8.1 W/m^2) multiplied by the sum of the gross conditioned floor area of all floors not to exceed the combined gross conditioned floor area of the three largest floors.

Exceptions: The following buildings or building sites shall comply with Section C405.15.2:

1. A building site located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).
2. A *building* where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.
3. Any building where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.
4. A *building* with gross conditioned floor area less than ~~5,000~~ 10,000 square feet (465 m^2).

C405.15.2 Off-site renewable energy. *Buildings* that qualify for one or more of the exceptions to Section 405.15.1 and do not meet the requirements of Section 405.15.1 either in part or in full, with an on-site renewable energy system, shall procure off-site renewable electrical energy, in accordance with C405.15.2.1 and C405.15.2.2, that shall not be less than the total off-site renewable electrical energy determined in accordance with Equation 4-14.

(Equation 4-14)

$$TREoff = (RENoff \times \cancel{0.75}\ \underline{0.50}\ W/ft^2 \times FLRA - IREon) \times 15$$

TREoff = Total off-site renewable electrical energy in kilowatt-hours (kWh) to be procured in accordance with Table C405.15.2
RENoff = Annual off-site renewable electrical energy from Table C405.15.2, in units of kilowatt-hours per watt of array capacity
FLRA = the sum of the gross conditioned floor area of all floors not to exceed the combined floor area of the three largest floors
IREon = Annual on-site renewable electrical energy generation of a new on-site renewable energy system, to be installed as part of the building project, whose rated capacity is less than the rated capacity required in Section C405.15.1

TABLE C405.15.2 Annual Off-site Renewable Energy Requirement

~~Climate Zone~~ Annual Horizontal Solar Irradiance	Annual Off-site Renewable Electrical Energy (kWh/W)
~~1A, 2B, 3B, 3C, 4B, and 5B~~ >= 5.5 kWh/m^2/Day	~~1.75~~ **1.40** kWh/W
~~0A, 0B, 1B, 2A, 3A, and 6B~~ >= 4.5 kWh/m^2/Day and < 5.5 kWh/m^2/Day	~~1.55~~ **1.20** kWh/W
~~4A, 4C, 5A, 5C, 6A, and 7~~ >= 3.5 kWh/m^2/Day and < 4,5 kWh/m^2/Day	~~1.35~~ **1.00** kWh/W

C405.15.2.1 Off-site procurement. The building owner as defined in the *International Building Code* shall procure and be credited for the total amount of off-site renewable electrical energy, not less than required in accordance with Equation 4-14, with one or more of the following:

1. A *physical renewable energy power purchase agreement*
2. A *financial renewable energy power purchase agreement*
3. A *community renewable energy facility*
4. Off-site renewable energy system owned by the building property owner
5. Utility Green Power Program

C405.15.2.2 Off-site contract. The *renewable energy* shall be delivered or credited to the building site under an energy contract with a duration of not less than 10 years. ~~The contract shall be structured to survive a partial or full transfer of ownership of the building property.~~ The total required off-site renewable ~~electrical~~ energy shall be procured in equal installments over the duration of the off-site contract.

C405.15.3 Renewable energy certificate documentation. The property owner or owner's authorized agent shall demon-strate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections C405.15.1 and C405.15.2 all of the following criteria for RECs and EACs shall be met:

~~1.~~ ~~Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years or the duration of the contract in C405.15.2.2 whichever is less;~~

~~2.~~ 1. Are created within a 12-month period of the use of the REC; and

~~3.~~ 2. Are from a generating asset ~~constructed~~ placed in service no more than 5 years before the issuance of the certificate of occupancy.

C405.15.4 Renewable energy certificate purchase. A *building* that qualifies for one or more of the exceptions to Section C405.15.1 and where it can be demonstrated to the *code official* that the requirements of Section C405.15.2 cannot be met, the building owner shall contract for renewable ~~electricity~~ energy products complying with the Green-e Energy National Standard for Renewable ~~Electricity~~ Energy products equivalent to ~~five times~~ the amount of total off-site renewable energy calculated in accordance with Equation 4-14.

Reason: The proposed changes will inprove this section in the following ways:
-Align with values in ASHRAE 90.1-2022

-Add more flexibility for building owners for off-site renewable energy options.

-Remove unenforceable language out of the section.

-Aligns off-site requirements with solar irradiance rather than climate zone, as shown at the following NREL web site: https://www.nrel.gov/gis/solar-resource-maps.html

-Removes language on REC's that does not belong in a minimum energy code.

-Revises the formula in C405.15.4 to reduce the cost burden on building owners (as currently written, the owner will have to purchase REC's equal to 75 years of renewable energy usage).

Cost Impact: The code change proposal will decrease the cost of construction.
This will reduce costs by lowering the requirements and providing more flexibility.

Bibliography: NREL Solar Resources Maps and Data, available at https://www.nrel.gov/gis/solar-resource-maps.html

Workgroup Recommendation

CED1-184-22

Proponents: Charles Eley, representing Architecture 2030 (charles@eley.com)

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Revise as follows:

C405.15.2.2 Off-site contract. The *renewable energy* shall be delivered or credited to the building site under an energy contract with a duration of not less than ~~10~~ 15 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. The total required off-site renewable electrical energy shall be procured in equal installments over the duration of the off-site contract.

C405.15.3 Renewable energy certificate documentation. The property owner or owner's authorized agent shall demon-strate that where RECs or EACs are associated with on-site and off-site renewable energy production required by Sections C405.15.1 and C405.15.2 all of the following criteria for RECs and EACs shall be met:

1. Are retained and retired by or on behalf of the property owner or tenant for a period of not less than 15 years~~ or the duration of the contract in C405.15.2.2 whichever is less~~;
2. Are created within a 12-month period of the use of the REC; and
3. Are from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

Reason: The 10-year time period for the contract is inconsistent with the 15 years referenced in C405.15.3 and the requirements in CC103.3.2.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
15 years is already required in other places.

Bibliography: None.

Workgroup Recommendation

Proposal # 703

CED1-185-22

Proponents: Reid Hart, rep. Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**); Michael Tillou, representing Pacific Northwest National Laboratory (michael.tillou@pnnl.gov)

2024 International Energy Conservation Code [CE Project]

SECTION C406 ADDITIONAL EFFICIENCY, RENEWABLE, AND LOAD MANAGEMENT REQUIREMENTS. *Staff note: proposed code changes to existing C406 having been removed by CEPI-193-21 are not incorporated into this draft*

Revise as follows:

C406.1 Compliance. *Buildings* shall comply as follows:

1. *Buildings* with greater than 2000 square feet (190 m^2) of floor area shall comply with Section C406.1.1.
2. *Buildings* with greater than 5000 square feet (465 m^2) of *conditioned floor area* shall comply with Sections C406.1.1 and C406.1.2.
3. Build-out construction greater than 1000 square feet (93 m^2) of *conditioned floor area* that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.3.

Exceptions: Core and shell *buildings* where no less than 20 percent of the *net floor area* is without final lighting or final HVAC that comply with all of the following:

1. *Buildings* with greater than 5000 (465 m) of *conditioned floor* area shall comply with Section C406.1.2.
2. Portions of the *building* where the *net floor area* is without final lighting or final HVAC shall comply with Section C406.1.3
3. Portions of the *building* where the *net floor area* has final lighting and final HVAC systems shall comply with C406.1.1.

TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

Building Occupancy Group	Climate Zone																	
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1	64	59	70	69	73	89	72	90	90	63	90	70	51	75	66	48	~~48~~ 58	50	42
I-2	31	32	33	32	33	36	31	40	34	32	43	32	29	37	33	34	~~34~~ 33	27	23
R-1	41	40	48	44	48	58	54	61	63	50	61	47	42	55	50	41	~~41~~ 51	40	32
B	63	64	74	75	78	89	83	90	90	77	90	86	68	90	83	72	~~72~~ 81	68	58
A-2	12	12	13	13	12	17	13	17	17	12	17	13	12	12	12	12	12	8	7
M	71	70	84	84	90	90	90	90	90	81	90	90	77	90	90	76	~~76~~ 84	71	58
E	49	55	64	61	69	83	73	90	90	67	90	75	61	86	74	66	~~66~~ 76	60	47
S-1 and S-2	90	90	90	90	90	90	90	90	90	90	90	90	70	90	90	61	~~61~~ 85	61	53
All Other	56	55	66	63	69	80	69	87	88	59	86	68	51	72	66	51	~~51~~ 60	48	40

[Note to staff and reviewers: some of the above revisions are overwritten by proposal 717 which takes precedence]

~~**C406.1.1.1**~~ **C406.1.3 Building Core/Shell and ~~Initial~~ Build-Out Construction.** Where separate permits are issued for core and shell buildings and build-outconstruction, compliance shall be in accordance with the following requirements.

1. Core and shell buildings or portions of buildings shall comply with one of the following:
   1.1. Where the permit includes a central HVAC system or service water heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required in Table C406.1.1 in accordance with Section C406.2.
   1.2. Alternatively, the project shall achieve not less than 33 percent of the energy credits required in Table C406.1.1.
2. For core and shell *buildings* or portions of *buildings* the energy credits achieved shall be subject to the following adjustments:
   2.1. Lighting measure credits shall be determined only for areas with final lighting installed.
   2.2. Where HVAC or service water heating systems are designed to serve the entire building, full HVAC or service water heating measure credits shall be achieved.
   2.3. Where HVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achievedshall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed.
3. Build-out construction shall be deemed to comply with Section C406.1 where either:
   3.1. Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required in Table C406.1.1.
   3.2. Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required in Table C406.1.1
   3.3. Where the core and shell building was approved in accordance with C407 under 2021 IECC or later.

Delete without substitution:

~~**C406.1.3 Substantial Alterations to Existing Buildings.** The *building envelope*, *equipment*, and *systems* in *alterations* to *buildings* exceeding 5000 square feet (46.5 m^2) of *gross conditioned floor area* shall comply with the requirements of Section C406.1.1 and C406.1.2 where the alteration includes replacementof two or more of the following:~~

1. ~~HVAC unitary systems or HVAC central heating or cooling equipment serving the alteration area, not including ductwork or *piping*.~~
2. ~~80% or more of the lighting fixtures in the *alteration* area.~~
3. ~~Building envelope components in the *alteration* area including new exterior cladding, fenestration, or insulation.~~

~~**C406.1.4 Energy Credits Achieved.** Energy credits achieved for the project shall be the sum of measure energy credits for individual measures included in the project.Credits are available for the measures listed in Section C406.2. Base energy credits are shown in Tables C406.1.4(1) through C406.1.4(9) based on building occupancies and climate zones. Measure energy credits achieved shall be determined in one of three ways, depending on the measure:~~

1. ~~The measure energy credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the measure description in Section C406.2.~~

2. ~~The measure energy credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the measure description in Section C406.2. Where adjustments are applied, each measure energy credit shall be rounded to the nearest whole number.~~

3. ~~The measure energy credit shall be by direct formula as stated in the measure description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.~~

Revise as follows:

C406.2 Additional Energy Efficiency Credits Achieved. Each energy efficiency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the base credits listed for the measure and occupancy type in Tables C406.2(1) through C406.2(9) or, where calculations required by Sections C406.2.1 through C406.2.7 create or modify the table credits, the credits achieved shall be based upon the calculations. Energy credits achieved for measures shall be determined by one of the following, as applicable:

1. The measure's energy credit shall be the base energy credit from Tables C406.2(1) through C406.2(9) for the measure where no adjustment factor or calculation is included in the description of the measure in Section C406.2.
2. The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.
3. The measure's energy credit shall be calculation as stated in the measure~~s~~ description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Energy credits achieved for the project shall be the sum of the individual measure’s energy credits. Credits are available for the measures listed in this Section. Where a project contains multiple building occupancy groups:

1. Credits achieved for each occupancy group shall be summed and then weighted by the floor area of each occupancy group to determine the weighted average project energy credits achieved.
2. ~~Credits for improved~~ Improved envelope efficiency (E01 through E06) and lighting reduction (L06) measure credits shall be determined for the building or permitted floor area as a whole. Credits for other measures shall be determined for each occupancy separately. Credits shall be taken from applicable tables or calculations for each occupancy and weighted by the building occupancy group floor area.

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leakage reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	7	7	9	65	16	~~1~~ 11	73	43	52	26
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	~~1~~ 4	7	7	6	8
E05	Add Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	~~1~~ 3	14	12	13	13

a. "x" indicates credit is not available for that measure.

[Note to reviewers and staff: Other proposals may update credits for E02 and W09 in all tables and take precedence]

TABLE 406.2(2) BASE ENERGY CREDITS FOR GROUP I-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leak<u>age</u> reduction	C406.2.1.3	5	3	4	3	5	8	8	3	2	6	2	2	7	3	1	9	7	19	5

a. "x" indicates credit is not available for that measure.

TABLE 406.2(3) BASE ENERGY CREDITS FOR GROUP R-1 OCCUPANICES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leakage reduction	C406.2.1.3	~~5~~	~~3~~	~~4~~	~~2~~	~~2~~	~~2~~	~~5~~	~~1~~	~~1~~	~~8~~	~~1~~	~~2~~	~~13~~	~~4~~	1	~~18~~	~~9~~	~~18~~	~~7~~
E03	Envelope leakage reduction	C406.2.1.3	15	9	12	8	6	16	7	5	10	14	3	1	19	5	1	28	16	28	18
E04	Add Roof Insulation	C406.2.1.4	~~2~~	~~2~~	~~2~~	2	2	~~2~~	~~3~~	~~2~~	1	~~3~~	1	2	~~3~~	~~2~~	2	3	~~3~~	2	3
E04	Add Roof Insulation	C406.2.1.4	1	1	1	2	2	1	2	1	1	2	1	2	2	1	2	3	**2**	**2**	**3**
E05	Add Wall Insulation	C406.2.1.5	~~13~~	~~14~~	~~8~~	~~11~~	~~4~~	4	~~7~~	~~4~~	~~1~~	~~5~~	2	4	~~6~~	4	~~3~~	~~9~~	~~7~~	~~10~~	~~8~~
E05	Add Wall Insulation	C406.2.1.5	18	26	11	25	3	4	5	3	1	6	2	4	7	4	4	8	6	8	5
E06	Improve Fenestration	C406.2.1.6	~~5~~	~~5~~	~~4~~	~~5~~	~~7~~	~~7~~	~~8~~	~~2~~	1	~~8~~	~~2~~	4	~~10~~	~~5~~	~~1~~	~~21~~	~~17~~	~~10~~	~~9~~
E06	Improve Fenestration	C406.2.1.6	2	2	1	2	2	3	5	3	1	6	3	4	9	7	6	13	8	6	6

a. "x" indicates credit is not available for that measure.

[Note to reviewers and staff: replacements shown in separate rows for clarity; repeated cell values do not change unless struckout and underlined - typical for several tables]

TABLE 406.2(4) BASE ENERGY CREDITS FOR GROUP B OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E02	UA reduction (15%)	C406.2.1.2	4	7	4	7	3	4	7	2	~~0~~ 1	7	2	3	10	6	4	12	9	19	11
E03	Envelope leakage reduction	C406.2.1.3	5	3	4	2	2	2	5	1	~~0~~ 1	8	~~0~~ 1	2	13	4	~~0~~ 1	18	9	18	7

a. "x" indicates measure is not available for building occupancy in that climate zone.

TABLE 406.2(5) BASE ENERGY CREDITS FOR GROUP A-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	**Energy Credit Measure**	**Section**	**Climate Zone**																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leakage reduction	C406.2.1.3	2	1	1	1	2	3	11	2	1	24	4	6	33	9	3	42	29	36	16
E04	Add Roof Insulation	C406.2.1.4	1	1	~~0~~ 1	1	1	1	2	1	1	1	1	1	2	2	1	2	2	1	2
E05	Add Wall Insulation	C406.2.1.5	1	1	~~0~~ 1	1	1	2	3	3	1	2	1	1	2	2	2	2	2	2	2
L02	Lighting dimming & tuning	C406.2.5.2	2	2	2	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	~~0~~ 1
L03	Increase occp. sensor	C406.2.5.3	2	2	2	2	2	2	2	2	2	1	1	1	1	1	1	1	1	1	~~0~~ 1

a. "x" indicates measure is not available for that measure.

TABLE 406.2(6) BASE ENERGY CREDITS FOR GROUP M OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leak<u>age</u> reduction	C406.2.1.3	3	3	2	2	3	3	19	3	1	44	6	11	56	13	6	64	44	43	19
W05	Point of Use Water Heaters	C406.2.3.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	<u>x</u>

a. "x" indicates credit is not available for that measure.

TABLE 406.2(7) BASE ENERGY CREDITS FOR GROUP E OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leakage reduction	C406.2.1.3	4	3	3	3	2	5	2	1	1	1	1	1	1	1	1	2	1	1	1
E06	Improve Fenestration	C406.2.1.6	8	10	6	9	11	11	15	9	1	16	8	15	22	18	19	33	~~9~~ 29	19	18

a. "x" indicates measure is not available for that measure.

TABLE 406.2(8) BASE ENERGY CREDITS FOR GROUP S-1 AND S-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E03	Envelope leakage reduction	C406.2.1.3	2	2	1	2	1	3	31	3	1	77	14	17	92	25	8	95	71	69	26

a. "x" indicates measure is not available for building occupancy in that climate zone.

TABLE 406.2(9) BASE ENERGY CREDITS FOR OTHER OCCUPANCIES[a,b]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
H05	DOAS/fan control	C406.2.2.5	~~7~~ 37	36	31	34	30	28	43	32	23	61	42	49	75	61	49	90	77	93	90
W08	SHW submeters	C406.2.3.4	~~11~~	~~11~~	~~13~~	~~13~~	~~15~~	~~16~~	~~18~~	~~18~~	~~22~~	~~19~~	~~20~~	~~22~~	~~19~~	~~20~~	~~24~~	~~17~~	~~20~~	~~18~~	~~18~~
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	~~29~~	~~30~~	~~36~~	~~35~~	~~41~~	~~43~~	~~48~~	~~48~~	~~56~~	~~50~~	~~53~~	~~59~~	~~51~~	~~54~~	~~62~~	~~47~~	~~52~~	~~49~~	~~48~~
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x

a. "x" indicates measure is not available for that measure.

b. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

C406.2.1.6 E06 Improve fenestration. Energy credits ~~for one selected fenestration energy credit ID~~ shall be achieved for improved energy characteristics of all vertical fenestration in the project meeting the requirements in ~~one of the rows of~~ Table C406.2.1.6. The area-weighted average U-factor and SHGC of all vertical fenestration shall be equal to or less than the value shown in the ~~selected~~ table ~~row~~. The area-weighted average visible transmittance (VT) of allvertical fenestration shall be equal to or greater than the value shown in the ~~selected~~ table ~~row~~.

C406.2.2 More Efficient HVAC Equipment Performance. All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables referenced by Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal or part-load efficiencies including SEER, ~~EER/~~integrated energy efficiency ratio (IEER), integrated part load value (IPLV), or AFUE. Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity. Systems are permitted to achieve HVAC energy credits by meeting the requirements of either:

1. C406.2.2.1 H01
2. C406.2.2.2 H02
3. C406.2.2.3 H03
4. C406.2.2.4 H04
5. C406.2.2.5 H05
6. Any combination of H02, H03, H04 and H05
7. The combination of H01 and H04

C406.2.2.2 H02 More efficient HVAC equipment heating performance. No less than 90 percent of the total HVAC capacity serving the total *conditioned floor area* of the entire ~~building~~ *building*, or tenant space in accordance with Section C406.1.1, shall comply with the requirements of this Section.

1. Equipment installed shall be types that ~~are~~ have their efficiency listed in Tables referenced by Section C403.3.2. Electric resistance heating capacity shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.
2. Equipment shall exceed the minimum heating efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-18 rounded to the nearest whole number.

(Equation 4-18)

$$EEC_{HEH} = EEC_{H5} \times (HEI / 0.05)$$

where:

EEC_{HEH}= energy efficiency credits for heating efficiency improvement

EEC_{H5}= C406.2.2.2 credits from Tables C406.2(1) through C406.2(9)

HEI = the lesser of: the improvement (as a fraction) above minimum heating efficiency requirements, or 20 percent(0.20). Where heating equipment with different minimum efficiencies are included in the ~~building~~ *building*, a heating capacity weighted average improvement shall be used. Where electric resistance primary heating or reheat is included in the ~~building~~ *building* it shall be included in the weighted average improvement with an HEI of 0. Supplemental gas and electric heat for heat pump systems shall be excluded from the weighted HEI. For heat pumps rated at multiple ambient temperatures, the efficiency at 47ºF (8.3ºC) shall be used.

For metrics that increase as efficiency increases, HEI shall be calculated as follows:
$HEI = (HM_{DES}/HM_{MIN})-1$
Where:
HM_{DES}= Design heating efficiency metric, part-load or annualized where available
HM_{MIN}= Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2

> **Exception:** In low energy spaces complying with Section C402.1.1, no less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall only achieve base energy credits for EEC_{H5}.

C406.2.2.3 H03 More efficient HVAC cooling equipment ~~cooling~~ and fan performance. No less than 90 percent of the total HVAC cooling capacity serving the total conditioned floor area of the entire building or tenant space in accordance with Section C406.1.1, shall comply with all of the requirements of this section.

1. Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2.
2. Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. For water-cooled chiller plants, heat rejection equipment ~~efficiency~~ performance in Table C403.3.2(7) shall also be increased by at least the chiller efficiency improvement. Where equipment exceeds both the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-19, rounded to the nearest whole number.

Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fanpower or horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1.

(Equation 4-19)

$$EEC_{HEC} = EEC_5 \times (CEI/0.05)$$

where:
EEC_{HEC}= energy efficiency credits for cooling efficiency improvement

EEC_5= the lesser of: the improvement above minimum cooling efficiency and heat rejection ~~efficiency~~ performance requirements expressed as a fraction, or 0.20 (20percent). Where cooling equipment with different minimum efficiencies are included in the ~~building~~ *building*, a cooling capacity weighted average improvement shall be used. Where multiple cooling efficiency or performance requirements are provided, the equipment shall exceed the annualized energy or part-load requirement. Meeting both part-load and full-load efficiencies is not required.
For metrics that increase as efficiency increases, CEI shall be calculated as follows:
$CEI = (CM_{DES}/CM_{MIN}) - 1$
For metrics that decrease as efficiency increases, CEI shall be calculated as follows:
$CEI = (CM_{MIN}/CM_{DES}) - 1$
Where:
CM_{DES}= Design cooling efficiency metric, part-load or annualized where available
CM_{MIN}= Minimum required cooling efficiency metric, part-load or annualized where available from Section C403.3.2
For Data Centers using ASHRAE Standard 90.4, CEI shall be calculated as follows:
$CEI = (AMLC_{MAX}/ AMLC_{DES}) - 1$
Where:
$AMLC_{DES}$= As-Designed Annualized Mechanical Load Component calculated in accordance with ASHRAE Standard 90.4, Section 6.5
$AMLC_{MAX}$= Maximum Annualized Mechanical Load Component from ASHRAE Standard 90.4, Table 6.5

C406.2.2.5 H05 Dedicated Outdoor Air System. Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:

1. Zone controls shall cycle the heating/cooling unit fans off when not providing required heating and cooling or shall limit fan power to 0.12 watts/cfm of zone outdoor air.
2. Outdoor air shall be supplied by an independent ventilation system designed to provide no more than 110 percent of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code*.
3. The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65 percent or more at heating design conditions in climate zones 3 through 8 and an *enthalpy recovery ratio* of 65 percent or more at cooling design conditions in climate zones 0, 1, 2, 3A, 3B, 4A, 4B, 5A, and 6A. In"A" climate zones, energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on sensible *energy recovery ratio*. Where energy recovery effectiveness is less than the 65 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.

4. Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode. partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:

   4.1. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).

   4.2. The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

5. Ventilation systems providing mechanical dehumidifi cation shall use recovered energy for reheat within the limits of item 4. This shall not limit the use of latent energy recovery for dehumidification.

Where only a portion of the building is permitted to be served by constant air volume units or theenthalpy recovery ratio or sensible *energy recovery ratio* is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:

(Equation 4-20)

$$EC_{DOAS} = EC_{BASE} \times FLOOR_{CAV} \times ERE_{ADJ}$$

where:

EC_{DOAS}= Energy credits achieved for H05 ~~H06~~

EC_{base}= ~~H06~~ H06 base energy credits in Section C406.2
$FLOOR_{CAV}$= Fraction of whole project gross conditioned fl oor area not required to have variable speed or multi-speed fan airflow control in accordance with Section C403.8.6.
ERE_{adj}= The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating *enthalpy recovery ratio* or *sensible energy recovery ratio* where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.

TABLE C406.2.2.5 DOAS Energy Recovery Adjustments

ERE_{adj} based on lower of actual heating or cooling energy recovery effectiveness where required		
Cooling ERR is ~~≥~~ at least	Heating enthalpy recovery ratio or sensible energy recovery ratio ~~is ≥~~ at least	Energy Recovery Effectiveness Adjustment (ERE_{adj})
65%	65%	1.00
60%	60%	0.67
55%	55%[a]	0.33
50%	50%[a]	0.25

a. In climate zones where heating recovery is required in Section C403 ~~for this measure~~, for dwelling units a heating recovery effectiveness below 60 percent is not allowed.

C406.2.3 Reduced Energy Use In-service Water Heating. Projects with service water-heating equipment that serves the whole building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of either:

1. C406.2.3.1 by selecting one allowed measure W01, W02, ~~or~~ W03 , or a combination in accordance with Section C406.2.3.1.4
2. C406.2.3.2 W04
3. C406.2.3.3 by selecting one allowed measure W05, W06, or W07
4. C406.2.3.4 W08
5. C406.2.3.5 W09
6. C406.2.3.6 W10
7. Any combination of measures in C402.2.3.1 through C402.2.3.6 as long no more than one allowed measure from C406.2.3.1 and C406.2.3.3 are selected.

C406.2.3.1.1 W01 Recovered or renewable water heating. The *building* service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the *building's* annual hot water requirements, or sized to provide not less than 70 percent of the *building's* annual hot water requirements if the *buildingis* required to comply with Section C403.10.5:

1. Waste heat recovery from SHW, heat recovery chillers, *building* equipment, or process equipment.
2. A water-to-water heat pump that precools chilled water return for *building* cooling while heating SHW.
3. On-site renewable energy water-heating systems.

C406.2.3.1.2 W02 Heat pump water heater. Air-source heat pump water heaters shall be installed according to manufacturer's instructions and at least 30 percent of design end use service water heating requirements shall be met using only heat pump heating at an ambient condition of 67.5 F, db without supplemental electric resistance or fossil fuel heating. For a heat pump water heater with supplemental electric resistance heating, the heat pump only capacity shall be deemed at 40 percent of first hour draw. Where the heat pump only capacity exceeds 50 percent of the design end use load excluding recirculating system losses, the credits from the Section C406.2 tables shall be prorated as follows:

$$EC_{HPWH} = (EC_{BASE}/0.5) \times \{(CAP_{HPWH})/(ENDLOAD)\ [\text{not greater than } 2]\} \quad \textbf{(Equation 4-21)}$$

where:

EC_{HPWH}= Energy credits achieved for W02

EC_{BASE}= W02 base energy credits from Tables C406.2(1) through C406.2(9) ~~Section 13.5.3~~
ENDLOAD = End use peak hot water load, excluding load for heat trace or recirculation, Btu/hr or kW
CAP_{HPWH} = the heat pump only capacity at 50ºF (10ºC) entering air and 70ºF (21ºC) entering potable water without supplemental electric resistance or fossil fuel heat, Btu/hr or kW
The heat pump service water heating system shall comply with the following requirements:

1. For systems with an installed total output capacity of more than 100,000 Btu/hr (30 kW) at an ambient condition of 67.5ºF (19.7ºC), db a preheat storage tank with greater than or equal 0.75 gallons per 1000 Btu/hr (≥9.7 L/kW) of design end use service water heating requirements shall be heated only with heat pump heating when the ambient temperature is greater than 45ºF (7.2ºC).
2. For systems with piping temperature maintenance, either a heat trace system or a separate water heater in series for recirculating system and final heating shall be installed.

3. Heat pump water heater efficiency shall meet or exceed one of the following:

   3.1. Output-capacity-weighted-average UEF of 3.0 in accordance with 10 CFR 430 Appendix E.

   3.2. Output-capacity-weighted-average COP of not less than 4.0 tested at 50ºF (10ºC) entering air and 70ºF (21ºC) entering potable water in accordance with AHRI standard 1300.

Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50 percent of the design end-use load excluding recirculating system losses, the base credits from Section C406.2 shall be prorated based on Equation 4-20.

(Equation 4-22)

$$\text{W02 credit} = \text{base W02 table credit} \times (HP_{LF}/50\%)$$

HP_{LF} = Heat pump capacity as a fraction of the design end-use SHW requirements excluding recirculating system losses, not to exceed 80 percent.

C406.2.3.1.3 W03 Efficient fossil fuel water heater. The combined input-capacity-weighted-average equipment rating of all gas water-heating equipment in the *building* shall be not less than 95 percent Et or 0.93 UEF. ~~This measure shall receive only thirty percent of the listed energy credits for *buildings* required to comply with C404.2.1. Projects where the installed *building* service water heating capacity is less than 200,000 Btu/hr (59 kW) and weighted UEF is not less than 0.82 shall achieve 25 percent of the base table W03 credit.~~ Adjustments shall apply as follows:

1. Where the service water heating system is required to comply with Section C404.2.1, this measure shall achieve 30 percent of the listed base W03 energy credits in Tables C406.2(1) through C406.2(9)
2. Where the installed *building* service water heating capacity is less than 200,000 Btu/hr (59 kW) and weighted UEF is less than 0.93 UEF and not less than 0.82 this measure shall achieve 25 percent of the base W03 credit in Tables C406.2(1) through C406.2(9)

Add new text as follows:

C406.2.3.2 W04: Service Hot Water Piping Insulation Increase. . Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hot water source to the fixture shutoff. Where no more than 50 percent of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.
[Note to reviewers and staff: this text is just relocated to a separate section from "Water heating distribution temperature maintenance" Renumber following sections as needed. Section numbers in tables already match new numbering]

Revise as follows:

C406.2.3.3 ~~**C406.2.3.2**~~ **Water-heating distribution temperature maintenance.** A project is allowed to claim energy credits from only one of the following SHW distribution temperature maintenance measures.

~~1.~~ ~~**W04: Service Hot Water Piping Insulation Increase.** Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hotwater source to the fixture shutoff. Where no more than 50 percent of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.~~

~~2~~ 1. **W05 Point of use water heaters.** Credits are available for ~~office or school buildings~~ Group B or E *building*s larger than 10,000 ft^2 (930 m^2). Fixtures requiring hot water shall be supplied from a localized source of hot water with no recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume in piping from the water heater to the termination of the fixture supply pipe shall be limited as follows:

   ~~2.1~~ 1.1. Non-residential lavatories: not more than 2 oz (60 mL)

   ~~2.2~~ 1.2. All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 L)

   Exception: Where all remotely located hot water uses meet the requirements for measure W05, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.

~~3~~ 2. **W06 Thermostatic balancing valves.** Credits are available where service water heating is provided centrally and distributed throughout the ~~building~~ *building* with a recirculating system. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 120°F (49°C) ~~115°F (46°C)~~.

~~4~~ 3. **W07 Heat trace system.** Credits are available for projects with gross floor area greater than 10,000 square feet (930 m^2) and a central water-heating system. The energy credits achieved shall be from Tables C406.1.2(1) through C406.1.2(9). This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.

[Renumber following water heating measures and tables as required]

C406.2.5.4 L04 Increase daylight area. The total daylight area of the project (DLA_{BLDG}) with continuous daylight dimming meeting the requirements of C405.2.4 shall be at least 5 percent greater than the typical daylit area (DLA_{TYP}).Credits for measure L04 shall be determined based on Equation 4-24:

(Equation 4-24)

$$EC_{DL} = EC_{DL5} \times 20 \times [(DLA_{BLDG}/GLFA) - DLA_{TYP}]$$

where:

EC_{DL}= achieved L04 energy credits

ECDL5= C406.2.5.4 L04 base energy credits from Section C406.2
DLA_{BLDG} = The lesser of :

1. actual area of *daylight zones* in the *building* with continuous daylight dimming, ft^2 or m^2 ~~and~~
2. (GLFA x DLA_{max}) see TableC406.2.5.4.

Daylight zones shall meet the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit *daylight zones*, secondary sidelit *daylight zones*, and toplit *daylight zones*.

GLFA = Project gross lighted fl oor area, ft^2 or m^2
DLATYP= Typical ~~%~~ percentage of *building* area with daylight control (as a fraction) from Table C406.2.5.4~~:~~
~~ECDL5= C406.2.5.4 L04 base energy credits from Section C406.2~~

C406.2.6.1 Q01 Efficient Elevator Equipment. Qualifying elevators in the building shall be Energy efficiency class A per ISO 25745-2, Table 7. Only buildings 3 or more floors above grade may use this credit. Credits shall be prorated based on Equation 4-26, rounded to the nearest whole credit. Projects with acompliance ratio below 0.5 do not qualify for this credit.

(Equation 4-26)

$$EC_e = EC_t \times CR_e$$

where:

EC_e= Elevator energy credit achieved for the *building*

EC_t= C406.2.7.1 Table energy credit
CR_e= Compliance Ratio = (F_A/ F_B)
F_A= Sum of floors served by class A elevators
F_B= Sum of floors served by all *building* elevators and escalators

TABLE C406.2.6.2(1) Minimum Efficiency Requirements: Commercial Fryers

~~For SI: BTU/h = 0.293W~~

C406.3.1 R01 Renewable Energy. Projects installing on-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08W/m2) of building area or securing off-site renewable energy shall achieve energy credits for this measure calculated as follows:

(Equation 4-28)

$$EC_R = EC_{0.1} \times (R_t + R_{off} - R_{ex}) / (0.1 \times PGFA)$$

where:

EC_R= C406.3.1 R01 energy credits achieved for this project

~~R_t= Actual total rating of on-site renewable energy systems (W)~~
~~PGFA = Project gross fl oor area, ft^2~~
$EC_{0.1}$= C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9)
R_t= Actual total rating of on-site renewable energy systems (W)
R_{OFF}= Actual total equivalent rating of off-site renewable energy contracts (W), calculated as follows:

R_{OFF}= TRE/(REN X 20)
where:
TRE = Total off-site renewable electrical energy in kilowatt-hours (kWh) that is procured in accordance with Sections C405.13.2.1 through C405.13.4
REN = Annual off-site renewable electrical energy from Table C405.13.2, in units of kilowatt-hours per watt of array capacity

R_{ex}= Rating (W) of renewable energy resources capacity excluded from credit calculated as follows:

$R_{ex}= RR_r + RR_x + RR_c$
where:
RR_r= Rating of on-site renewable energy systems required by Section C405.13.1, without exception (W).
RR_x= Rating of renewable energy resources used to meet any exceptions of this code (W).
RR_c= Rating of renewable energy resources used to achieve other energy credits in Section C406 (W).

PGFA = Project gross floor area, ft^2

Where renewable requirements, exceptions, or credits are expressed in annual kWh or Btu rather than Watts of output capacity, they shall be converted as 3413 Btu = 1 kWh and converted to W equivalent capacity as follows:
RR_w= Actual total equivalent rating of renewable energy capacity (W), calculated as follows:
$RR_w = TRE_x / (REN \times PGFA)$
where:
TRE_x= Total renewable energy in kilowatt-hours (kWh) that is excluded from R01 energy credits

C406.3.6 G05 Cooling Energy Storage. Automatic load management controls shall be capable of activating ice or chilled water storage equipment to reduced demand during summer peak periods. Storage tank standby loss shall be demonstrated through analysis to be no more than 2 percent of storage capacity over a 24 hour period for the cooling design day.
Base credits in Section C406.3 are based on storage capacity of the design peak hour cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 times the design day peak hour cooling load, rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the range above. Energy credits shall be determined as follows:

(Equation 4-31)

$$ECs = EC1.0 \times (1.44 X SR + 0.71) / 2.15$$

[Note: Change EC1.0 to $EC_{1.0}$ with subscript in formula]
where:
ECs = Cooling Storage credit achieved for Project

$EC_{1.0}$ = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load
SR = Storage ratio in ton-hours storage per design day ton (kWh/kW) of cooling load where $0.5 \le SR \le 4.0$

C406.3.8 G07 Building Thermal Mass. The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:

1. Interior to the *building envelope* insulation, provide 10 lb/ft(50 kg/m) of project conditioned floor area of passive thermal mass in the *building interior wall*, the inside of the *exterior wall*, or interior floor construction. Mass *construction* shall have mass surfaces directly contacting the air in *conditioned spaces* with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or *exterior wall* mass that is on the exterior of the insulation layer (e.g., the portion of CMU block on the exterior of insulation filled cell cavities) shall not be included toward the *building* mass required.
2. HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush *control* sequence.
3. Night flush controls shall be configured with the following sequence or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating, and is approved by the *authority having jurisdiction*.

   3.1. Summer mode shall be activated when outdoor air temperature exceeds 70ºF (21ºC) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45ºF (7ºC). During summer mode, the occupied cooling *set point* shall be set 1ºF (0.6ºC) higher than normal and the occupied heating *set point* shall be reset 2ºF (1.1ºC) lower than normal.

   3.2. When all the following conditions exist, night flush shall be activated:

      3.2.1. Summer mode is active in accordance with item 3.1.

      3.2.2. Outdoor air temperature is 5ºF (2.8ºC) or more below indoor average zone temperature.

      3.2.3. Indoor average zone temperature is greater than morning occupied heating *set point*.

      3.2.4. In climate zones 0A, 1A, 2A, and ~~through~~ 3A, outdoor dewpoint is below 50ºF (10ºC) or outdoor air enthalpy is less than indoor air enthalpy.

      3.2.5. Local time is between 10:00 pm and 6:00 am.

   3.3. When night flush is active, *automatic* night flush controls shall operate outdoor air *economizers* at low fan speed not exceeding 66 percent during the unoccupied period with *mechanical cooling* and heating locked out.

C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2(1).
2. An annual energy cost that is less than or equal to the percent of the annual energy cost (PAEC) of the *standard reference design* calculated in Equation 4-32. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exceptions:

1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.
2. Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the energy use shall be calculated using source energy factors from Table C407.2(2) For electricity, U.S. locations shall use values eGRID subregions. Locations outside the United States shall use the value for "All other electricity" or locally derived values.

PAEC = 100 x (0.80 ~~0.85~~ + 0.025 - ECr/1000 **(Equation 4-32)**
where:

PAEC = Percentage of annual energy cost applied to standard reference design

EC_r= Energy efficiency credits required for the building in accordance with Section C406.1 (do not include load management and renewable credits)

CF102.1 Advanced Energy Credit Package requirements. The requirements of this Section ~~supercede~~ supersede the requirements of Section C406.1.1. Projects shall comply with measures from C406.2 to achieve the minimum number of required efficiency credits from Table CD102.1 based on building occupancy group and climate zone. Projects with multiple occupancies, unconditioned parking garages, ~~*alterations*,~~ and *buildings* with separate shell-and-core and build-out construction permits shall comply as follows:
Where a project contains multiple occupancies, credits in Table CD102.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406 and Appendix CD.

Exceptions:

1. Unconditioned parking garages that achieve 50 percent of the credits required for use groups S-1 and S-2 in Table CD102.1.
2. Portions of buildings devoted to manufacturing or industrial use.

Reason: This public comment reconciles the as voted document from Subcommittee as modified and voted by the consensus committee from May 12, 2022. The changes are editorial in nature. A few additional editorial changes were made:

- E06 fenestration language was clarified
- H03 heat rejection efficiency changed to performance to match C403 table.
- H05 reference to allowed heating systems clarified
- C406.2.3 clarified that combinations are allowed per C406.2.3.1.4
- W03 adjustment language clarified
- W04, SHW piping insulation separated from distribution temperature maintenance measure group
- Equation variable subscripts clarified and variables reordered to match equation order
- Other minor editorial changes
- Where an "x" was provided in intermediate climate zones due to rounding down a partial credit, it was updated to 1 credit

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposal is editorial only.

Workgroup Recommendation

Proposal # 637

CED1-186-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

CHAPTER 4 [CE]
COMMERCIAL ENERGY EFFICIENCY

Revise as follows:

~~**SECTION C406 ADDITIONAL EFFICIENCY, RENEWABLE, AND LOAD MANAGEMENT REQUIREMENTS.** *Staff note: proposed code changes to existing C406 having been removed by CEPI-193-21 are not incorporated into this draft*~~

~~**C406.1 Compliance.** Buildings shall comply as follows:~~

1. ~~*Buildings* with greater than 2000 square feet (190 m) of floor area shall comply with Section C406.1.1.~~
2. ~~*Buildings* with greater than 5000 square feet (465 m) of *conditioned floor area* shall comply with Sections C406.1.1 and C406.1.2.~~
3. ~~Build-out construction greater than 1000 square feet (93 m) of *conditioned floor area* that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.3.~~

~~**Exceptions:** Core and shell *buildings* where no less than 20 percent of the *net floor area* is without final lighting or final HVAC that comply with all of thefollowing:~~

~~1. *Buildings* with greater than 5000 (465 m) of *conditioned floor* area shall comply with Section C406.1.2.~~

~~2. Portions of the *building* where the *net floor area* is without final lighting or final HVAC shall comply with Section C406.1.3~~

~~3. Portions of the *building* where the *net floor area* has final lighting and final HVAC systems shall comply with C406.1.1.~~

~~**C406.1.1 Additional energy efficiency credit requirements**. *Buildings* shall comply with measures from C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone.~~
~~Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of SectionC406.~~

~~**Exceptions:**~~

~~1. Unconditioned parking garages that achieve 50% of the credits required for use groups S-1 and S-2 in Table C406.1.1.~~

~~2. Portions of buildings devoted to manufacturing or industrial use.~~

~~TABLE C406.1.1 ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP~~

~~Building Occupancy Group~~	**~~Climate Zone~~**																		
	~~0A~~	**~~0B~~**	**~~1A~~**	**~~1B~~**	**~~2A~~**	**~~2B~~**	**~~3A~~**	**~~3B~~**	**~~3C~~**	**~~4A~~**	**~~4B~~**	**~~4C~~**	**~~5A~~**	**~~5B~~**	**~~5C~~**	**~~6A~~**	**~~6B~~**	**~~7~~**	**~~8~~**
~~R-2, R-4, and I-1~~	~~65~~	~~66~~	~~67~~	~~77~~	~~80~~	~~86~~	~~80~~	~~81~~	~~90~~	~~86~~	~~90~~	~~90~~	~~86~~	~~90~~	~~90~~	~~70~~	~~89~~	~~80~~	~~78~~
~~I-2~~	~~43~~	~~42~~	~~38~~	~~37~~	~~36~~	~~38~~	~~32~~	~~32~~	~~30~~	~~36~~	~~36~~	~~35~~	~~43~~	~~43~~	~~44~~	~~46~~	~~47~~	~~50~~	~~53~~
~~R-1~~	~~63~~	~~62~~	~~66~~	~~65~~	~~70~~	~~71~~	~~77~~	~~80~~	~~84~~	~~81~~	~~83~~	~~88~~	~~85~~	~~86~~	~~90~~	~~83~~	~~87~~	~~87~~	~~85~~
~~B~~	~~62~~	~~62~~	~~64~~	~~66~~	~~66~~	~~65~~	~~64~~	~~64~~	~~68~~	~~70~~	~~72~~	~~74~~	~~71~~	~~73~~	~~77~~	~~71~~	~~74~~	~~74~~	~~71~~
~~A-2~~	~~70~~	~~70~~	~~72~~	~~72~~	~~75~~	~~75~~	~~70~~	~~73~~	~~82~~	~~69~~	~~74~~	~~78~~	~~67~~	~~72~~	~~78~~	~~60~~	~~67~~	~~57~~	~~51~~
~~M~~	~~80~~	~~79~~	~~83~~	~~79~~	~~81~~	~~84~~	~~67~~	~~74~~	~~87~~	~~80~~	~~66~~	~~65~~	~~79~~	~~62~~	~~50~~	~~75~~	~~67~~	~~75~~	~~58~~
~~E~~	~~56~~	~~57~~	~~55~~	~~58~~	~~58~~	~~57~~	~~59~~	~~62~~	~~59~~	~~61~~	~~66~~	~~62~~	~~64~~	~~67~~	~~67~~	~~65~~	~~67~~	~~63~~	~~58~~
~~S-1 and S-2~~	~~61~~	~~60~~	~~61~~	~~60~~	~~58~~	~~57~~	~~44~~	~~54~~	~~62~~	~~85~~	~~68~~	~~75~~	~~90~~	~~82~~	~~72~~	~~90~~	~~89~~	~~90~~	~~90~~
~~All Other~~	~~31~~	~~31~~	~~31~~	~~32~~	~~32~~	~~33~~	~~30~~	~~32~~	~~36~~	~~35~~	~~35~~	~~35~~	~~37~~	~~36~~	~~36~~	~~36~~	~~37~~	~~36~~	~~34~~

~~C406.1.1.1 Building Core/Shell and Initial Build-Out Construction.~~ ~~Where separate permits are issued for core and shell buildings and build-outconstruction, compliance shall be in accordance with the following requirements.~~

1. ~~Core and shell buildings or portions of buildings shall comply with one of the following:~~

   1.1. ~~Where the permit includes a central HVAC system or service water-heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required in Table C406.1.1 in accordance with Section C406.2.~~

   1.2. ~~Alternatively, the project shall achieve not less than 33 percent of the energy credits required in Table C406.1.1.~~

~~2.~~ ~~For core and shell *buildings* or portions of *buildings* the energy credits achieved shall be subject to the following adjustments:~~

   ~~2.1.~~ ~~Lighting measure credits shall be determined only for areas with final lighting installed.~~

   ~~2.2.~~ ~~Where HVAC or service water heating systems are designed to serve the entire building, full HVAC or service water heating measure credits shall be achieved.~~

   ~~2.3.~~ ~~Where HVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achievedshall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed.~~

3. ~~Build-out construction shall be deemed to comply with Section C406.1 where either~~:

   3.1. ~~Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required in Table C406.1.1.~~

   3.2. ~~Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required in Table C406.1.1~~

   3.3. ~~Where the core and shell building was approved in accordance with C407 under 2021 IECC or later.~~

~~C406.1.2 Additional renewable and load management credit requirements.~~ ~~Buildings shall comply with measures from C406.3 to achieve not less than the number of required renewable and load management credits from Table C406.1.2 based on building occupancy group and climate zone. Where a project contains multiple occupancies, credits in Table C406.1.2 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.~~

~~TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP~~

~~Building Occupancy Group~~	**~~Climate Zone~~**																		
	~~0A~~	**~~0B~~**	**~~1A~~**	**~~1B~~**	**~~2A~~**	**~~2B~~**	**~~3A~~**	**~~3B~~**	**~~3C~~**	**~~4A~~**	**~~4B~~**	**~~4C~~**	**~~5A~~**	**~~5B~~**	**~~5C~~**	**~~6A~~**	**~~6B~~**	**~~7~~**	**8**
~~R-2, R-4, and I-1~~	~~64~~	~~59~~	~~70~~	~~69~~	~~73~~	~~89~~	~~72~~	~~90~~	~~90~~	~~63~~	~~90~~	~~70~~	~~51~~	~~75~~	~~66~~	~~48~~	~~48~~	~~50~~	42
~~I-2~~	~~31~~	~~32~~	~~33~~	~~32~~	~~33~~	~~36~~	~~31~~	~~40~~	~~34~~	~~32~~	~~43~~	~~32~~	~~29~~	~~37~~	~~33~~	~~34~~	~~34~~	~~27~~	23
~~R-1~~	~~41~~	~~40~~	~~48~~	~~44~~	~~48~~	~~58~~	~~54~~	~~61~~	~~63~~	~~50~~	~~61~~	~~47~~	~~42~~	~~55~~	~~50~~	~~41~~	~~41~~	~~40~~	32
~~B~~	~~63~~	~~64~~	~~74~~	~~75~~	~~78~~	~~89~~	~~83~~	~~90~~	~~90~~	~~77~~	~~90~~	~~86~~	~~68~~	~~90~~	~~83~~	~~72~~	~~72~~	~~68~~	58
~~A-2~~	~~12~~	~~12~~	~~13~~	~~13~~	~~12~~	~~17~~	~~13~~	~~17~~	~~17~~	~~12~~	~~17~~	~~13~~	~~12~~	~~12~~	~~12~~	~~12~~	~~12~~	~~8~~	7
~~M~~	~~71~~	~~70~~	~~84~~	~~84~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~81~~	~~90~~	~~90~~	~~77~~	~~90~~	~~90~~	~~76~~	~~76~~	~~71~~	58
~~E~~	~~49~~	~~55~~	~~64~~	~~61~~	~~69~~	~~83~~	~~73~~	~~90~~	~~90~~	~~67~~	~~90~~	~~75~~	~~61~~	~~86~~	~~74~~	~~66~~	~~66~~	~~60~~	47
~~S-1 and S-2~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~70~~	~~90~~	~~90~~	~~61~~	~~61~~	~~61~~	53
~~All Other~~	~~56~~	~~55~~	~~66~~	~~63~~	~~69~~	~~80~~	~~69~~	~~87~~	~~88~~	~~59~~	~~86~~	~~68~~	~~51~~	~~72~~	~~66~~	~~51~~	~~51~~	~~48~~	40

~~**C406.1.3 Substantial Alterations to Existing Buildings.** The *building envelope*, *equipment*, and *systems* in *alterations* to *buildings* exceeding 5000 square feet (46.5 m^2) of *gross conditioned floor area* shall comply with the requirements of Section C406.1.1 and C406.1.2 where the alteration includes replacementof two or more of the following:~~

1. ~~HVAC unitary systems or HVAC central heating or cooling equipment serving the alteration area, not including ductwork or *piping*.~~
2. ~~80% or more of the lighting fixtures in the *alteration* area.~~
3. ~~Building envelope components in the *alteration* area including new exterior cladding, fenestration, or insulation.~~

~~**C406.1.4 Energy Credits Achieved.** Energy credits achieved for the project shall be the sum of measure energy credits for individual measures included in the project.Credits are available for the measures listed in Section C406.2. Base energy credits are shown in Tables C406.1.4(1) through C406.1.4(9) based on building occupancies and climate zones. Measure energy credits achieved shall be determined in one of three ways, depending on the measure:~~

1. ~~The measure energy credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the measure description in Section C406.2.~~
2. ~~The measure energy credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the measure description in Section C406.2. Where adjustments are applied, each measure energy credit shall be rounded to the nearest whole number.~~
3. ~~The measure energy credit shall be by direct formula as stated in the measure description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.~~

~~**C406.2 Additional Energy Efficiency Credits Achieved.** Each energy effi ciency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the base credits listed for the measure and occupancy type in Tables C406.2(1) through C406.2(9) or, where calculations required by Sections C406.2.1 through C406.2.7 create or modify the table credits, the credits achieved shall be based upon the calculations. Energy credits achieved for measures shall be determined by one of the following, as applicable:~~

1. ~~The measure's energy credit shall be the base energy credit for the measure where no adjustment factor or calculation is included in the description ofthe measure in Section C406.2.~~
2. ~~The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.~~
3. ~~The measure's energy credit shall be calculation as stated in the measures description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.~~

~~Energy credits achieved for the project shall be the sum of the individual measure's energy credits. Credits are available for the measures listed in this Section. Where a project contains multiple building occupancy groups:~~

1. ~~Credits achieved for each occupancy group shall be summed and then weighted by the fl oor area of each occupancy group to determine the weighted average project energy credits achieved.~~
2. ~~Credits for improved envelope effi ciency and lighting reduction (L06) shall be determined for the building or permitted fl oor area as a whole. Credits for other measures shall be taken from applicable tables or calculations weighted by the building occupancy group floor area.~~

~~TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]~~

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	8	13	7	11	6	8	9	6	1	24	8	9	30	15	5	32	28	31	36
E03	Envelope leak reduction	C406.2.1.3	15	10	12	8	6	16	13	5	1	7	7	9	65	16	1	73	43	52	26
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	4	3	1	5	3	4	6	5	1	7	7	6	8
E05	Add Wall Insulation	C406.2.1.5	10	10	6	8	5	6	8	4	1	8	3	4	11	7	1	14	12	13	13
E06	Improve Fenestration	C406.2.1.6	7	7	4	6	9	11	13	3	1	22	5	10	27	18	7	41	33	22	21
H01	HVAC Performance	C406.2.2.1	20	19	16	17	14	13	11	11	5	13	10	8	15	12	7	18	14	17	19
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	3	1	1	6	2	3	10	5	2	14	10	13	16
H03	Cooling efficiency	C406.2.2.3	7	6	4	4	3	3	1	1	1	1	1	1	1	1	x	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	9	10	8	22	20	25	16	17	32	21	24	17	23	27	16	21	24	18	18
H05	DOAS/fan control	C406.2.2.5	32	31	27	28	23	23	28	21	12	42	24	24	56	36	19	73	54	70	79
W01	SHW preheat recovery	C406.2.3.1 a	61	63	74	74	85	88	101	100	121	103	109	122	102	111	130	93	106	99	96
W02	Heat pump water heater	C406.2.3.1 b	50	52	62	61	72	74	86	85	104	88	94	106	88	96	112	81	92	87	84
W03	Efficient gas water heater	C406.2.3.1 c	38	39	46	46	53	55	63	62	76	64	68	76	64	69	81	58	66	62	60
W04	SHW pipe insulation	C406.2.3.2	7	7	8	7	8	8	8	9	10	8	9	9	7	8	9	6	7	6	6
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	3	3	3	3	3	3	3	3	4	3	3	4	3	3	4	3	3	3	2
W07	SHW heat trace system	C406.2.3.3 c	12	12	13	13	14	15	15	15	18	14	15	16	13	14	16	11	13	11	10
W08	SHW submeters	C406.2.3.4	11	11	13	13	15	16	18	18	22	19	20	22	19	20	24	17	20	18	18
W09	SHW distribution sizing	C406.2.3.5	45	46	55	54	63	65	74	73	89	75	80	89	74	81	95	68	77	72	70
W10	Shower heat recovery	C406.2.3.6	15	16	19	19	22	23	26	26	32	27	29	32	27	29	34	25	28	27	26
P01	Energy monitoring	C406.2.4	3	3	2	3	2	2	2	2	2	2	2	2	2	2	2	3	2	2	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
L03	Increase occp. sensor	C406.2.5.3	3	3	4	4	4	4	3	4	3	2	3	2	1	1	2	1	1	1	1
L04	Increase daylight area	C406.2.5.4	5	5	5	5	5	5	4	4	4	4	4	3	3	4	3	2	3	3	2
L05	Residential light control	C406.2.5.5	8	8	9	9	9	9	8	8	10	6	8	7	4	6	8	3	5	4	3
L06	Light power reduction	C406.2.5.7	2	2	2	2	2	2	2	2	2	1	2	1	1	1	1	1	1	1	1
Q01	Efficient elevator	C406.2.7.1	4	4	4	4	5	5	5	5	5	4	5	5	4	4	5	4	4	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	15	15	17	16	17	18	17	18	20	16	17	18	15	16	18	13	15	13	12
Q04	Fault detection	C406.2.7.4	3	3	2	3	2	2	2	2	1	2	2	1	1	2	1	3	2	3	3

~~a. "x" indicates credit is not available for that measure.~~

TABLE 406.2(2) BASE ENERGY CREDITS FOR GROUP I-2 OCCUPANCIES[a]

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	6	11	6	11	7	9	6	6	2	3	3	3	4	3	7	5	5	17	3
E03	Envelope leak reduction	C406.2.1.3	5	3	4	3	5	8	8	3	2	6	2	2	7	3	1	9	7	19	5
E04	Add Roof Insulation	C406.2.1.4	1	1	1	1	1	1	1	1	1	1	1	1	2	1	1	2	1	2	3
E05	Add Wall Insulation	C406.2.1.5	1	3	1	3	2	2	9	4	1	4	1	1	3	1	1	3	3	3	3
E06	Improve Fenestration	C406.2.1.6	1	1	1	1	1	1	1	1	1	4	3	5	5	1	1	5	5	2	2
H01	HVAC Performance	C406.2.2.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H02	Heating efficiency	C406.2.2.2	x	x	x	x	2	3	4	3	7	6	4	6	8	6	10	11	12	15	19
H03	Cooling efficiency	C406.2.2.3	6	6	4	4	3	3	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	41	41	40	40	42	36	42	37	39	49	40	46	56	46	61	65	68	82	93
W01	SHW preheat recovery	C406.2.3.1 a	4	4	4	4	5	5	5	5	6	6	6	6	6	6	6	6	5	5	5
W02	Heat pump water heater	C406.2.3.1 b	2	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3
W03	Efficient gas water heater	C406.2.3.1 c	2	2	2	2	2	3	3	3	3	3	3	3	3	3	3	3	3	3	3
W04	SHW pipe insulation	C406.2.3.2	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W05	Point of use water heaters	C406.2.3.3 a	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
W07	SHW heat trace system	C406.2.3.3 c	1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1	1	1
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1
P01	Energy monitoring	C406.2.4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	5	5	6	5	6	6	5	6	6	5	5	5	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	5	5	5	5	5	5	5	5	6	5	5	6	5	5	5	4	4	3	2
L04	Increase daylight area	C406.2.5.4	7	7	7	7	7	7	7	7	8	6	6	6	6	6	5	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	7	7	7	7	7	7	7	7	9	7	7	8	6	7	7	5	5	4	3
Q01	Efficient elevator	C406.2.7.1	1	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	2	1	1
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	3	3	3	3	3	3	3	3	2	3	3	2	3	3	3	3	3	4	4

a. "x" indicates credit is not available for that measure.

~~TABLE 406.2(3) BASE ENERGY CREDITS FOR GROUP R-1 OCCUPANICES[a]~~

~~ID~~	~~Energy Credit Measure~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	5B	5C	6A	6B	7	8
~~E01~~	~~Envelope Performance~~	~~C406.2.1.1~~	~~Determined in accordance with Section C406.2.1.1~~																		
~~E02~~	~~UA reduction (15%)~~	~~C406.2.1.2~~	~~4~~	~~7~~	~~4~~	~~7~~	~~3~~	~~4~~	~~7~~	~~2~~	~~1~~	~~7~~	~~2~~	~~3~~	~~10~~	6	4	12	9	19	11
~~E03~~	~~Envelope leakage reduction~~	~~C406.2.1.3~~	~~5~~	~~3~~	~~4~~	~~2~~	~~2~~	~~2~~	~~5~~	~~1~~	~~1~~	~~8~~	~~1~~	~~2~~	~~13~~	4	1	18	9	18	7
~~E04~~	~~Add Roof Insulation~~	~~C406.2.1.4~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~2~~	~~1~~	~~3~~	~~1~~	~~2~~	~~3~~	2	2	3	3	2	3
~~E05~~	~~Add Wall Insulation~~	~~C406.2.1.5~~	~~13~~	~~14~~	~~8~~	~~11~~	~~4~~	~~4~~	~~7~~	~~4~~	~~1~~	~~5~~	~~2~~	~~4~~	~~6~~	4	3	9	7	10	8
~~E06~~	~~Improve Fenestration~~	~~C406.2.1.6~~	~~5~~	~~5~~	~~4~~	~~5~~	~~7~~	~~7~~	~~8~~	~~2~~	~~1~~	~~8~~	~~2~~	~~4~~	~~10~~	5	1	21	17	10	9
~~H01~~	~~HVAC Performance~~	~~C406.2.2.1~~	~~21~~	~~20~~	~~17~~	~~18~~	~~16~~	~~13~~	~~12~~	~~12~~	~~11~~	~~11~~	~~11~~	~~8~~	~~11~~	11	8	13	11	14	16
~~H02~~	~~Heating efficiency~~	~~C406.2.2.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~1~~	~~1~~	~~6~~	~~2~~	~~1~~	~~1~~	~~3~~	2	2	6	4	8	11
~~H03~~	~~Cooling efficiency~~	~~C406.2.2.3~~	~~7~~	~~6~~	~~4~~	~~4~~	~~3~~	~~2~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	1	1	x	x	x	x
~~H04~~	~~Residential HVAC control~~	~~C406.2.2.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~H05~~	~~DOAS/fan control~~	~~C406.2.2.5~~	~~32~~	~~30~~	~~26~~	~~28~~	~~25~~	~~23~~	~~24~~	~~22~~	~~28~~	~~26~~	~~22~~	~~20~~	~~30~~	26	19	41	34	48	62
~~W01~~	~~SHW preheat recovery~~	~~C406.2.3.1 a~~	~~18~~	~~19~~	~~22~~	~~22~~	~~25~~	~~27~~	~~31~~	~~21~~	~~32~~	~~34~~	~~34~~	~~38~~	~~37~~	36	40	36	37	36	35
~~W02~~	~~Heat pump water heater~~	~~C406.2.3.1 b~~	~~14~~	~~15~~	~~18~~	~~17~~	~~20~~	~~22~~	~~25~~	~~25~~	~~27~~	~~29~~	~~29~~	~~32~~	~~31~~	31	34	30	32	31	30
~~W03~~	~~Efficient gas water heater~~	~~C406.2.3.1 c~~	~~11~~	~~12~~	~~14~~	~~14~~	~~16~~	~~17~~	~~19~~	~~19~~	~~20~~	~~21~~	~~21~~	~~24~~	~~23~~	23	25	22	23	23	22
~~W04~~	~~SHW pipe insulation~~	~~C406.2.3.2~~	~~3~~	~~3~~	~~4~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	4	4	4	4	4	3
~~W05~~	~~Point of use water heaters~~	~~C406.2.3.3 a~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~W06~~	~~Thermostatic bal. valves~~	~~C406.2.3.3 b~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	2	2	2	2	1	1
~~W07~~	~~SHW heat trace system~~	~~C406.2.3.3 c~~	~~5~~	~~6~~	~~6~~	~~6~~	~~6~~	~~7~~	~~7~~	~~7~~	~~7~~	~~7~~	~~7~~	~~8~~	~~7~~	7	8	7	7	6	6
~~W08~~	~~SHW submeters~~	~~C406.2.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~W09~~	~~SHW flow reduction~~	~~C406.2.3.5~~	~~13~~	~~14~~	~~16~~	~~16~~	~~18~~	~~20~~	~~22~~	~~22~~	~~23~~	~~25~~	~~25~~	~~28~~	~~27~~	26	29	26	27	26	25
~~W10~~	~~Shower heat recovery~~	~~C406.2.3.6~~	~~4~~	~~5~~	~~5~~	~~5~~	~~6~~	~~7~~	~~8~~	~~8~~	~~8~~	~~9~~	~~9~~	~~10~~	~~10~~	9	10	9	10	10	9
~~P01~~	~~Energy monitoring~~	~~C406.2.4~~	~~3~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	2	2	2	2	2	2
~~L01~~	~~Lighting Performance~~	~~C406.2.5.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~L02~~	~~Lighting dimming & tuning~~	~~C406.2.5.2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	1	1	1	1	1	1
~~L03~~	~~Increase occp. sensor~~	~~C406.2.5.3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~4~~	~~2~~	~~3~~	~~2~~	2	3	2	2	1	1
~~L04~~	~~Increase daylight area~~	~~C406.2.5.4~~	~~4~~	~~5~~	~~5~~	~~4~~	~~5~~	~~5~~	~~4~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~3~~	4	3	3	3	3	2
~~L05~~	~~Residential light control~~	~~C406.2.5.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~L06~~	~~Light power reduction~~	~~C406.2.5.7~~	~~1~~	~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~1~~	1	2	1	1	1	1
~~Q01~~	~~Efficient elevator~~	~~C406.2.7.1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	3	3	2	2	2	2
~~Q02~~	~~Commercial kitchen equip.~~	~~C406.2.7.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~Q03~~	~~Residential kitchen equip.~~	~~C406.2.7.3~~	~~9~~	~~9~~	~~10~~	~~10~~	~~10~~	~~11~~	~~11~~	~~11~~	~~11~~	~~11~~	~~11~~	~~12~~	~~11~~	11	12	10	11	10	9
~~Q04~~	~~Fault detection~~	~~C406.2.7.4~~	~~3~~	~~3~~	~~3~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	2	1	2	2	2	2

~~a. "x" indicates credit is not available for that measure.~~

~~TABLE 406.2(4) BASE ENERGY CREDITS FOR GROUP B OCCUPANCIES~~[~~a~~]

~~ID~~	~~Energy Credit Measure~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	5B	5C	6A	6B	7	8
~~E01~~	~~Envelope Performance~~	~~C406.2.1.1~~	~~Determined in accordance with Section C406.2.1.1~~																		
~~E02~~	~~UA reduction (15%)~~	~~C406.2.1.2~~	~~4~~	~~7~~	~~4~~	~~7~~	~~3~~	~~4~~	~~7~~	~~2~~	~~0~~	~~7~~	~~2~~	~~3~~	~~10~~	~~6~~	~~4~~	~~12~~	~~9~~	~~19~~	~~11~~
~~E03~~	~~Envelope leak reduction~~	~~C406.2.1.3~~	~~5~~	~~3~~	~~4~~	~~2~~	~~2~~	~~2~~	~~5~~	~~1~~	~~0~~	~~8~~	~~0~~	~~2~~	~~13~~	~~4~~	~~0~~	~~18~~	~~9~~	~~18~~	~~7~~
~~E04~~	~~Add Roof Insulation~~	~~C406.2.1.4~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~2~~	~~1~~	~~3~~	~~1~~	~~2~~	~~3~~	~~2~~	~~2~~	~~3~~	~~3~~	~~2~~	~~3~~
~~E05~~	~~Add Wall Insulation~~	~~C406.2.1.5~~	~~13~~	~~14~~	~~8~~	~~11~~	~~4~~	~~4~~	~~7~~	~~4~~	~~1~~	~~5~~	~~2~~	~~4~~	~~6~~	~~4~~	~~3~~	~~9~~	~~7~~	~~10~~	~~8~~
~~E06~~	~~Improve Fenestration~~	~~C406.2.1.6~~	~~5~~	~~5~~	~~4~~	~~5~~	~~7~~	~~7~~	~~8~~	~~2~~	~~1~~	~~8~~	~~2~~	~~4~~	~~10~~	~~5~~	~~1~~	~~21~~	~~17~~	~~10~~	~~9~~
~~H01~~	~~HVAC Performance~~	~~C406.2.2.1~~	~~22~~	~~22~~	~~19~~	~~20~~	~~17~~	~~17~~	~~15~~	~~15~~	~~11~~	~~15~~	~~15~~	~~11~~	~~16~~	~~15~~	~~11~~	~~19~~	~~17~~	~~18~~	~~20~~
~~H02~~	~~Heating efficiency~~	~~C406.2.2.2~~	~~X~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~1~~	~~1~~	~~1~~	~~3~~	~~2~~	~~2~~	~~5~~	~~4~~	~~3~~	~~9~~	~~7~~	~~8~~	~~12~~
~~H03~~	~~Cooling efficiency~~	~~C406.2.2.3~~	~~7~~	~~6~~	~~4~~	~~5~~	~~3~~	~~3~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H04~~	~~Residential HVAC control~~	~~C406.2.2.4~~	~~X~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H05~~	~~DOAS/fan control~~	~~C406.2.2.5~~	~~31~~	~~31~~	~~27~~	~~29~~	~~25~~	~~25~~	~~28~~	~~26~~	~~18~~	~~35~~	~~28~~	~~28~~	~~47~~	~~38~~	~~29~~	~~64~~	~~53~~	~~58~~	~~74~~
~~W01~~	~~SHW preheat recovery~~	~~C406.2.3.1 a~~	~~8~~	~~9~~	~~10~~	~~9~~	~~11~~	~~11~~	~~12~~	~~12~~	~~14~~	~~13~~	~~13~~	~~14~~	~~13~~	~~13~~	~~15~~	~~12~~	~~13~~	~~14~~	~~14~~
~~W02~~	~~Heat pump water heater~~	~~C406.2.3.1 b~~	~~3~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~	~~5~~	~~4~~	~~5~~	~~5~~	~~5~~	~~6~~	~~5~~	~~5~~	~~6~~	~~5~~	~~5~~	~~6~~	~~6~~
~~W03~~	~~Efficient gas water heater~~	~~C406.2.3.1 c~~	~~5~~	~~5~~	~~6~~	~~6~~	~~7~~	~~7~~	~~8~~	~~7~~	~~8~~	~~8~~	~~8~~	~~9~~	~~8~~	~~8~~	~~9~~	~~8~~	~~8~~	~~9~~	~~8~~
~~W04~~	~~SHW pipe insulation~~	~~C406.2.3.2~~	~~3~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~4~~	~~4~~
~~W05~~	~~Point of use water heaters~~	~~C406.2.3.3 a~~	~~12~~	~~15~~	~~17~~	~~16~~	~~18~~	~~18~~	~~19~~	~~19~~	~~22~~	~~20~~	~~20~~	~~22~~	~~20~~	~~20~~	~~22~~	~~18~~	~~19~~	~~20~~	~~19~~
~~W06~~	~~Thermostatic bal. valves~~	~~C406.2.3.3 b~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~
~~W07~~	~~SHW heat trace system~~	~~C406.2.3.3 c~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~6~~	~~5~~	~~5~~	~~6~~	~~5~~	~~5~~	~~6~~	~~5~~	~~5~~	~~5~~	~~5~~
~~W08~~	~~SHW submeters~~	~~C406.2.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W09~~	~~SHW flow reduction~~	~~C406.2.3.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W10~~	~~Shower heat recovery~~	~~C406.2.3.6~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~P01~~	~~Energy monitoring~~	~~C406.2.4~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~
~~L01~~	~~Lighting Performance~~	~~C406.2.5.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~L02~~	~~Lighting dimming & tuning~~	~~C406.2.5.2~~	~~5~~	~~5~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~7~~	~~6~~	~~6~~	~~6~~	~~5~~	~~5~~	~~6~~	~~4~~	~~5~~	~~3~~	~~2~~
~~L03~~	~~Increase occp. sensor~~	~~C406.2.5.3~~	~~5~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~8~~	~~6~~	~~6~~	~~6~~	~~5~~	~~5~~	~~6~~	~~4~~	~~5~~	~~4~~	~~3~~
~~L04~~	~~Increase daylight area~~	~~C406.2.5.4~~	~~7~~	~~7~~	~~8~~	~~8~~	~~8~~	~~8~~	~~8~~	~~8~~	~~9~~	~~6~~	~~7~~	~~7~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~7~~	~~5~~
~~L05~~	~~Residential light control~~	~~C406.2.5.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~L06~~	~~Light power reduction~~	~~C406.2.5.7~~	~~7~~	~~7~~	~~8~~	~~8~~	~~8~~	~~8~~	~~8~~	~~8~~	~~9~~	~~7~~	~~8~~	~~8~~	~~6~~	~~7~~	~~8~~	~~5~~	~~6~~	~~5~~	~~3~~
~~Q01~~	~~Efficient elevator~~	~~C406.2.7.1~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~4~~	~~5~~	~~4~~	~~4~~
~~Q02~~	~~Commercial kitchen equip.~~	~~C406.2.7.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~Q03~~	~~Residential kitchen equip.~~	~~C406.2.7.3~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~Q04~~	~~Fault detection~~	~~C406.2.7.4~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~

~~a. "x" indicates measure is not available for building occupancy in that climate zone.~~

~~TABLE 406.2(5) BASE ENERGY CREDITS FOR GROUP A-2 OCCUPANCIES[a]~~

~~ID~~	~~Energy Credit Measure~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~E01~~	~~Envelope Performance~~	~~C406.2.1.1~~	~~Determined in accordance with Section C406.2.1.1~~																		
~~E02~~	~~UA reduction (15%)~~	~~C406.2.1.2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~2~~	~~9~~	~~2~~	~~1~~	~~19~~	~~4~~	~~5~~	~~26~~	~~7~~	~~3~~	~~33~~	~~23~~	~~29~~	~~13~~
~~E03~~	~~Envelope leak reduction~~	~~C406.2.1.3~~	~~2~~	~~1~~	~~1~~	~~1~~	~~2~~	~~3~~	~~11~~	~~2~~	~~1~~	~~24~~	~~4~~	~~6~~	~~33~~	~~9~~	~~3~~	~~42~~	~~29~~	~~36~~	~~16~~
~~E04~~	~~Add Roof Insulation~~	~~C406.2.1.4~~	~~1~~	~~1~~	~~0~~	~~1~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~2~~	~~1~~	~~2~~	~~2~~	~~1~~	~~2~~
~~E05~~	~~Add Wall Insulation~~	~~C406.2.1.5~~	~~1~~	~~1~~	~~0~~	~~1~~	~~1~~	~~2~~	~~3~~	~~3~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~
~~E06~~	~~Improve Fenestration~~	~~C406.2.1.6~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~2~~	~~1~~	~~1~~	~~2~~	~~2~~	~~3~~	~~2~~	~~1~~	~~4~~	~~4~~	~~1~~	~~1~~
~~H01~~	~~HVAC Performance~~	~~C406.2.2.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H02~~	~~Heating efficiency~~	~~C406.2.2.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~1~~	~~1~~	~~6~~	~~3~~	~~3~~	~~10~~	~~6~~	~~8~~	~~15~~	~~11~~	~~10~~	~~19~~	~~15~~	~~23~~	~~28~~
~~H03~~	~~Cooling efficiency~~	~~C406.2.2.3~~	~~6~~	~~5~~	~~3~~	~~4~~	~~3~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H04~~	~~Residential HVAC control~~	~~C406.2.2.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H05~~	~~DOAS/fan control~~	~~C406.2.2.5~~	~~29~~	~~27~~	~~20~~	~~25~~	~~24~~	~~21~~	~~36~~	~~27~~	~~15~~	~~51~~	~~35~~	~~38~~	~~67~~	~~53~~	~~45~~	~~84~~	~~70~~	~~97~~	~~115~~
~~W01~~	~~SHW preheat recovery~~	~~C406.2.3.1 a~~	~~24~~	~~26~~	~~31~~	~~29~~	~~33~~	~~35~~	~~37~~	~~38~~	~~45~~	~~38~~	~~41~~	~~44~~	~~37~~	~~40~~	~~44~~	~~34~~	~~38~~	~~33~~	~~30~~
~~W02~~	~~Heat pump water heater~~	~~C406.2.3.1 b~~	~~15~~	~~16~~	~~19~~	~~18~~	~~21~~	~~23~~	~~25~~	~~25~~	~~29~~	~~26~~	~~28~~	~~30~~	~~26~~	~~28~~	~~31~~	~~25~~	~~27~~	~~24~~	~~22~~
~~W03~~	~~Efficient gas water heater~~	~~C406.2.3.1 c~~	~~15~~	~~16~~	~~19~~	~~18~~	~~21~~	~~22~~	~~23~~	~~24~~	~~28~~	~~24~~	~~25~~	~~27~~	~~23~~	~~25~~	~~27~~	~~21~~	~~24~~	~~21~~	~~18~~
~~W04~~	~~SHW pipe insulation~~	~~C406.2.3.2~~	~~2~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~2~~	~~3~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~
~~W05~~	~~Point of use water heaters~~	~~C406.2.3.3 a~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W06~~	~~Thermostatic bal. valves~~	~~C406.2.3.3 b~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~
~~W07~~	~~SHW heat trace system~~	~~C406.2.3.3 c~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~3~~	~~4~~	~~4~~	~~3~~	~~3~~	~~3~~	~~3~~
~~W08~~	~~SHW submeters~~	~~C406.2.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W09~~	~~SHW flow reduction~~	~~C406.2.3.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W10~~	~~Shower heat recovery~~	~~C406.2.3.6~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~P01~~	~~Energy monitoring~~	~~C406.2.4~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~2~~	~~1~~	~~2~~	~~2~~	~~2~~	~~3~~
~~L01~~	~~Lighting Performance~~	~~C406.2.5.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~L02~~	~~Lighting dimming & tuning~~	~~C406.2.5.2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~0~~
~~L03~~	~~Increase occp. sensor~~	~~C406.2.5.3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~0~~
~~L04~~	~~Increase daylight area~~	~~C406.2.5.4~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~
~~L05~~	~~Residential light control~~	~~C406.2.5.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~L06~~	~~Light power reduction~~	~~C406.2.5.7~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~1~~	~~1~~
~~Q01~~	~~Efficient elevator~~	~~C406.2.7.1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~
~~Q02~~	~~Commercial kitchen equip.~~	~~C406.2.7.2~~	~~24~~	~~26~~	~~28~~	~~27~~	~~28~~	~~29~~	~~27~~	~~29~~	~~32~~	~~26~~	~~28~~	~~29~~	~~24~~	~~26~~	~~28~~	~~21~~	~~23~~	~~19~~	~~17~~
~~Q03~~	~~Residential kitchen equip.~~	~~C406.2.7.3~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~Q04~~	~~Fault detection~~	~~C406.2.7.4~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~2~~	~~1~~	~~2~~	~~2~~	~~2~~	~~3~~	~~2~~	~~3~~	~~4~~

~~a. "x" indicates measure is not available for that measure.~~

~~TABLE 406.2(6) BASE ENERGY CREDITS FOR GROUP M OCCUPANCIES[a]~~

ID	~~Energy Credit Measure~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	5B	5C	6A	6B	7	8
~~E01~~	~~Envelope Performance~~	~~C406.2.1.1~~	~~Determined in accordance with Section C406.2.1.1~~																		
~~E02~~	~~UA reduction (15%)~~	~~C406.2.1.2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~15~~	~~2~~	~~1~~	~~36~~	~~5~~	~~9~~	~~45~~	11	5	51	36	35	15
~~E03~~	~~Envelope leak reduction~~	~~C406.2.1.3~~	~~3~~	~~3~~	~~2~~	~~2~~	~~3~~	~~3~~	~~19~~	~~3~~	~~1~~	~~44~~	~~6~~	~~11~~	~~56~~	13	6	64	44	43	19
~~E04~~	~~Add Roof Insulation~~	~~C406.2.1.4~~	~~8~~	~~6~~	~~5~~	~~7~~	~~7~~	~~7~~	~~18~~	~~16~~	~~4~~	~~19~~	~~18~~	~~20~~	~~21~~	22	23	24	26	24	30
~~E05~~	~~Add Wall Insulation~~	~~C406.2.1.5~~	~~64~~	~~65~~	~~48~~	~~62~~	~~13~~	~~15~~	~~23~~	~~18~~	~~4~~	~~27~~	~~21~~	~~27~~	~~25~~	24	25	23	24	24	16
~~E06~~	~~Improve Fenestration~~	~~C406.2.1.6~~	~~4~~	~~3~~	~~3~~	~~3~~	~~4~~	~~4~~	~~6~~	~~5~~	~~2~~	~~7~~	~~5~~	~~7~~	~~7~~	5	7	10	10	3	3
~~H01~~	~~HVAC Performance~~	~~C406.2.2.1~~	~~31~~	~~30~~	~~26~~	~~28~~	~~23~~	~~21~~	~~23~~	~~20~~	~~14~~	~~27~~	~~21~~	~~22~~	~~29~~	25	23	32	28	30	33
~~H02~~	~~Heating efficiency~~	~~C406.2.2.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~10~~	~~3~~	~~1~~	~~19~~	~~8~~	~~15~~	~~26~~	17	18	29	24	27	31
~~H03~~	~~Cooling efficiency~~	~~C406.2.2.3~~	~~10~~	~~9~~	~~7~~	~~7~~	~~5~~	~~4~~	~~2~~	~~2~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	1	1	x	x	x	x
~~H04~~	~~Residential HVAC control~~	~~C406.2.2.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~H05~~	~~DOAS/fan control~~	~~C406.2.2.5~~	~~48~~	~~48~~	~~42~~	~~47~~	~~40~~	~~38~~	~~66~~	~~46~~	~~31~~	~~98~~	~~61~~	~~82~~	~~120~~	91	90	134	115	125	141
~~W01~~	~~SHW preheat recovery~~	~~C406.2.3.1 a~~	~~12~~	~~13~~	~~16~~	~~15~~	~~18~~	~~20~~	~~19~~	~~21~~	~~26~~	~~17~~	~~21~~	~~21~~	~~16~~	19	21	13	16	15	13
~~W02~~	~~Heat pump water heater~~	~~C406.2.3.1 b~~	~~3~~	~~3~~	~~4~~	~~3~~	~~4~~	~~5~~	~~5~~	~~5~~	~~7~~	~~5~~	~~6~~	~~6~~	~~4~~	5	6	4	4	4	4
~~W03~~	~~Efficient gas water heater~~	~~C406.2.3.1 c~~	~~6~~	~~7~~	~~8~~	~~8~~	~~10~~	~~10~~	~~10~~	~~11~~	~~14~~	~~9~~	~~11~~	~~11~~	~~8~~	10	11	7	8	8	7
~~W04~~	~~SHW pipe insulation~~	~~C406.2.3.2~~	~~3~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	4	5	4	4	4	4
~~W05~~	~~Point of use water heaters~~	~~C406.2.3.3 a~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	
~~W06~~	~~Thermostatic bal. valves~~	~~C406.2.3.3 b~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	1	1	1	1	1	1
~~W07~~	~~SHW heat trace system~~	~~C406.2.3.3 c~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~6~~	~~5~~	~~5~~	~~6~~	~~5~~	5	6	5	5	5	5
~~W08~~	~~SHW submeters~~	~~C406.2.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~W09~~	~~SHW flow reduction~~	~~C406.2.3.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~W10~~	~~Shower heat recovery~~	~~C406.2.3.6~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~P01~~	~~Energy monitoring~~	~~C406.2.4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	~~5~~	5	5	5	5	5	5
~~L01~~	~~Lighting Performance~~	~~C406.2.5.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~L02~~	~~Lighting dimming & tuning~~	~~C406.2.5.2~~	~~9~~	~~9~~	~~11~~	~~10~~	~~12~~	~~13~~	~~11~~	~~13~~	~~15~~	~~9~~	~~12~~	~~11~~	~~7~~	9	10	5	7	5	3
~~L03~~	~~Increase occp. sensor~~	~~C406.2.5.3~~	~~9~~	~~9~~	~~11~~	~~10~~	~~12~~	~~13~~	~~12~~	~~13~~	~~15~~	~~10~~	~~12~~	~~11~~	~~7~~	10	11	6	8	5	4
~~L04~~	~~Increase daylight area~~	~~C406.2.5.4~~	~~12~~	~~13~~	~~15~~	~~14~~	~~16~~	~~17~~	~~15~~	~~16~~	~~20~~	~~11~~	~~14~~	~~13~~	~~9~~	12	11	8	10	10	8
~~L05~~	~~Residential light control~~	~~C406.2.5.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~L06~~	~~Light power reduction~~	~~C406.2.5.7~~	~~12~~	~~12~~	~~14~~	~~14~~	~~15~~	~~16~~	~~12~~	~~15~~	~~19~~	~~8~~	~~12~~	~~9~~	~~6~~	10	7	6	7	6	5
~~Q01~~	~~Efficient elevator~~	~~C406.2.7.1~~	~~3~~	~~3~~	~~4~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~3~~	~~4~~	~~4~~	~~3~~	4	4	3	3	3	2
~~Q02~~	~~Commercial kitchen equip.~~	~~C406.2.7.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~Q03~~	~~Residential kitchen equip.~~	~~C406.2.7.3~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~Q04~~	~~Fault detection~~	~~C406.2.7.4~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~	~~2~~	~~2~~	~~1~~	~~2~~	2	2	3	2	3	4

~~a. "x" indicates credit is not available for that measure.~~

TABLE 406.2(7) BASE ENERGY CREDITS FOR GROUP E OCCUPANCIES[a]

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	9	22	8	20	9	12	5	11	3	4	9	2	3	6	0	4	3	4	3
E03	Envelope leak reduction	C406.2.1.3	4	3	3	3	2	5	2	1	1	1	1	1	1	1	1	2	1	1	1
E04	Add Roof Insulation	C406.2.1.4	8	8	4	9	5	7	16	7	1	14	7	10	18	13	13	23	25	22	28
E05	Add Wall Insulation	C406.2.1.5	5	7	4	8	3	6	8	6	2	6	3	6	5	5	6	7	6	7	8
E06	Improve Fenestration	C406.2.1.6	8	10	6	9	11	11	15	9	1	16	8	15	22	18	19	33	9	19	18
H01	HVAC Performance	C406.2.2.1	30	28	25	26	23	21	20	18	15	19	18	17	19	20	15	23	20	25	29
H02	Heating efficiency	C406.2.2.2	x	x	x	x	x	x	4	3	3	5	5	10	9	11	6	15	11	18	26
H03	Cooling efficiency	C406.2.2.3	9	8	6	7	5	4	2	2	1	1	1	1	1	1	1	x	x	x	x
H04	Residential HVAC control	C406.2.2.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
H05	DOAS/fan control	C406.2.2.5	45	42	37	41	36	34	41	39	30	43	46	58	57	65	40	79	63	88	117
W01	SHW preheat recovery	C406.2.3.1 a	7	7	9	8	10	11	13	13	15	14	15	15	15	14	17	13	15	14	12
W02	Heat pump water heater	C406.2.3.1 b	4	4	6	5	7	7	9	9	10	10	10	11	11	10	12	10	11	10	9
W03	Efficient gas water heater	C406.2.3.1 c	4	4	6	5	6	7	8	8	9	9	9	10	9	9	11	8	10	9	7
W04	SHW pipe insulation	C406.2.3.2	3	3	4	4	4	4	4	5	6	5	5	6	5	5	7	4	5	4	4
W05	Point of use water heaters	C406.2.3.3 a	3	4	4	4	4	5	5	5	6	5	5	5	5	5	6	4	5	4	3
W06	Thermostatic bal. valves	C406.2.3.3 b	1	1	1	1	1	1	1	2	2	2	2	2	2	2	2	1	2	1	1
W07	SHW heat trace system	C406.2.3.3 c	4	4	4	4	5	5	5	6	7	6	6	7	6	6	8	5	7	5	5
W08	SHW submeters	C406.2.3.4	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W09	SHW flow reduction	C406.2.3.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
W10	Shower heat recovery	C406.2.3.6	2	2	2	2	3	3	3	3	4	3	3	4	3	3	4	3	3	3	3
P01	Energy monitoring	C406.2.4	4	4	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	3	4
L01	Lighting Performance	C406.2.5.1	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L02	Lighting dimming & tuning	C406.2.5.2	5	5	5	6	6	6	5	6	7	6	6	6	5	5	6	4	4	3	2
L03	Increase occp. sensor	C406.2.5.3	4	4	5	5	5	6	6	6	7	6	6	5	4	4	5	3	4	3	2
L04	Increase daylight area	C406.2.5.4	6	6	7	7	7	7	7	7	8	6	6	6	5	5	6	5	5	5	4
L05	Residential light control	C406.2.5.5	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
L06	Light power reduction	C406.2.5.7	6	7	7	7	8	8	8	8	10	7	8	7	6	7	8	5	6	4	2
Q01	Efficient elevator	C406.2.7.1	3	4	4	4	4	5	5	5	5	5	5	5	5	5	5	4	5	4	3
Q02	Commercial kitchen equip.	C406.2.7.2	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q03	Residential kitchen equip.	C406.2.7.3	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x	x
Q04	Fault detection	C406.2.7.4	4	4	4	4	3	3	3	3	2	3	3	3	3	3	2	4	3	4	4

a. "x" indicates measure is not available for that measure.

~~TABLE 406.2(8) BASE ENERGY CREDITS FOR GROUP S-1 AND S-2 OCCUPANCIES[a]~~

~~ID~~	~~Energy Credit Measure~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~E01~~	~~Envelope Performance~~	~~C406.2.1.1~~	~~Determined in accordance with Section C406.2.1.1~~																		
~~E02~~	~~UA reduction (15%)~~	~~C406.2.1.2~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	~~2~~	~~25~~	~~2~~	~~1~~	~~62~~	~~11~~	~~14~~	~~74~~	~~21~~	~~6~~	~~75~~	~~57~~	~~58~~	~~21~~
~~E03~~	~~Envelope leak reduction~~	~~C406.2.1.3~~	~~2~~	~~2~~	~~1~~	~~2~~	~~1~~	~~3~~	~~31~~	~~3~~	~~1~~	~~77~~	~~14~~	~~17~~	~~92~~	~~25~~	~~8~~	~~95~~	~~71~~	~~69~~	~~26~~
~~E04~~	~~Add Roof Insulation~~	~~C406.2.1.4~~	~~13~~	~~12~~	~~10~~	~~11~~	~~10~~	~~11~~	~~18~~	~~17~~	~~7~~	~~14~~	~~19~~	~~18~~	~~14~~	~~20~~	~~22~~	~~10~~	~~14~~	~~12~~	~~19~~
~~E05~~	~~Add Wall Insulation~~	~~C406.2.1.5~~	~~19~~	~~23~~	~~13~~	~~21~~	~~7~~	~~10~~	~~15~~	~~12~~	~~3~~	~~10~~	~~12~~	~~13~~	~~9~~	~~12~~	~~12~~	~~7~~	~~9~~	~~9~~	~~8~~
~~E06~~	~~Improve Fenestration~~	~~C406.2.1.6~~	~~7~~	~~5~~	~~8~~	~~7~~	~~6~~	~~6~~	~~2~~	~~4~~	~~2~~	~~4~~	~~1~~	~~6~~	~~5~~	~~1~~	~~7~~	~~3~~	~~4~~	~~4~~	~~7~~
~~H01~~	~~HVAC Performance~~	~~C406.2.2.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H02~~	~~Heating efficiency~~	~~C406.2.2.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~16~~	~~3~~	~~1~~	~~33~~	~~17~~	~~22~~	~~41~~	~~31~~	~~21~~	~~44~~	~~38~~	~~43~~	~~43~~
~~H03~~	~~Cooling efficiency~~	~~C406.2.2.3~~	~~7~~	~~7~~	~~4~~	~~5~~	~~3~~	~~3~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H04~~	~~Residential HVAC control~~	~~C406.2.2.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~H05~~	~~DOAS/fan control~~	~~C406.2.2.5~~	~~35~~	~~37~~	~~26~~	~~33~~	~~24~~	~~27~~	~~77~~	~~35~~	~~14~~	~~141~~	~~83~~	~~96~~	~~168~~	~~132~~	~~90~~	~~180~~	~~157~~	~~177~~	~~178~~
~~W01~~	~~SHW preheat recovery~~	~~C406.2.3.1 a~~	~~8~~	~~7~~	~~9~~	~~8~~	~~10~~	~~10~~	~~8~~	~~10~~	~~12~~	~~5~~	~~8~~	~~8~~	~~4~~	~~6~~	~~9~~	~~3~~	~~4~~	~~3~~	~~3~~
~~W02~~	~~Heat pump water heater~~	~~C406.2.3.1 b~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~1~~	~~2~~	~~2~~	~~1~~	~~2~~	~~2~~	~~1~~	~~1~~	~~1~~	~~1~~
~~W03~~	~~Efficient gas water heater~~	~~C406.2.3.1 c~~	~~4~~	~~4~~	~~5~~	~~4~~	~~5~~	~~5~~	~~4~~	~~5~~	~~6~~	~~3~~	~~4~~	~~4~~	~~2~~	~~3~~	~~5~~	~~2~~	~~2~~	~~2~~	~~2~~
~~W04~~	~~SHW pipe insulation~~	~~C406.2.3.2~~	~~3~~	~~3~~	~~4~~	~~3~~	~~3~~	~~3~~	~~2~~	~~3~~	~~4~~	~~2~~	~~2~~	~~3~~	~~1~~	~~2~~	~~3~~	~~1~~	~~1~~	~~1~~	~~1~~
~~W05~~	~~Point of use water heaters~~	~~C406.2.3.3 a~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W06~~	~~Thermostatic bal. valves~~	~~C406.2.3.3 b~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~
~~W07~~	~~SHW heat trace system~~	~~C406.2.3.3 c~~	~~4~~	~~4~~	~~4~~	~~3~~	~~4~~	~~4~~	~~3~~	~~4~~	~~5~~	~~2~~	~~3~~	~~3~~	~~2~~	~~2~~	~~4~~	~~2~~	~~2~~	~~2~~	~~2~~
~~W08~~	~~SHW submeters~~	~~C406.2.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W09~~	~~SHW flow reduction~~	~~C406.2.3.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~W10~~	~~Shower heat recovery~~	~~C406.2.3.6~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~P01~~	~~Energy monitoring~~	~~C406.2.4~~	~~5~~	~~5~~	~~6~~	~~6~~	~~6~~	~~6~~	~~5~~	~~6~~	~~6~~	~~5~~	~~5~~	~~5~~	~~5~~	5	6	5	5	5	5
~~L01~~	~~Lighting Performance~~	~~C406.2.5.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	~~x~~
~~L02~~	~~Lighting dimming & tuning~~	~~C406.2.5.2~~	~~10~~	~~10~~	~~12~~	~~11~~	~~12~~	~~14~~	~~9~~	~~12~~	~~14~~	~~6~~	~~9~~	~~9~~	~~3~~	6	9	3	5	3	2
~~L03~~	~~Increase occp. sensor~~	~~C406.2.5.3~~	~~12~~	~~12~~	~~14~~	~~13~~	~~15~~	~~14~~	~~12~~	~~14~~	~~17~~	~~7~~	~~11~~	~~11~~	~~5~~	7	11	4	6	3	3
~~L04~~	~~Increase daylight area~~	~~C406.2.5.4~~	~~15~~	~~14~~	~~18~~	~~16~~	~~18~~	~~17~~	~~13~~	~~16~~	~~21~~	~~7~~	~~12~~	~~11~~	~~5~~	8	10	4	6	6	5
~~L05~~	~~Residential light control~~	~~C406.2.5.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~L06~~	~~Light power reduction~~	~~C406.2.5.7~~	~~14~~	~~14~~	~~17~~	~~16~~	~~17~~	~~17~~	~~13~~	~~17~~	~~19~~	~~8~~	~~13~~	~~12~~	~~5~~	8	12	4	6	4	2
~~Q01~~	~~Efficient elevator~~	~~C406.2.7.1~~	~~15~~	~~14~~	~~18~~	~~16~~	~~18~~	~~18~~	~~15~~	~~18~~	~~21~~	~~9~~	~~14~~	~~14~~	~~7~~	10	14	5	7	5	5
~~Q02~~	~~Commercial kitchen equip.~~	~~C406.2.7.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~Q03~~	~~Residential kitchen equip.~~	~~C406.2.7.3~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x	x	x	x	x	x
~~Q04~~	~~Fault detection~~	~~C406.2.7.4~~	~~3~~	~~3~~	~~2~~	~~3~~	~~2~~	~~2~~	~~3~~	~~2~~	~~1~~	~~5~~	~~3~~	~~3~~	~~5~~	4	3	6	5	6	6

~~a. "x" indicates measure is not available for building occupancy in that climate zone.~~

~~TABLE 406.2(9) BASE ENERGY CREDITS FOR OTHER OCCUPANCIES[a,b]~~

~~ID~~	~~Energy Credit Measure~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	8
~~E01~~	~~Envelope Performance~~	~~C406.2.1.1~~	~~Determined in accordance with Section C406.2.1.1~~																		
~~E02~~	~~UA reduction (15%)~~	~~C406.2.1.2~~	~~5~~	~~9~~	~~5~~	~~8~~	~~5~~	~~6~~	~~10~~	~~5~~	~~2~~	~~20~~	~~6~~	~~6~~	~~25~~	~~10~~	~~4~~	~~28~~	~~22~~	~~26~~	16
~~E03~~	~~Envelope leak reduction~~	~~C406.2.1.3~~	~~6~~	~~4~~	~~5~~	~~4~~	~~3~~	~~7~~	~~12~~	~~3~~	~~2~~	~~28~~	~~5~~	~~6~~	~~36~~	~~9~~	~~3~~	~~41~~	~~27~~	~~33~~	15
~~E04~~	~~Add Roof Insulation~~	~~C406.2.1.4~~	~~4~~	~~4~~	~~3~~	~~4~~	~~4~~	~~4~~	~~8~~	~~6~~	~~2~~	~~7~~	~~6~~	~~7~~	~~9~~	~~8~~	~~9~~	~~9~~	~~10~~	~~9~~	12
~~E05~~	~~Add Wall Insulation~~	~~C406.2.1.5~~	~~16~~	~~19~~	~~11~~	~~17~~	~~5~~	~~6~~	~~10~~	~~7~~	~~2~~	~~9~~	~~6~~	~~8~~	~~9~~	~~7~~	~~7~~	~~9~~	~~9~~	~~10~~	8
~~E06~~	~~Improve Fenestration~~	~~C406.2.1.6~~	~~4~~	~~4~~	~~3~~	~~4~~	~~5~~	~~6~~	~~6~~	~~4~~	~~1~~	~~9~~	~~4~~	~~7~~	~~11~~	~~7~~	~~6~~	~~16~~	~~14~~	~~8~~	8
~~H01~~	~~HVAC Performance~~	~~C406.2.2.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~H02~~	~~Heating efficiency~~	~~C406.2.2.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~6~~	~~2~~	~~3~~	~~11~~	~~6~~	~~8~~	~~15~~	~~11~~	~~9~~	~~18~~	~~15~~	~~19~~	23
~~H03~~	~~Cooling efficiency~~	~~C406.2.2.3~~	~~7~~	~~7~~	~~5~~	~~5~~	~~4~~	~~3~~	~~1~~	~~2~~	~~1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~H04~~	~~Residential HVAC control~~	~~C406.2.2.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~H05~~	~~DOAS/fan control~~	~~C406.2.2.5~~	~~7~~	~~36~~	~~31~~	~~34~~	~~30~~	~~28~~	~~43~~	~~32~~	~~23~~	~~61~~	~~42~~	~~49~~	~~75~~	~~61~~	~~49~~	~~90~~	~~77~~	~~93~~	90
~~W01~~	~~SHW preheat recovery~~	~~C406.2.3.1 a~~	~~18~~	~~19~~	~~22~~	~~21~~	~~25~~	~~26~~	~~28~~	~~29~~	~~34~~	~~29~~	~~31~~	~~34~~	~~29~~	~~31~~	~~35~~	~~26~~	~~29~~	~~27~~	26
~~W02~~	~~Heat pump water heater~~	~~C406.2.3.1 b~~	~~12~~	~~12~~	~~15~~	~~14~~	~~17~~	~~17~~	~~20~~	~~20~~	~~24~~	~~21~~	~~22~~	~~25~~	~~21~~	~~23~~	~~26~~	~~20~~	~~22~~	~~21~~	20
~~W03~~	~~Efficient gas water heater~~	~~C406.2.3.1 c~~	~~11~~	~~11~~	~~13~~	~~13~~	~~15~~	~~16~~	~~17~~	~~17~~	~~21~~	~~18~~	~~19~~	~~21~~	~~18~~	~~19~~	~~22~~	~~16~~	~~18~~	~~17~~	16
~~W04~~	~~SHW pipe insulation~~	~~C406.2.3.2~~	~~3~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~3~~	~~4~~	~~3~~	3
~~W05~~	~~Point of use water heaters~~	~~C406.2.3.3 a~~	~~8~~	~~10~~	~~11~~	~~10~~	~~11~~	~~12~~	~~12~~	~~12~~	~~14~~	~~13~~	~~13~~	~~14~~	~~13~~	~~13~~	~~14~~	~~11~~	~~12~~	~~12~~	11
~~W06~~	~~Thermostatic bal. valves~~	~~C406.2.3.3 b~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	~~2~~	~~1~~	~~1~~	~~1~~	1
~~W07~~	~~SHW heat trace system~~	~~C406.2.3.3 c~~	~~5~~	~~5~~	~~5~~	~~5~~	~~6~~	~~6~~	~~6~~	~~6~~	~~7~~	~~6~~	~~6~~	~~7~~	~~5~~	~~6~~	~~7~~	~~5~~	~~5~~	~~5~~	5
~~W08~~	~~SHW submeters~~	~~C406.2.3.4~~	~~11~~	~~11~~	~~13~~	~~13~~	~~15~~	~~16~~	~~18~~	~~18~~	~~22~~	~~19~~	~~20~~	~~22~~	~~19~~	~~20~~	~~24~~	~~17~~	~~20~~	~~18~~	18
~~W09~~	~~SHW flow reduction~~	~~C406.2.3.5~~	~~29~~	~~30~~	~~36~~	~~35~~	~~41~~	~~43~~	~~48~~	~~48~~	~~56~~	~~50~~	~~53~~	~~59~~	~~51~~	~~54~~	~~62~~	~~47~~	~~52~~	~~49~~	48
~~W10~~	~~Shower heat recovery~~	~~C406.2.3.6~~	~~6~~	~~6~~	~~7~~	~~7~~	~~8~~	~~9~~	~~10~~	~~10~~	~~11~~	~~10~~	~~11~~	~~12~~	~~10~~	~~11~~	~~12~~	~~10~~	~~11~~	~~10~~	10
~~P01~~	~~Energy monitoring~~	~~C406.2.4~~	~~4~~	~~4~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	4
~~L01~~	~~Lighting Performance~~	~~C406.2.5.1~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~L02~~	~~Lighting dimming & tuning~~	~~C406.2.5.2~~	~~5~~	~~5~~	~~5~~	~~5~~	~~6~~	~~6~~	~~5~~	~~6~~	~~7~~	~~5~~	~~5~~	~~5~~	~~4~~	~~4~~	~~5~~	~~3~~	~~4~~	~~3~~	2
~~L03~~	~~Increase occp. sensor~~	~~C406.2.5.3~~	~~5~~	~~6~~	~~6~~	~~6~~	~~7~~	~~7~~	~~6~~	~~7~~	~~8~~	~~5~~	~~6~~	~~6~~	~~4~~	~~5~~	~~6~~	~~3~~	~~4~~	~~3~~	2
~~L04~~	~~Increase daylight area~~	~~C406.2.5.4~~	~~7~~	~~8~~	~~9~~	~~8~~	~~9~~	~~9~~	~~8~~	~~8~~	~~10~~	~~6~~	~~7~~	~~7~~	~~5~~	~~6~~	~~6~~	~~4~~	~~5~~	~~5~~	4
~~L05~~	~~Residential light control~~	~~C406.2.5.5~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~L06~~	~~Light power reduction~~	~~C406.2.5.7~~	~~7~~	~~7~~	~~8~~	~~7~~	~~8~~	~~8~~	~~7~~	~~8~~	~~9~~	~~5~~	~~7~~	~~6~~	~~4~~	~~5~~	~~6~~	~~4~~	~~4~~	~~3~~	2
~~Q01~~	~~Efficient elevator~~	~~C406.2.7.1~~	~~4~~	~~4~~	~~5~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~6~~	~~4~~	~~5~~	~~5~~	~~4~~	~~4~~	~~5~~	~~3~~	~~4~~	~~3~~	3
~~Q02~~	~~Commercial kitchen equip.~~	~~C406.2.7.2~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~Q03~~	~~Residential kitchen equip.~~	~~C406.2.7.3~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	x
~~Q04~~	~~Fault detection~~	~~C406.2.7.4~~	~~3~~	~~3~~	~~3~~	~~3~~	~~3~~	~~2~~	~~3~~	~~2~~	~~2~~	~~3~~	~~3~~	~~2~~	~~3~~	~~3~~	~~2~~	~~4~~	~~3~~	~~4~~	4

a. ~~"x" indicates measure is not available for that measure.~~

b. ~~Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.~~

~~**C406.2.1 More Efficient Building Envelope.** A project shall achieve credits for improved envelope performance by complying with one of the following measures:~~

1. ~~Section C406.2.1.1: E01~~
2. ~~Section C406.2.1.2: E02~~
3. ~~Section C406.2.1.3: E03~~
4. ~~Both E02 and E03~~

5. ~~Any combination of:~~

   5.1. ~~Section C406.2.1.3: E03~~

   5.2. ~~Section C406.2.1.4: E04~~

   5.3. ~~Section C406.2.1.5: E05~~

   5.4. ~~Section C406.2.1.6: E06~~

~~**C406.2.1.1 EO1 Improved envelope performance 901 Appendix C.** *Building* envelope measures shall be installed to improve the energy performance ofthe project. The achieved energy credits shall be determined using Equation 4-15.~~

(~~Equation 4-15~~)

~~EC_{ENV}= E01 measure energy credits~~
~~EPFB= base envelope performance factor calculated in accordance with ASHRAE 90.1-2019 Appendix C.~~
~~EPF_{P}= proposed envelope performance factor calculated in accordance with ASHRAE 90.1-2019 Appendix C.~~

~~**C406.2.1.2 E02 Total UA envelope reduction.** Energy credits shall be achieved where the total UA of the *building thermal envelope* as designed is not less than 15 percent below the total UA of the *building thermal envelope* in accordance with Section C402.1.5.~~

~~**C406.2.1.3 E03 Reduced air leakage.** Energy credits shall be achieved where tested building air leakage is not less than 10 percent less than the maximumleakage permitted by Section C402.5.2 provided the building is tested in accordance with the applicable method in Section C402.5.2. Energy credits achievedfor measure E03 shall be determined as follows:~~

(~~Equation 4-16~~)

~~EC_{E03}= Energy effi ciency credits achieved for envelope leakage reduction~~
~~EC_{B}= C406.2.1.3 credits from Tables C406.2(1) through C406.2(9)~~
~~EC_{adj}= Ls/EC_{a}~~
~~Ls = Leakage savings fraction: the lessor of [(Lr-Lm)/Lr] or 0.8~~
~~Lr = Maximum leakage permitted for tested *buildings*, by occupancy group, in accordance with Secction C402.5.2~~
~~Lm = Measured leakage in accordance with Section C402.5.2.1 or C402.5.2.2~~
~~EC_{a}= Energy Credit alignment factor: 0.37 for whole building tests in accordance with Section C402.5.2.1 or 0.25 for dwelling and sleeping unit enclosure tests in accordance with Section C402.5.2.2~~

~~**C406.2.1.4 E04 Add Roof Insulation.** Energy credits shall be achieved for insulation that is in addition to the required insulation in Table C402.1.3. All roof areas in the project shall have additional R-10 continuous insulation included in the roof assembly. For attics this is permitted to be achieved with fill or batt insulation rated at R-10 that is continuous and not interrupted by ceiling or roof joists. Where interrupted by joists, the added insulation shall be not less than R-13. Alternatively, one-half of the base credits shall be achieved where the added R-value is one-half of the additional R-value required by this section.~~

~~**C406.2.1.5 E05 Added wall insulation.** Energy credits shall be achieved for insulation applied to not less than 90 percent of all opaque wall area in theproject that is in addition to the required insulation in Table C402.1.3.~~
~~Opaque walls shall have additional R-5 continuous insulation included in the wall assembly. Alternatively, one-half of the base credits shall be achieved wherethe added R-value is R-2.5.~~

~~**C406.2.1.6 E06 Improve fenestration.** Energy credits for one selected fenestration energy credit ID shall be achieved for improved energy characteristics ofall vertical fenestration in the project meeting the requirements in one of the rows of Table C406.2.1.6. The area-weighted average U-factor and SHGC of all vertical fenestration shall be equal to or less than the value shown in the selected table row. The area-weighted average visible transmittance (VT) of allvertical fenestration shall be equal to or greater than the value shown in the selected table row.~~

~~TABLE C406.2.1.6 Vertical Fenestration Requirements for Energy Credit E06~~

~~Applicable Climate Zone~~	~~Maximum U-Factor~~		~~Maximum SHGC~~	~~Minimum VT~~
	~~Fixed~~	~~Operable~~		
~~0-2~~	~~0.45~~	~~0.52~~	~~0.21~~	~~0.28~~
~~3~~	~~0.33~~	~~0.44~~	~~0.23~~	~~0.30~~
~~4-5~~	~~0.31~~	~~0.38~~	~~0.34~~	~~0.41~~
~~6-7~~	~~0.26~~	~~0.32~~	~~0.38~~	~~0.44~~
~~8~~	~~0.24~~	~~0.28~~	~~0.38~~	~~0.44~~

~~C406.2.2 More Efficient HVAC Equipment Performance.~~ ~~All heating and cooling systems shall meet the minimum requirements of Section C403 and efficiency improvements shall be referenced to minimum efficiencies listed in Tables referenced by Section C403.3.2. Where multiple efficiency requirements are listed, equipment shall meet the seasonal or part-load efficiencies including SEER, EER/integrated energy efficiency ratio (IEER), integrated part load value (IPLV), or AFUE. Equipment that is larger than the maximum capacity range indicated in Tables referenced by Section C403.3.2 shall utilize the values listed for the largest capacity equipment for the associated equipment type shown in the table. Where multiple individual heating or cooling systems serve the project, the improvement shall be the weighted average improvement based on individual system capacity. Systems are permitted to achieve HVAC energy credits by meeting the requirements of either:~~

1. ~~C406.2.2.1 H01~~
2. ~~C406.2.2.2 H02~~
3. ~~C406.2.2.3 H03~~
4. ~~C406.2.2.4 H04~~
5. ~~C406.2.2.5 H05~~
6. ~~Any combination of H02, H03, H04 and H05~~
7. ~~The combination of H01 and H04~~

~~C406.2.2.1 H01 HVAC Performance (TSPR).~~ ~~H01 energy credits shall be achieved for systems allowed to use Section C403.1.3, HVAC total system performance ratio, where the proposed TSPR exceeds the minimum TSPR requirement by 5 percent. If improvement is greater, base energy credits from Table C406.2(1) through C406.2(9) are permitted to be prorated up to a 20 percent improvement using Equation 4-17. Energy credits for H01 may not becombined with energy credits from HVAC measures H02, H03 and H05.~~

~~(Equation 4-17)~~

H01 energy credit = H01 base energy credit x TSPRs / 0.05

~~TSPRs = the lessor of 0.20 and (1-(TSPRp/TSPRt))~~
~~where:~~
~~TSPRt = TSPRr / MPF~~
~~TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.~~
~~TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.~~
~~MPF = Mechanical Performance Factor from Table C409.4 based on climate zone and building use type~~
~~Where a building has multiple building use types, MPF shall be area weighted in accordance with Section C409.4~~

~~C406.2.2.2 H02 More efficient HVAC equipment heating performance.~~ ~~No less than 90 percent of the total HVAC capacity serving the total~~ ~~*conditioned floor area*~~ ~~of the entire building, or tenant space in accordance with Section C406.1.1, shall comply with the requirements of this Section.~~

1. ~~Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2. Electric resistance heating capacity shall be limited to 20 percent of system capacity, with the exception of heat pump supplemental heating.~~
2. ~~Equipment shall exceed the minimum heating efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. Where equipment exceeds the minimum annual heating efficiency requirements by more than 5 percent, energy efficiency credits for heating shall be determined using Equation 4-18 rounded to the nearest whole number.~~

(~~Equation 4-18)~~

~~EEC_{HEH} = energy efficiency credits for heating efficiency improvement~~
~~EEC_{H5} = C406.2.2.2 credits from Tables C406.2(1) through C406.2(9)~~
~~HEI = the lesser of: the improvement (as a fraction) above minimum heating efficiency requirements, or 20 percent(0.20). Where heating equipment with different minimum efficiencies are included in the building, a heating capacity-weighted average improvement shall be used. Where electric resistance primary heating or reheat is included in the building it shall be included in the weighted average improvement with an HEI of 0. Supplemental gas and electric heat for heat pump systems shall be excluded from the weighted HEI. For heat pumps rated at multiple ambient temperatures, the efficiency at 47°F (8.3°C) shall be used.~~
~~For metrics that increase as efficiency increases, HEI shall be calculated as follows:~~

~~HEI = (HM/HM)-1~~

~~Where:~~

~~HM_{DES}= Design heating efficiency metric, part-load or annualized where available~~

~~HM_{MIN}= Minimum required heating efficiency metric, part-load or annualized where available from Section C403.3.2~~

> ~~**Exception:** In low energy spaces complying with Section C402.1.1, no less than 90 percent of the installed heating capacity is provided by electric infrared or gas-fired radiant heating equipment for localized heating applications. Such spaces shall only achieve energy credits for EEC.~~

~~**C406.2.2.3 H03 More efficient HVAC equipment cooling and fan performance.** No less than 90 percent of the total HVAC cooling capacity serving the total conditioned floor area of the entire building or tenant space in accordance with Section C406.1.1, shall comply with all of the requirements of this section.~~

1. ~~Equipment installed shall be types that are listed in Tables referenced by Section C403.3.2.~~
2. ~~Equipment shall exceed the minimum cooling efficiency requirements listed in Tables referenced by Section C403.3.2 by at least 5 percent. For water-cooled chiller plants, heat rejection equipment efficiency shall also be increased by at least the chiller efficiency improvement. Where equipment exceeds the minimum annual cooling efficiency and heat rejection efficiency requirements by more than 5 percent, energy efficiency credits for cooling shall be determined using Equation 4-19, rounded to the nearest whole number.~~

~~Where fan energy is not included in packaged equipment rating or it is and the fan size has been increased from the as-rated equipment condition, fanpower or horsepower shall be less than 95 percent of the allowed fan power in Section C403.8.1.~~

~~**(Equation 4-19)**~~

~~EEC_{HEC}= energy efficiency credits for cooling efficiency improvement~~

~~EEC_5= the lesser of: the improvement above minimum cooling and heat rejection efficiency requirements expressed as a fraction, or 0.20 (20percent). Where cooling equipment with different minimum efficiencies are included in the building, a cooling capacity-weighted average improvement shall be used. Where multiple cooling performance requirements are provided, the equipment shall exceed the annualized energy or part-load requirement. Meeting both part-load and full-load efficiencies is not required.~~

~~For metrics that increase as efficiency increases, CEI shall be calculated as follows:~~

~~$CEI = (CM_{DES}/CM_{MIN}) - 1$~~

~~For metrics that decrease as efficiency increases, CEI shall be calculated as follows:~~

~~$CEI = (CM_{MIN}/CM_{DES}) - 1$~~

~~Where:~~

~~CM_{DES}= Design cooling efficiency metric, part-load or annualized where available~~

~~CM_{MIN}= Minimum required cooling efficiency metric, part-load or annualized where available from Section C403.3.2~~

~~For Data Centers using ASHRAE Standard 90.4, CEI shall be calculated as follows:~~

~~$CEI = (AMLC/AMLC_{DES}) - 1$~~

~~Where:~~

~~$AMLC_{DES}$= As-Designed Annualized Mechanical Load Component calculated in accordance with ASHRAE Standard 90.4, Section 6.5~~

~~$AMLC_{MAX}$= Maximum Annualized Mechanical Load Component from ASHRAE Standard 90.4, Table 6.5~~

~~**C406.2.2.4 H04 Residential HVAC control.** HVAC systems serving *dwelling units* or *sleeping units* shall be controlled to automatically activate a setback atleast 5°F (3°C) for both heating and cooling. The temperature controller shall be configured to provide setback during occupied sleep periods. The unoccupied setback mode shall be configured to operate in conjunction with one of the following:~~

1. ~~A manual main control device by each *dwelling unit* main entrance that initiates setback and non-ventilation mode for all HVAC units in the dwelling unit and is clearly identifi ed as "Heating/Cooling Master Setback."~~
2. ~~Occupancy sensors in each room of the *dwelling unit* combined with a door switch to initiate setback and non-ventilation mode for all HVAC units in the dwelling within 20 minutes of all spaces being vacant immediately after a door switch operation. Where separate room HVAC units are used, an individual occupancy sensor on each unit that is confi gured to provide setback shall meet this requirement.~~
3. ~~An advanced learning thermostat or controller that recognizes occupant presence and automatically creates a schedule for occupancy and provides a dynamic setback schedule based on when the spaces are generally unoccupied.~~
4. ~~An automated control and sensing system that uses geographic fencing connected to the dwelling unit occupants' cell phones and initiates the setback condition when all occupants are away from the building.~~

~~**C406.2.2.5 H05 Dedicated Outdoor Air System.** Credits for this measure are only allowed where single zone HVAC units are not required to have multi-speed or variable-speed fan control in accordance with Section C403.8.6.1. HVAC controls and ventilation systems shall include all of the following:~~

1. ~~Zone controls shall cycle the heating/cooling unit fans off when not providing required heating and cooling or shall limit fan power to 0.12 watts/cfm of zone outdoor air.~~
2. ~~Outdoor air shall be supplied by an independent ventilation system designed to provide no more than 110 percent of the minimum outdoor air to each individual occupied zone, as specified by the *International Mechanical Code.*~~

3. ~~The ventilation system shall have energy recovery with an *enthalpy recovery ratio* of 65 percent or more at heating design conditions in climate zones 3 through 8 and an *enthalpy recovery ratio* of 65 percent or more at cooling design conditions in climate zones 0, 1, 2, 3A, 3B, 4A, 4B, 5A, and 6A. In"A" climate zones, energy recovery shall include latent recovery. Where no humidification is provided, heating energy recovery effectiveness is permitted to be based on sensible *energy recovery ratio*. Where energy recovery effectiveness is less than the 65 percent required for full credit, adjust the credits from Section C406.2 by the factors in Table C406.2.2.5.~~
4. ~~Where the ventilation system serves multiple zones and the system is not in a latent recovery outside air dehumidification mode. partial economizer cooling through an outdoor air bypass or wheel speed control shall automatically do one of the following:~~

    ~~4.1. Set the energy recovery leaving-air temperature 55°F (13°C) or 100 percent outdoor air bypass when a majority of zones require cooling and outdoor air temperature is below 70°F (21°C).~~

    ~~4.2. The HVAC ventilation system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.~~

5. ~~Ventilation systems providing mechanical dehumidifi cation shall use recovered energy for reheat within the limits of item 4. This shall not limit the use of latent energy recovery for dehumidification.~~

~~Where only a portion of the building is permitted to be served by constant air volume units or theenthalpy recovery ratio or sensible *energy recovery ratio* is less than 65 percent, the base energy credits shown in Section C406.2 shall be prorated as follows:~~

~~**(Equation 4-20)**~~

~~EC_{DOAS}= Energy credits achieved for H06~~
~~EC_{base}= H06 base energy credits in Section C406.2~~
~~$FLOOR_{CAV}$= Fraction of whole project gross conditioned fl oor area not required to have variable speed or multi-speed fan airflow control in accordance with Section C403.8.6.~~
~~ERE_{adj}= The energy recovery adjustment from Table C406.2.2.5 based on the lower of actual cooling or heating *enthalpy recovery ratio* or *sensible energy recovery ratio* where required for the climate zone. Where recovery ratios vary, use a weighted average by supply airflow.~~

~~TABLE C406.2.2.5 DOAS Energy Recovery Adjustments~~

~~ERE_{adj} based on lower of actual heating or cooling energy recovery effectiveness where required~~		
~~Cooling ERR is ≥~~	~~Heating enthalpy recovery ratio or sensible energy recovery ratio is ≥~~	~~Energy Recovery Effectiveness Adjustment (ERE_{adj})~~
~~65%~~	~~65%~~	~~1.00~~
~~60%~~	~~60%~~	~~0.67~~
~~55%~~	~~55%[a]~~	~~0.33~~
~~50%~~	~~50%[a]~~	~~0.25~~

a. ~~In climate zones where heating recovery is required for this measure, for dwelling units a heating recovery effectiveness below 60 percent is not allowed.~~

~~**C406.2.3 Reduced Energy Use In-service Water Heating.** Projects with service water-heating equipment that serves the whole building, a building addition or a tenant space shall achieve credits through compliance with the requirements of this section. Systems are permitted to achieve energy credits by meeting the requirements of either:~~

1. ~~C406.2.3.1 by selecting one allowed measure W01, W02 or W03~~
2. ~~C406.2.3.2 W04~~
3. ~~C406.2.3.3 by selecting one allowed measure W05, W06, or W07~~
4. ~~C406.2.3.4 W08~~
5. ~~C406.2.3.5 W09~~
6. ~~C406.2.3.6 W10~~
7. ~~Any combination of measures in C402.2.3.1 through C402.2.3.6 as long no more than one allowed measure from C406.2.3.1 and C406.2.3.3 are selected.~~

~~**C406.2.3.1 Service water-heating system efficiency.** A project is allowed to achieve energy credits from only one of Sections C406.2.3.1.1 through C406.2.3.1.4.~~

~~**C406.2.3.1.1 W01 Recoverd or renewable water heating.** The *building* service water-heating system shall have one or more of the following that are sized to provide not less than 30 percent of the *building's* annual hot water requirements, or sized to provide not less than 70 percent of the *building's* annual hot water requirements if the *buildingis* required to comply with Section C403.10.5:~~

1. ~~Waste heat recovery from SHW, heat recovery chillers, *building* equipment, or process equipment.~~
2. ~~A water-to-water heat pump that precools chilled water return for *building* cooling.~~
3. ~~On-site renewable energy water-heating systems.~~

~~**C406.2.3.1.2 W02 Heat pump water heater.** Air-source heat pump water heaters shall be installed according to manufacturer's instructions and at least 30 percent of design end use service water heating requirements shall be met using only heat pump heating at an ambient condition of 67.5 F, db without supplemental electric resistance or fossil fuel heating. For a heat pump water heater with supplemental electric resistance heating, the heat pump only capacity shall be deemed at 40 percent of first hour draw. Where the heat pump only capacity exceeds 50 percent of the design end use load excluding recirculating system losses, the credits from the Section C406.2 tables shall be prorated as follows:~~

~~**(Equation 4-21)**~~

~~EC_{HPWH} = Energy credits achieved for W02~~
~~EC_{BASE} = W02 base energy credits Section 13.5.3~~
~~ENDLOAD = End use peak hot water load, excluding load for heat trace or recirculation, Btu/hr or kW~~
~~CAP_{HPWH} = the heat pump only capacity at 50ºF (10ºC) entering air and 70ºF (21ºC) entering potable water without supplemental electric resistance or fossil fuel heat, Btu/hr or kW~~

~~The heat pump service water heating system shall comply with the following requirements:~~

1. ~~For systems with an installed total output capacity of more than 100,000 Btu/hr (30 kW) at an ambient condition of 67.5ºF (19.7ºC), db a preheat storage tank with greater than or equal 0.75 gallons per 1000 Btu/hr (≥9.7 L/kW) of design end use service water heating requirements shall be heated only with heat pump heating when the ambient temperature is greater than 45ºF (7.2ºC).~~
2. ~~For systems with piping temperature maintenance, either a heat trace system or a separate water heater in series for recirculating system and final heating shall be installed.~~

3. ~~Heat pump water heater efficiency shall meet or exceed one of the following:~~

   3.1. ~~Output-capacity-weighted-average UEF of 3.0 in accordance with 10 CFR 430 Appendix E.~~

   3.2. ~~Output-capacity-weighted-average COP of not less than 4.0 tested at 50ºF (10ºC) entering air and 70ºF (21ºC) entering potable water in accordance with AHRI standard 1300.~~

~~Where the heat pump capacity at 50°F (10°C) entering air and 70°F (21°C) entering water exceeds 50 percent of the design end-use load excluding recirculating system losses, the base credits from Section C406.2 shall be prorated based on Equation 4-20.~~

~~(Equation 4-22)~~

~~HP_{LF} = Heat pump capacity as a fraction of the design end-use SHW requirements excluding recirculating system losses, not to exceed 80 percent.~~

~~C406.2.3.1.3 W03 Efficient fossil fuel water heater.~~ ~~The combined input-capacity-weighted-average equipment rating of all gas water-heating equipment in the *building* shall be not less than 95 percent Et or 0.93 UEF. This measure shall receive only thirty percent of the listed energy credits for *buildings* required to comply with C404.2.1. Projects where the installed *building* service water heating capacity is less than 200,000 Btu/hr (59 kW) and weighted UEF is not less than 0.82 shall achieve 25 percent of the base table W03 credit.~~

~~C406.2.3.1.4 Combination service water heating systems.~~ ~~Shall achieve credits using one of the measure combinations as follows:~~

1. ~~(W01 + W02) Where service water heating employs both energy recovery and heat pump water heating, W01 may be combined with W02 and receive the sum of both credits.~~
2. ~~(W01 + W03) Where service water heating employs both energy recovery and efficient gas water heating, W01 may be combined with W03 and receive the sum of the W01 credit and the portion of the W03 credit based on item 4.~~
3. ~~(W02 + W03) Where service water heating employs both heat pump water heating and efficient gas water heating, W02 may be combined with W03 and receive the sum of the W02 credit and the portion of the W03 credit based on item 4.~~

~~For items 2 and 3, the achieved W03 credit shall be the Section C406.2.3.1.3 W03 credit multiplied by the fractional share of total water heating installed capacity served by gas water heating that is not less than 95 percent Et or 0.93 UEF. In no case shall the achieved W03 credit exceed 60 percent of the W03 credit in Section C406.2 tables. In *Buildings* that have a service water heating design generating capacity greater than 900,000 Btu/h that proportioned W03 credit shall be further multiplied by 30 percent.~~

~~C406.2.3.2 Water-heating distribution temperature maintenance.~~ ~~A project is allowed to claim energy credits from only one of the following SHW distribution temperature maintenance measures.~~

1. **~~W04: Service Hot Water Piping Insulation Increase.~~** ~~Where service hot water is provided by a central water heating system, the hot water pipe insulation thickness shall be at least 1.5 times the thickness required in Section C404.4. All service hot water piping shall be insulated from the hotwater source to the fixture shutoff. Where no more than 50 percent of hot water piping does not have increased insulation due to installation in partitions, the credit shall be prorated as a percentage of lineal feet of piping with increased insulation.~~
2. **~~W05 Point of use water heaters.~~** ~~Credits are available for office or school buildings larger than 10,000 ft^2 (930 m^2). Fixtures requiring hot water shall be supplied from a localized source of hot water with no recirculating system or heat trace piping. Supply piping from the water heater to the termination of the fixture supply pipe shall be insulated to the levels shown in Table C403.12.3 without exception. The volume from the water heater to the termination of the fixture supply pipe shall be limited as follows:~~

   2.1. ~~Non-residential lavatories: not more than 2 oz (60 mL)~~

   2.2. ~~All other plumbing fixtures or appliances: not more than 0.25 gallons (0.95 L)~~

   ~~Exception:~~ ~~Where all remotely located hot water uses meet the requirements for measure W05, separate water heaters serving commercial kitchens or showers in locker rooms shall be permitted to have a local recirculating system or heat trace piping.~~

3. **~~W06 Thermostatic balancing valves.~~** ~~Credits are available where service water heating is provided centrally and distributed throughout the building. Each recirculating system branch return connection to the main SHW supply piping shall have an automatic thermostatic balancing valve set to a minimal return water flow when the branch return temperature is greater than 115°F (46°C).~~
4. **~~W07 Heat trace system.~~** ~~Credits are available for projects with gross floor area greater than 10,000 square feet (930 m^2) and a central water-heating system. The energy credits achieved shall be from Tables C406.1.2(1) through C406.1.2(9). This system shall include self-regulating electric heat cables, connection kits, and electronic controls. The cable shall be installed directly on the hot water supply pipes underneath the insulation to replace standby losses.~~

~~C406.2.3.3 W08 Water-heating system submeters.~~ ~~Each individual *dwelling unit* in a Group R-2 occupancy served by a central service water-heating system shall be provided with a service hot water meter connected to a reporting system that provides individual *dwelling unit* reporting of actual domestic hot water use. Preheated water serving the cold water inlet to showers need not be metered.~~

~~C406.2.3.4 W09 Service hot water flow reduction.~~ ~~Dwelling unit, sleeping unit, and guest room plumbing fixtures that are connected to the service~~

~~water-heating system shall have a flow or consumption rating less than or equal to the values shown in Table C406.2.3.5.~~

~~TABLE C406.2.3.4 Maximum Flow Rating for Residential Plumbing Fixtures with Heated Water~~

~~Plumbing Fixture~~	~~Maximum Flow Rate~~
~~Faucet for private lavatory,[a] hand sinks, or bar sinks~~	~~1.50 gpm at 60 psi (0.095 L/s at 410 kPa)~~
~~Faucet for residential kitchen sink [a,b, c]~~	~~1.8 gpm at 60 psi 0.11 L/s at 410 kPa)~~
~~Shower head (including hand-held shower spray) [a, b, d]~~	~~2.0 gpm at 80 psi (0.13 L/s at 550 kPa)~~

a. ~~Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)- (p).~~

b. ~~Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.~~

c. ~~Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410 kPa) and must default to the maximum flow rate listed.~~

d. ~~When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.~~

~~C406.2.3.5 W10 Shower drain heat recovery.~~ ~~Cold water serving building showers shall be preheated by shower drain heat recovery units that comply with Section C404.7. The efficiency of drain heat recovery units shall be 54 percent or greater measured in accordance with CSA B55.1. Full credits are applicable to the following building uses: I-2, I-4, R-1, R-2 and also group E where there are more than eight showers. Partial credits are applicable to buildings where all but ground floor showers are served where the base energy credit from Section C406.2 is adjusted by Equation 4-23.~~

~~(Equation 4-23)~~

~~TABLE C406.2.3.5 MAXIMUM FLOW RATING FOR RESIDENTIAL PLUMBING FIXTURES WITH HEATED WATER~~

~~**Plumbing Fixture**~~	~~**Maximum Flow Rate**~~
~~Faucet for private lavatory[a], hand sinks, or bar sinks~~	~~1.50 gpm at 60 psi (0.095 L/s at 410 kPa)~~
~~Faucet for residential kitchen sink[a, b, c]~~	~~1.8 gpm at 60 psi 0.11 L/s at 410 kPa)~~
~~Shower head (including hand-held shower spray)[a, b, d]~~	~~2.0 gpm at 80 psi (0.13 L/s at 550 kPa)~~

a. ~~Showerheads, lavatory faucets and kitchen faucets are subject to U.S. Federal requirements listed in 10 CFR 430.32(o)-(p).~~

b. ~~Maximum flow allowed is less than required by flow rates listed in U.S. 10 CFR 430.32(o)-(p) for showerheads and kitchen faucets.~~

c. ~~Residential kitchen faucet may temporarily increase the flow above the maximum rate, but not above 2.2 gallons per minute at 60 psi (0.14 L/s at 410kPa) and must default to the maximum flow rate listed.~~

c. ~~When a shower is served by multiple shower heads, the combined flow rate of all shower heads controlled by a single valve shall not exceed the maximum flow rate listed or the shower shall be designed to allow only one shower head to operate at a time.~~

~~C406.2.4 P01 Energy Monitoring.~~ ~~A project not required to comply with C405.12 can achieve energy credits for installing an energy monitoring system that complies with all the requirements of C405.12.1 through C405.12.5.~~

~~C406.2.5 Energy Savings in Lighting Systems.~~ ~~Projects are permitted to achieve energy credits for increased lighting system performance by meeting the requirements of either:~~

1. ~~C406.2.5.2 L02~~
2. ~~C406.2.5.3 L03~~
3. ~~C406.2.5.4 L04~~
4. ~~C406.2.5.5 L05~~
5. ~~C406.2.5.6 L06~~
6. ~~Any combination of L03, L04, L05 and L06~~
7. ~~Any combination of L02, L03 and L04~~

~~Where lighting energy credit measures include reductions in lighting power, the lighting shall achieve ANSI/IES recommended practice for minimum illuminance levels as referenced at "The Interactive Illuminance Selector," which includes minimum recommended illuminance levels from various ANSI/IESRP-## standards.~~

~~C406.2.5.1 L01 Lighting system performance (reserved).~~ *Reserved for future use*

~~C406.2.5.2 L02 Enhanced digital lighting controls.~~ ~~Measure credits shall be achieved where no less than 50 percent of the gross floor area within the project shall comply with the requirements of this section.~~

~~1.~~ ~~Lighting controls function. Interior general lighting shall be located, scheduled and operated in accordance with Section C405.2 and shall be configured with the following enhanced control functions:~~

~~1.1.~~ ~~Luminaires shall be configured for continuous dimming.~~

~~1.2.~~ ~~Each luminaire shall be individually addressed.~~

~~Exceptions:~~

~~1.~~ ~~Multiple luminaires mounted on no more than 12 linear feet (3.66 m) of a single lighting track and addressed as a single luminaire.~~

~~2.~~ ~~Multiple linear luminaires that are ganged together to create the appearance of a single longer fixture and addressed as a single luminaire, where the total length of the combined luminaires is not more than 12 feet (3.66 m).~~

~~1.3.~~ ~~No more than eight luminaires within a daylight zone are permitted to be controlled by a~~ *~~single daylight responsive control.~~*

2 ~~Luminaires shall be controlled by a digital control system configured with the following capabilities:~~

~~2.1.~~ ~~Sheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.~~

~~2.2.~~ ~~Load shedding.~~

~~2.3.~~ ~~Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.~~

3. ~~Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.~~
4. ~~High-end trim. Luminaires shall be initially configured with the following:~~

   ~~4.1.~~ ~~High-end trim, setting the maximum light output of individual luminaires or groups of luminaires to support visual needs of a space or area, shall be implemented and construction documents shall state that maximum light output or power of controlled lighting shall be initially reduced by atleast 15 percent from full output. The average maximum light output or power of the controlled lighting shall be documented without high-end trim and with high-end trim to verify reduction of light output or power by at least 15 percent when tuned.~~

   ~~4.2.~~ ~~Where lumen maintenance control is used, controls shall be configured to limit the initial maximum lumen output or maximum lighting power to 85 percent or less of full light output or full power draw and lumen maintenance controls shall be limited to increasing lighting power by 1 percent per year.~~

   ~~4.3.~~ ~~High-end trim and lumen maintenance controls shall be accessible only to authorized personnel.~~

~~Where general lighting in more than 50 percent of the gross lighted floor area receives high-end trim, the base credits from Tables C406.1.2(1) through C406.1.2(9) shall be prorated as follows:~~
~~[Tuned lighted fl oor area,%] × [Base energy credits for C406.2.5.2] / 50%~~

~~C406.2.5.3 L03 Increase occupancy sensor.~~ ~~Lighting controls shall comply with C406.2.5.3.1, C406.2.5.3.2 and C406.2.5.3.3.~~

~~C406.2.5.3.1 Occupant sensor controls.~~ ~~Occupant sensor controls shall be installed to control lights in the following space types:~~
1. ~~Courtroom~~
2. ~~Electrical/mechanical room~~
3. ~~Food preparation area~~
4. ~~Laboratory~~
5. ~~Elevator lobby~~
6. ~~Pharmacy area~~
7. ~~Vehicular maintenance area~~
8. ~~Workshop.~~
9. ~~Chapel in a facility for the visually impaired~~
10. ~~Recreation room in a facility for the visually impaired~~
11. ~~Exercise area in a fitness center~~
12. ~~Playing area in a fitness center~~
13. ~~Exam/treatment room in a healthcare facility~~
14. ~~Imaging room in a healthcare facility~~
15. ~~Physical therapy room in a healthcare facility~~
16. ~~Library reading area~~
17. ~~Library stacks~~
18. ~~Detailed manufacturing area~~
19. ~~Equipment room in a manufacturing facility~~
20. ~~Low-bay area in a manufacturing facility~~
21. ~~Post office sorting area~~
22. ~~Religious fellowship hall~~
23. ~~Religious worship/pulpit/choir area~~
24. ~~Hair salon~~
25. ~~Nail salon~~
26. ~~Banking activity area~~
27. ~~Computer room, data center~~
28. ~~Laundry/washing area~~

29 ~~Medical supply room in a healthcare facility~~

30. ~~Telemedicine room in a healthcare facility~~

31. ~~Museum restoration room~~

~~**C406.2.5.3.2 Occupant sensor control function.** Occupant sensor controls shall automatically turn lights off within 10 minutes after all occupants have leftthe space. A manual control complying with C405.2.6 shall allow occupants to turn off lights.Time-switch controls are not required.~~

> ~~**Exception:** In spaces where an automatic shutoff could endanger occupant safety or security occupant sensor controls shall uniformly reduce lighting power to not more than 20 percent of full power within 10 minutes after all occupants have left the space.Time-switch controls complying with C405.2.2.1 shall automatically turn lights off.~~

~~**C406.2.5.3.3 Occupant sensor time function.** *Occupant sensor controls* installed in accordance with Sections C405.2.1.1, C405.2.1.2, C405.2.1.3, and C405.2.1.4 shall automatically turn lights off or reduce lighting power within 10 minutes after all occupants have left the space. Where lighting power is reduced, the unoccupied setpoint shall be 20 percent of full power or in egress areas to the power level required to meet egress light levels.~~

~~**C406.2.5.4 L04 Increase daylight area.** The total daylight area of the project (DLA_{BLDG}) with continuous daylight dimming meeting the requirements of C405.2.4 shall be at least 5 percent greater than the typical daylit area (DLA_{TYP}).Credits for measure L04 shall be determined based on Equation 4-24:~~

~~(Equation 4-24)~~

~~EC_{DL}= The lesser of actual area of *daylight zones* in the *building* with continuous daylight dimming, ft^2 or m^2 and (GLFA x DLA_{max}) see TableC406.2.5.4. *Daylight zones* shall meet the criteria in Sections C405.2.4.2 and C405.2.4.3 for primary sidelit *daylight zones*, secondary sidelit *daylight zones*,and toplit *daylight zones*.~~
~~GLFA = Project gross lighted fl oor area, ft^2 or m^2~~
~~DLATYP= Typical % of *building* area with daylight control (as a fraction) from Table C406.2.5.4:~~
~~ECDL5= C406.2.5.4 L04 base energy credits from Section C406.2~~

~~TABLE C406.2.5.4 G PARADDED DAYLIGHTINAMETERS~~

~~Building use type~~	~~DLA_{TYP}~~	~~DLA_{MAX}~~
~~Group B; Office ≤ 5000 ft^2 (460 m^2)~~	~~10%~~	~~20%~~
~~Group B; Office > 5000 ft^2 (460 m^2)~~	~~21%~~	~~31%~~
~~Group M; Retail with ≤ 1000 ft^2 (900 m^2) roof area~~	~~0%~~	~~20%~~
~~Group M; Retail with > 1000 ft^2 (900 m^2) roof area~~	~~60%~~	~~80%~~
~~Group E; Education~~	~~42%~~	~~52%~~
~~Groups S-1 and S-2; Warehouse~~	~~50%~~	~~70%~~
~~Group I-2, R, and other; Medical, hotel, multifamily, dormitory, and other~~	~~NA~~	~~NA~~

~~**C406.2.5.5 L05 Residential light control.** In *buildings* with Group R-2 occupancy spaces, interior lighting systems shall comply with the following:~~

1. ~~Common area Restrooms, laundry rooms, storage rooms, and utility rooms shall have automatic full OFF occupancy sensor controls that comply with the requirements of C405.2.1.1. Each additional control device shall control no more than 5,000 sq.ft (464 m^2).~~
2. ~~Each dwelling unit shall have a main control by the main entrance that turns off all the lights and all switched receptacles in the dwelling unit. Two switched receptacles shall be provided in living and sleeping rooms or areas and clearly identified. All switched receptacles shall be located within 12 inches (30 cm) of an unswitched receptacle. The main control shall be permitted to have two controls, one for permanently wired lighting and one for switched receptacles. The main controls should be clearly identified as "lights master off" and "switched outlets master off."~~

~~**C406.2.5.6 L06 Reduced lighting power.** Interior lighting within the whole building shall comply with all the requirements of this section. The net connected interior lighting power (LPn) shall be 95 percent or less than the net interior lighting power allowance (LPAn) determined in accordance with Section C405.3.2.2. In R-1 and R-2 occupancies the credit is calculated for all common areas other than dwelling units and sleeping units. No less than 95 percent of the permanently installed light fixtures in dwelling units and sleeping units, excluding kitchen appliance lighting, shall be provided by high efficacy lamps with aminimum efficacy of 90 lumens per watt or high efficacy luminaires that have a minimum efficacy of 55 lumens per watt. Energy credits shall not be greater than four times the L06 base credit from Section C406.2 and shall be determined using Equation 4-25:~~

~~**(Equation 4-25)**~~

~~EC_{LPA} = additional energy credit for lighting power reduction~~
~~LP_n = net connected interior lighting power calculated in accordance with Section C405.3.1, watts, excluding any additional lighting power allowed in Section C405.3.2.2.1~~
~~LPA_n = interior lighting power allowance calculated in accordance with the requirements of Section C405.3.2.2, watts, less any additional interior lighting power allowed in Section C405.3.2.2.1~~
~~EC5 = L06 base credit from Section C406.2~~

~~**C406.2.6 Efficient Equipment Credits.** Projects are permitted to achieve energy credits using any combination of Efficient Equipment Credits Q01 through Q04.~~

~~**C406.2.6.1 Q01 Efficient Elevator Equipment.** Qualifying elevators in the building shall be Energy efficiency class A per ISO 25745-2, Table 7. Only buildings 3 or more floors above grade may use this credit. Credits shall be prorated based on Equation 4-26, rounded to the nearest whole credit. Projects with acompliance ratio below 0.5 do not qualify for this credit.~~

~~**(Equation 4-26)**~~

~~EC_e = Elevator energy credit achieved for the *building*~~
~~EC_t = C406.2.7.1 Table energy credit~~
~~CR_e = Compliance Ratio = (F/ F)~~
~~F_A = Sum of floors served by class A elevators~~
~~F_B = Sum of floors served by all *building* elevators and escalators~~

~~**C406.2.6.2 Q02 Efficient Commercial Kitchen Equipment.** For *buildings* and spaces designated as Group A-2, or facilities whose primary business type involves the use of a commercial kitchen where at least one gas or electric fryer is installed before the issuance of the Certificate of Occupancy all fryers, dishwashers, steam cookers and ovens installed before the issuance of the Certificate of Occupancy shall comply with all of the following:~~

1. ~~Achieve performance levels in accordance with the equipment specifications listed in Tables C406.2.7.2 (1) through C406.2.7.2 (4) when rated in accordance with the applicable test procedure.~~
2. ~~Have associated performance levels listed on the construction documents submitted for permitting.~~

~~TABLE C406.2.6.2(1) Minimum Efficiency Requirements: Commercial Fryers~~

	~~Heavy-Load Cooking Energy Efficiency~~	~~Idle Energy Rate~~	~~Test Procedure~~
~~Standard Open Deep-Fat Gas Fryers~~	~~≥ 50%~~	~~≤ 9,000 Btu/hr (≤ 2,600 watts)~~	~~ASTM F1361~~
~~Standard Open Deep-Fat Electric Fryers~~	~~≥ 83%~~	~~≤ 800 watts~~	
~~Large Vat Open Deep-Fat Gas Fryers~~	~~≥ 50%~~	~~≤ 12,000 Btu/hr (≤ 3,500 watts)~~	~~ASTM F2144~~
~~Large Vat Open Deep-Fat Electric Fryers~~	~~≥ 80%~~	~~≤ 1,100 watts~~	

For SI: BTU/h = 0.293W

~~TABLE C406.2.6.2(2) Minimum Efficiency Requirements: Commercial Steam Cookers~~

~~Fuel Type~~	~~Pan Capacity~~	~~Cooking Energy Efficiency[a]~~	~~Idle Energy Rate~~	~~Test Procedure~~
~~Electric Steam~~	~~3-pan~~	~~50%~~	~~400W~~	~~ASTM F1484~~
	~~4-pan~~	~~50%~~	~~530W~~	
	~~5-pan~~	~~50%~~	~~670W~~	
	~~6-pan and larger~~	~~50%~~	~~800W~~	
~~Gas Steam~~	~~3-pan~~	~~38%~~	~~6,250 Btu/h~~ ~~1.83 kW~~	
	~~4-pan~~	~~38%~~	~~8,350 Btu/h~~ ~~2.45 kW~~	
	~~5-pan~~	~~38%~~	~~10,400 Btu/h~~ ~~3.05 kW~~	
	~~6-pan and larger~~	~~38%~~	~~12,500 Btu/h~~ ~~3.66 kW~~	

a. ~~Cooking Energy Efficiency is based on heavy-load (potato) cooking capacity~~

~~TABLE C406.2.6.2(3) MINIMUM EFFICIENCY REQUIREMENTS: COMMERCIAL DISHWASHERS~~

~~Machine Type~~	~~High Temperature Efficiency Requirements~~			~~Low Temperature Efficiency Requirements~~			~~Test Procedure~~
	~~Idle Energy Rate~~[a]	~~Washing Energy~~	~~Water Consumption~~[b]	~~Idle Energy Rate~~[a]	~~Washing Energy~~	~~Water Consumption~~[b]	
~~Under Counter~~	~~≤ 0.30 kW~~	~~≤ 0.35 kWh/rack~~	~~≤ 0.86 GPR (≤ 3.3 LPR)~~	~~≤ 0.25 kW~~	~~≤ 0.15 kWh/rack~~	~~≤ 1.19 GPR ≤ 4.5 LPR~~	~~ASTM F1696~~ ~~ASTM F1920~~
~~Stationary Single Tank Door~~	~~≤ 0.55 kW~~	~~≤ 0.35 kWh/rack~~	~~≤ 0.89 GPR (≤ 3.4 LPR)~~	~~≤ 0.30 kW~~	~~≤ 0.15 kWh/rack~~	~~≤ 1.18 GPR ≤ 4.47 LPR~~	
~~Pot, Pan, and Utensil~~	~~≤ 0.90 kW~~	~~kWh/rack ≤ 0.55 + 0.05 × SF_{rack}~~[c] ~~(≤ 0.55 + 0.0046 × SM_{rack}~~[c]~~)~~	~~≤ 0.58 GPSF (≤ 2.2 LPSM)~~	~~NA~~	~~NA~~	~~NA~~	
~~Single Tank Conveyor~~	~~≤ 1.20 kW~~	~~≤ 0.36 kWh/rack~~	~~≤ 0.70 GPR (≤ 2.6 LPR)~~	~~≤ 0.85 kW~~	~~≤ 0.16 kWh/rack~~	~~≤ 0.79 GPR ≤ 3.0 LPR~~	
~~Multiple Tank Conveyor~~	~~≤ 1.85 kW~~	~~≤ 0.36 kWh/rack~~	~~≤ 0.54 GPR (≤ 2.0 LPR)~~	~~≤ 1.00 kW~~	~~≤ 0.22 kWh/rack~~	~~≤ 0.54 GPR ≤ 2.0 LPR~~	
~~Single Tank Flight Type~~	~~Reported~~	~~Reported~~	~~GPH ≤ 2.975c + 55.0 (LPH ≤ 0.276d+ 208)~~	~~NA~~	~~NA~~	~~NA~~	
~~Multiple Tank Flight Type~~	~~Reported~~	~~Reported~~	~~GPH ≤ 4.96c+ 17.00 (LPH ≤ 0.461d + 787)~~	~~NA~~	~~NA~~	~~NA~~	

a. ~~Idle results should be measured with the door closed and represent the total idle energy consumed by the machine including all tank heaters and controls. The most energy consumptive configuration in the product family shall be selected to test the idle energy rate. Booster heater (internal or external) energy consumption shall be measured and reported separately, if possible, per ASTM F1696 and ASTM F1920 Sections 10.8 and 10.9, respectively. However, if booster energy cannot be measured separately it will be included in the idle energy rate measurements.~~

b. ~~GPR = gallons per rack, LPR = Liters per rack, GPSF = gallons per square foot of rack, LPSM = liters per square meter of rack, GPH = gallons per hour, c = [maximum conveyor belt speed (feet/minute)] × [conveyor belt width (feet)], LPH = liters per hour, d = [maximum conveyor belt speed (m/minute)] × [conveyor belt width (m)]~~

c. ~~PPU Washing Energy is still in format kWh/rack when evaluated; SF_{rack} (SM_{rack}) is Square Feet of rack area (square meters of rack area), same as in PPU water consumption metric.~~

~~**TABLE C406.2.6.2(4) Minimum Efficiency Requirements: Commercial Ovens**~~

Fuel ~~type~~	~~Classification~~	~~Idle Rate~~	~~Cooking Energy Efficiency, %~~	~~Test Procedure~~
~~Convection Ovens~~				
~~Gas~~	~~Full-Size~~	~~≤ 12,000 Btu/h (3.5 kW)~~	~~≥ 46~~	~~ASTM F1496~~
~~Electric~~	~~Half-size~~	~~≤ 1.0 kW~~	~~≥ 71~~	
~~Electric~~	~~Full-size~~	~~≤ 1.60 kW~~		
~~Combination Ovens~~				
~~Gas~~	~~Steam Mode~~	~~≤ 200 P[a] + 6,511 Btu/h (≤ 0.059 P[a] + 1.9 kW)~~	~~≥ 41~~	~~ASTM F2861~~
	~~Convection Mode~~	~~≤ 150 P[a] + 5,425 Btu/h (≤ 0.044 P[a] + 1.6 kW)~~	~~≥ 56~~	
~~Electric~~	~~Steam Mode~~	~~≤ 0.133 P[a] + 0.6400 kW~~	~~≥ 55~~	
	~~Convection Mode~~	~~≤ 0.080 P[a] + 0.4989 kW~~	~~≥ 76~~	
~~Rack Ovens~~				
~~Gas~~	~~Single~~	~~≤ 25,000 Btu/h (7.3 kW)~~	~~≥ 48~~	~~ASTM F2093~~
	~~Double~~	~~≤ 30,000 Btu/h (8.8 kW)~~	~~≥ 52~~	

a. P = Pan Capacity: the number of steam table pans the combination oven is able to accommodate in accordance with ASTM F1495

~~**C406.2.6.3 Q03 Effi cient Residential Kitchen Equipment .** For projects with Group R-1 and R-2 occupancies, energy credits shall be achieved where all dishwashers, refrigerators, and freezers comply with all of the following:~~

1. ~~Achieve the Energy Star Most Efficient 2021 label in accordance with the specifications current as of:~~

   ~~1.1. Refrigerators and freezers 5.0, 9/15/2014~~

   ~~1.2. Dishwashers 6.0, 1/29/2016~~

2. ~~Be installed before the issuance of the certificate of occupancy.~~

~~For Group R-1 where only some guest rooms are equipped with both refrigerators and dishwashers, the table credits shall be prorated as follows:~~

~~**(Equation 4-27)**~~

~~**C406.2.6.4 Q04 Fault detection and diagnostics system.** A project not required to comply with C403.2.3 can achieve energy credits for installing a fault detection and diagnostics system to monitor the HVAC system's performance and automatically identify faults. The installed system shall comply with items 1 through 6 in Section C403.2.3.~~

~~**C406.3 Renewable and Load Management Credits achieved.** Renewable energy and load management measures installed in the buildingthat comply with Sections C406.3.1 through C406.3.8 shall achieve the credits listed for the occupancy group in Tables C406.3(1) through C406.3(9) or where calculations are required in Sections C406.3 to determine credits or modify the table credits, the credits achieved shall be based upon the Section C406.3 calculations. Measure credits achieved shall be determined in one of two ways, depending on the measure:~~

1. ~~The measure credit shall be the base energy credit for the measure where no adjustment factor or formula is shown in the description of the measure in Section C406.3.~~
2. ~~The measure credit shall be the base energy credit for the measure adjusted by a factor or formula as stated in the description of the measure in Section C406.3. Where adjustments are applied, each energy credit shall be rounded to the nearest whole number.~~

~~Load management and renewable credits achieved for the project shall be the sum of credits for individual measures included in the project. Credits are available for the measures listed in this Section. Where a project contains multiple building use groups credits achieved for each building use group shall be summed and then weighted by the gross fl oor area of each building use group to determine the weighted average project energy credits achieved.~~
~~The load management measures in Sections C406.3.2 (G01) through C406.3.7 (G06) require load management control sequences that are capable of and configured to automatically provide the load management operation specified based on indication of a peak period related to high short-term electric prices,grid condition, or peak building load. Such a peak period shall, where possible, be initiated by a demand response signal from the controlling entity, such as autility or service operator. When communications are disabled or unavailable, all demand responsive controls shall continue backup demand response based on a local schedule or building demand monitoring. The local building schedule shall be adjustable without programming and reflect the electric rate peak period dates and times. The load management control sequences shall be activated for peak period control by either:~~

1. ~~A certified OpenADR 2.0a or OpenADR 2.0b Virtual End Node (VEN), as specified under Clause 11, Conformance, in the applicable OpenADR 2.0 Specification, or~~
2. ~~A device certified by the manufacturer as being capable of responding to a demand response signal from a certified OpenADR 2.0b VEN by automatically implementing the control functions requested by the VEN for the equipment it controls, or~~
3. ~~A device that complies with IEC 62726-10-1, an international standard for the open automated demand response system interface between the appliance, system, or energy management system and the controlling entity, or~~
4. ~~An interface that complies with the communication protocol required by a controlling entity, to participate in an automated demand response program, or~~
5. ~~Where the controlling entity does not have a demand response program or protocol available, local demand response control shall be provided based on either:~~

   ~~5.1 Building demand management controls that monitor building electrical demand and initiate controls to minimize monthly or peak time period demand charges, or,~~

   ~~5.2 Where buildings are less than 25,000 gross square feet, a local building schedule that reflects the electric rate peak period dates and times. In this case a binary input to the control system shall be provided that activates the demand response sequence.~~

~~TABLE C406.3(1) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES~~

~~ID~~	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable Energy~~	~~C406.3.1~~	~~9~~	~~15~~	~~11~~	~~17~~	~~18~~	~~20~~	~~19~~	~~21~~	~~13~~	~~10~~	~~13~~	~~9~~	~~9~~	~~11~~	~~10~~	~~9~~	~~10~~	~~9~~	~~7~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~16~~	~~7~~	~~9~~	~~12~~	~~12~~	~~16~~	~~11~~	~~14~~	~~12~~	~~11~~	~~16~~	~~14~~	~~8~~	~~11~~	~~14~~	~~5~~	~~7~~	~~7~~	~~11~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~42~~	~~41~~	~~21~~	~~35~~	~~23~~	~~37~~	~~30~~	~~28~~	~~28~~	~~17~~	~~33~~	~~24~~	~~20~~	~~22~~	~~23~~	~~10~~	~~13~~	~~15~~	~~17~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~11~~	~~x~~	~~7~~	~~18~~	~~10~~	~~13~~	~~5~~	~~13~~	~~12~~	~~2~~	~~14~~	~~7~~	~~10~~	~~13~~	~~11~~	~~1~~	~~8~~	~~8~~	~~16~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~10~~	~~10~~	~~10~~	~~11~~	~~10~~	~~13~~	~~13~~	~~14~~	~~17~~	~~16~~	~~13~~	~~17~~	~~14~~	~~13~~	~~17~~	~~14~~	~~14~~	~~14~~	~~15~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~28~~	~~6~~	~~31~~	~~13~~	~~22~~	~~21~~	~~21~~	~~37~~	~~11~~	~~12~~	~~22~~	~~11~~	~~9~~	~~17~~	~~9~~	~~7~~	~~17~~	~~2~~	~~3~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~17~~	~~17~~	~~19~~	~~18~~	~~19~~	~~19~~	~~20~~	~~20~~	~~22~~	~~19~~	~~19~~	~~21~~	~~19~~	~~19~~	~~20~~	~~18~~	~~19~~	~~18~~	~~17~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~7~~	~~2~~	~~11~~	~~5~~	~~16~~	~~28~~	~~22~~	~~27~~	~~60~~	~~19~~	~~43~~	~~46~~	~~32~~	~~58~~	~~37~~	~~27~~	~~45~~	~~40~~	~~19~~

x = ~~Credits excluded from thisbuildinguse type and climate zone~~.

~~**TABLE C406.3(2) RENEWABLE AND LOAD MANAGEMENT CREDITS FOR GROUP I-2 OCCUPANICIES**~~

ID	~~**Energy Credit Abbreviated Title**~~	~~**Section**~~	~~**Climate Zone**~~																		
			~~**0A**~~	~~**0B**~~	~~**1A**~~	~~**1B**~~	~~**2A**~~	~~**2B**~~	~~**3A**~~	~~**3B**~~	~~**3C**~~	~~**4A**~~	~~**4B**~~	~~**4C**~~	~~**5A**~~	~~**5B**~~	~~**5C**~~	~~**6A**~~	~~**6B**~~	~~**7**~~	~~**8**~~
~~R01~~	~~Renewable Energy~~	~~C406.3.1~~	~~6~~	~~6~~	~~6~~	~~6~~	~~6~~	~~8~~	~~7~~	~~9~~	~~8~~	~~6~~	~~8~~	~~6~~	~~6~~	~~7~~	~~7~~	~~6~~	~~7~~	~~5~~	~~4~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~11~~	~~12~~	~~13~~	~~13~~	~~13~~	~~12~~	~~12~~	~~12~~	~~6~~	~~13~~	~~16~~	~~12~~	~~13~~	~~14~~	~~15~~	~~14~~	~~14~~	~~12~~	~~12~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~10~~	~~11~~	~~10~~	~~10~~	~~8~~	~~21~~	~~10~~	~~10~~	~~13~~	~~11~~	~~18~~	~~11~~	~~12~~	~~14~~	~~13~~	~~12~~	~~11~~	~~9~~	~~7~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~1~~	~~1~~	~~1~~	~~1~~	~~x~~	~~x~~	~~x~~	~~1~~	~~x~~	~~x~~	~~2~~	~~x~~	~~x~~	~~2~~	~~x~~	~~x~~	~~1~~	~~1~~	~~x~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~13~~	~~13~~	~~13~~	~~13~~	~~14~~	~~15~~	~~14~~	~~15~~	~~15~~	~~14~~	~~15~~	~~15~~	~~14~~	~~15~~	~~15~~	~~13~~	~~14~~	~~13~~	~~12~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~25~~	~~6~~	~~33~~	~~14~~	~~25~~	~~19~~	~~27~~	~~37~~	~~27~~	~~16~~	~~22~~	~~19~~	~~14~~	~~18~~	~~11~~	~~11~~	~~20~~	~~2~~	~~3~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~	~~4~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~6~~	~~2~~	~~10~~	~~4~~	~~15~~	~~25~~	~~20~~	~~24~~	~~57~~	~~18~~	~~39~~	~~44~~	~~31~~	~~53~~	~~33~~	~~25~~	~~40~~	~~34~~	~~14~~

x = Credits excluded from this *building* use type and climate zone.

~~TABLE C406.3(3) Renewable and Load Management Credits for Group R-1 Occupancies~~

ID	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable energy~~	~~C406.3.1~~	~~9~~	~~8~~	~~12~~	~~9~~	~~11~~	~~11~~	~~10~~	~~12~~	~~13~~	~~9~~	~~12~~	~~8~~	~~9~~	~~11~~	~~9~~	~~8~~	~~9~~	~~7~~	~~5~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~12~~	~~12~~	~~11~~	~~12~~	~~12~~	~~14~~	~~14~~	~~13~~	~~15~~	~~14~~	~~13~~	~~11~~	~~10~~	~~11~~	~~14~~	~~9~~	~~11~~	~~8~~	~~8~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~2~~	~~2~~	~~2~~	~~3~~	~~1~~	~~2~~	~~3~~	~~2~~	~~4~~	~~3~~	~~2~~	~~1~~	~~1~~	~~1~~	~~3~~	~~1~~	~~2~~	~~1~~	~~1~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~9~~	~~9~~	~~10~~	~~10~~	~~9~~	~~13~~	~~13~~	~~15~~	~~13~~	~~14~~	~~13~~	~~14~~	~~14~~	~~12~~	~~16~~	~~13~~	~~12~~	~~12~~	~~13~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~31~~	~~7~~	~~38~~	~~17~~	~~29~~	~~24~~	~~31~~	~~44~~	~~26~~	~~18~~	~~26~~	~~16~~	~~15~~	~~21~~	~~11~~	~~12~~	~~24~~	~~2~~	~~4~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~25~~	~~25~~	~~28~~	~~26~~	~~28~~	~~29~~	~~29~~	~~30~~	~~31~~	~~29~~	~~30~~	~~31~~	~~28~~	~~29~~	~~31~~	~~26~~	~~28~~	~~25~~	~~24~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~6~~	~~1~~	~~10~~	~~4~~	~~14~~	~~24~~	~~19~~	~~23~~	~~53~~	~~17~~	~~38~~	~~41~~	~~30~~	~~52~~	~~33~~	~~26~~	~~42~~	~~37~~	~~17~~

x = Credits excluded from this building use type and climate zone.

~~TABLE C406.3(4) Renewable and Load Management Credits for Group B Occupancies~~

~~ID~~	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable energy~~	~~C406.3.1~~	~~14~~	~~14~~	~~17~~	~~15~~	~~17~~	~~19~~	~~18~~	~~22~~	~~24~~	~~17~~	~~22~~	~~16~~	~~14~~	~~18~~	~~18~~	~~14~~	~~17~~	~~14~~	~~11~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~10~~	~~11~~	~~11~~	~~12~~	~~11~~	~~11~~	~~11~~	~~12~~	~~9~~	~~10~~	~~11~~	~~10~~	~~10~~	~~11~~	~~10~~	~~10~~	~~11~~	~~10~~	~~9~~
G02	~~HVAC load management~~	~~C406.3.3~~	~~x~~	~~10~~	~~10~~	~~9~~	~~9~~	~~3~~	~~8~~	~~12~~	~~7~~	~~12~~	~~8~~	~~11~~	~~9~~	~~10~~	~~12~~	~~8~~	~~9~~	~~10~~	~~2~~
G03	~~Automated shading~~	~~C406.3.4~~	~~4~~	~~7~~	~~7~~	~~8~~	~~7~~	~~8~~	~~5~~	~~6~~	~~6~~	~~4~~	~~6~~	~~5~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~4~~	~~7~~
G04	~~Electric energy storage~~	~~C406.3.5~~	~~14~~	~~15~~	~~14~~	~~14~~	~~16~~	~~16~~	~~17~~	~~16~~	~~18~~	~~17~~	~~16~~	~~18~~	~~17~~	~~17~~	~~18~~	~~16~~	~~15~~	~~17~~	~~18~~
G05	Cooling energy storage	C406.3.6	28	7	36	16	27	24	28	45	27	17	27	15	15	20	9	12	25	2	4
G06	SHW energy storage	C406.3.7	5	5	6	6	6	6	7	7	8	7	7	7	7	7	8	6	7	6	6
G07	Building thermal mass	C406.3.8	3	1	5	2	6	9	6	7	14	4	11	8	9	15	5	8	12	15	7

x ~~= Credits excluded from this building use type and climate zone.~~

~~TABLE C406.3(5) Renewable and Load Management Credits for Group A-2 Occupancies~~

~~ID~~	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable energy~~	~~C406.3.1~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~4~~	~~2~~	~~3~~	~~2~~	~~2~~	~~3~~	~~2~~	~~2~~	~~2~~	~~2~~	~~1~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~4~~	~~4~~	~~5~~	~~5~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~4~~	~~5~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	~~5~~	~~4~~	~~1~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~32~~	~~26~~	~~37~~	~~28~~	~~31~~	~~26~~	~~27~~	~~22~~	~~23~~	~~20~~	~~17~~	~~14~~	~~19~~	~~14~~	~~10~~	~~16~~	~~14~~	~~14~~	~~1~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~5~~	~~5~~	~~5~~	~~4~~	~~4~~	~~4~~	~~4~~	~~3~~	~~4~~	~~4~~	~~4~~	~~3~~	~~3~~	~~2~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~15~~	~~4~~	~~17~~	~~8~~	~~12~~	~~10~~	~~10~~	~~16~~	~~6~~	~~5~~	~~7~~	~~3~~	~~3~~	~~4~~	~~1~~	~~2~~	~~4~~	~~x~~	~~x~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~13~~	~~13~~	~~15~~	~~14~~	~~15~~	~~16~~	~~16~~	~~17~~	~~19~~	~~16~~	~~17~~	~~19~~	~~16~~	~~17~~	~~18~~	~~15~~	~~16~~	~~14~~	~~13~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~3~~	~~1~~	~~5~~	~~2~~	~~7~~	~~12~~	~~8~~	~~10~~	~~21~~	~~6~~	~~15~~	~~14~~	~~8~~	~~18~~	~~10~~	~~6~~	~~12~~	~~8~~	~~3~~

x = ~~Credits excluded from this building use type and climate zone.~~

~~TABLE C406.3(6) Renewable and Load Management Credits for Group M Occupancies~~

ID	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable energy~~	~~C406.3.1~~	~~8~~	~~8~~	~~12~~	~~9~~	~~11~~	~~12~~	~~12~~	~~17~~	~~17~~	~~11~~	~~13~~	~~9~~	~~10~~	~~11~~	~~10~~	~~9~~	~~10~~	~~9~~	~~6~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~16~~	~~16~~	~~18~~	~~19~~	~~17~~	~~19~~	~~19~~	~~21~~	~~17~~	~~18~~	~~21~~	~~21~~	~~18~~	~~21~~	~~22~~	~~18~~	~~22~~	~~18~~	~~16~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~x~~	~~15~~	~~16~~	~~15~~	~~15~~	~~6~~	~~15~~	~~21~~	~~13~~	~~23~~	~~15~~	~~23~~	~~17~~	~~19~~	~~26~~	~~14~~	~~17~~	~~18~~	~~3~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~7~~	~~11~~	~~11~~	~~12~~	~~11~~	~~13~~	~~10~~	~~11~~	~~11~~	~~7~~	~~11~~	~~11~~	~~8~~	~~10~~	~~11~~	~~8~~	~~9~~	~~8~~	~~12~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~6~~	~~10~~	~~8~~	~~10~~	~~11~~	~~12~~	~~11~~	~~10~~	~~14~~	~~11~~	~~10~~	~~12~~	~~10~~	~~11~~	~~12~~	~~11~~	~~9~~	~~10~~	~~8~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~40~~	~~9~~	~~51~~	~~22~~	~~35~~	~~31~~	~~34~~	~~53~~	~~21~~	~~17~~	~~28~~	~~10~~	~~11~~	~~19~~	~~4~~	~~9~~	~~18~~	~~2~~	~~2~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~3~~	~~3~~	~~4~~	~~3~~	~~4~~	~~4~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~5~~	~~4~~	~~4~~	~~4~~	~~3~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~5~~	~~1~~	~~6~~	~~3~~	~~8~~	~~12~~	~~10~~	~~10~~	~~20~~	~~7~~	~~17~~	~~15~~	~~14~~	~~24~~	~~10~~	~~13~~	~~20~~	~~24~~	~~12~~

x = Credits excluded from this building use type and climate zone.

~~**TABLE C406.3(7) Renewable and Load Management Credits for Group E Occupancies**~~

~~ID~~	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable Energy~~	~~C406.3.1~~	~~10~~	~~11~~	~~13~~	~~12~~	~~13~~	~~16~~	~~15~~	~~21~~	~~22~~	~~15~~	~~19~~	~~15~~	~~14~~	~~17~~	~~16~~	~~13~~	~~16~~	~~12~~	~~10~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~7~~	~~12~~	~~12~~	~~13~~	~~13~~	~~15~~	~~14~~	~~16~~	~~13~~	~~12~~	~~16~~	~~16~~	~~10~~	~~14~~	~~18~~	~~16~~	~~13~~	~~14~~	~~14~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~18~~	~~22~~	~~32~~	~~23~~	~~25~~	~~31~~	~~26~~	~~26~~	~~20~~	~~23~~	~~31~~	~~24~~	~~20~~	~~31~~	~~12~~	~~18~~	~~27~~	~~16~~	~~9~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~7~~	~~13~~	~~16~~	~~12~~	~~18~~	~~17~~	~~17~~	~~18~~	~~13~~	~~12~~	~~17~~	~~17~~	~~10~~	~~15~~	~~13~~	~~14~~	~~10~~	~~16~~	~~17~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~16~~	~~16~~	~~18~~	~~17~~	~~19~~	~~21~~	~~21~~	~~23~~	~~26~~	~~22~~	~~24~~	~~24~~	~~23~~	~~24~~	~~24~~	~~20~~	~~22~~	~~19~~	~~19~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~36~~	~~9~~	~~46~~	~~21~~	~~36~~	~~32~~	~~39~~	~~62~~	~~39~~	~~24~~	~~37~~	~~22~~	~~20~~	~~28~~	~~13~~	~~16~~	~~31~~	~~3~~	~~4~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~5~~	~~5~~	~~6~~	~~5~~	~~6~~	~~6~~	~~7~~	~~7~~	~~8~~	~~7~~	~~7~~	~~8~~	~~7~~	~~7~~	~~8~~	~~7~~	~~7~~	~~7~~	~~6~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~7~~	~~2~~	~~11~~	~~5~~	~~17~~	~~28~~	~~23~~	~~27~~	~~63~~	~~21~~	~~44~~	~~48~~	~~37~~	~~60~~	~~38~~	~~31~~	~~50~~	~~47~~	~~21~~

x = ~~Credits excluded from this building use type and climate zone.~~

~~TABLE C406.3(8) Renewable and Load Management Credits for Group S-1 and S-2 Occupancies~~

~~ID~~	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
R01	~~Renewable Energy~~	~~C406.3.1~~	~~38~~	~~37~~	~~55~~	~~45~~	~~53~~	~~53~~	~~49~~	~~58~~	~~66~~	~~36~~	~~56~~	~~38~~	~~29~~	~~41~~	~~36~~	~~24~~	~~32~~	~~23~~	~~16~~
G01	~~Lighting load management~~	~~C406.3.2~~	~~13~~	~~26~~	~~32~~	~~28~~	~~32~~	~~35~~	~~36~~	~~33~~	~~36~~	~~31~~	~~27~~	~~37~~	~~32~~	~~23~~	~~28~~	~~36~~	~~22~~	~~25~~	~~22~~
G02	~~HVAC load management~~	~~C406.3.3~~	~~18~~	~~46~~	~~37~~	~~37~~	~~28~~	~~36~~	~~29~~	~~26~~	~~22~~	~~23~~	~~17~~	~~12~~	~~16~~	~~13~~	~~5~~	~~14~~	~~8~~	~~10~~	~~3~~
G03	~~Automated shading~~	~~C406.3.4~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~	~~x~~
G04	~~Electric energy storage~~	~~C406.3.5~~	~~40~~	~~40~~	~~47~~	~~41~~	~~47~~	~~44~~	~~40~~	~~44~~	~~42~~	~~30~~	~~38~~	~~31~~	~~21~~	~~31~~	~~26~~	~~24~~	~~29~~	~~23~~	~~21~~
G05	~~Cooling energy storage~~	~~C406.3.6~~	~~20~~	~~5~~	~~21~~	~~11~~	~~14~~	~~14~~	~~11~~	~~21~~	~~5~~	~~5~~	~~9~~	~~2~~	~~2~~	~~5~~	~~1~~	~~1~~	~~3~~	~~x~~	~~x~~
G06	~~SHW energy storage~~	~~C406.3.7~~	~~3~~	~~3~~	~~3~~	~~3~~	~~4~~	~~3~~	~~4~~	~~4~~	~~4~~	~~3~~	~~4~~	~~4~~	~~3~~	~~3~~	~~4~~	~~2~~	~~2~~	~~2~~	~~2~~
G07	~~Building thermal mass~~	~~C406.3.8~~	~~7~~	~~2~~	~~12~~	~~5~~	~~17~~	~~29~~	~~23~~	~~28~~	~~66~~	~~18~~	~~44~~	~~47~~	~~28~~	~~56~~	~~37~~	~~20~~	~~39~~	~~29~~	~~13~~

~~“x” indicates measure is not available for building occupancy in that climate zone~~

~~TABLE C406.3(9) Renewable and Load Management Credits for Other[a] Occupancies~~

ID	~~Energy Credit Abbreviated Title~~	~~Section~~	~~Climate Zone~~																		
			~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R01~~	~~Renewable Energy~~	~~C406.3.1~~	~~12~~	~~13~~	~~16~~	~~14~~	~~16~~	~~18~~	~~17~~	~~20~~	~~21~~	~~13~~	~~18~~	~~13~~	~~12~~	~~15~~	~~14~~	~~11~~	~~13~~	~~10~~	~~8~~
~~G01~~	~~Lighting load management~~	~~C406.3.2~~	~~11~~	~~13~~	~~14~~	~~14~~	~~14~~	~~16~~	~~15~~	~~16~~	~~14~~	~~14~~	~~16~~	~~16~~	~~13~~	~~14~~	~~16~~	~~14~~	~~13~~	~~12~~	~~12~~
~~G02~~	~~HVAC load management~~	~~C406.3.3~~	~~24~~	~~24~~	~~23~~	~~22~~	~~20~~	~~23~~	~~21~~	~~21~~	~~18~~	~~18~~	~~20~~	~~17~~	~~16~~	~~18~~	~~14~~	~~13~~	~~14~~	~~13~~	~~6~~
~~G03~~	~~Automated shading~~	~~C406.3.4~~	~~5~~	~~6~~	~~7~~	~~9~~	~~8~~	~~9~~	~~7~~	~~9~~	~~8~~	~~5~~	~~9~~	~~7~~	~~5~~	~~8~~	~~7~~	~~5~~	~~6~~	~~6~~	~~9~~
~~G04~~	~~Electric energy storage~~	~~C406.3.5~~	~~14~~	~~15~~	~~16~~	~~15~~	~~16~~	~~17~~	~~17~~	~~18~~	~~19~~	~~16~~	~~17~~	~~17~~	~~15~~	~~16~~	~~17~~	~~14~~	~~15~~	~~14~~	~~14~~
~~G05~~	~~Cooling energy storage~~	~~C406.3.6~~	~~28~~	~~7~~	~~34~~	~~15~~	~~25~~	~~22~~	~~25~~	~~39~~	~~20~~	~~14~~	~~22~~	~~12~~	~~11~~	~~17~~	~~7~~	~~9~~	~~18~~	~~2~~	~~3~~
~~G06~~	~~SHW energy storage~~	~~C406.3.7~~	~~9~~	~~9~~	~~11~~	~~10~~	~~11~~	~~11~~	~~11~~	~~12~~	~~13~~	~~11~~	~~12~~	~~13~~	~~11~~	~~11~~	~~12~~	~~10~~	~~11~~	~~10~~	~~9~~
~~G07~~	~~Building thermal mass~~	~~C406.3.8~~	~~6~~	~~2~~	~~9~~	~~4~~	~~13~~	~~21~~	~~16~~	~~20~~	~~44~~	~~14~~	~~31~~	~~33~~	~~24~~	~~42~~	~~25~~	~~20~~	~~33~~	~~29~~	~~13~~

a. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, and R.

~~C406.3.1 R01 Renewable Energy.~~ ~~Projects installing on-site renewable energy systems with a capacity of at least 0.1 watts per gross square foot (1.08W/m2) of building area or securing off-site renewable energy shall achieve energy credits for this measure calculated as follows:~~

~~(Equation 4-28)~~

~~EC_R = C406.3.1 R01 energy credits achieved for this project~~
~~R_r = Actual total rating of on-site renewable energy systems (W)~~
~~PGFA = Project gross fl oor area, ft^2~~
~~$EC_{0.1}$ = C406.3.1 R01 base credits from Tables C406.3(1) through C406.3(9)~~
~~R_{OFF} = Actual total equivalent rating of off-site renewable energy contracts (W), calculated as follows:~~
~~ROFF = TRE/(REN X 20)~~
~~where:~~
~~TRE = Total off-site renewable electrical energy in kilowatt-hours (kWh) that is procured in accordance with Sections C405.13.2.1 through C405.13.4~~
~~REN = Annual off-site renewable electrical energy from Table C405.13.2, in units of kilowatt-hours per watt of array capacity~~
~~R_{ex} = Rating (W) of renewable energy resources capacity excluded from credit calculated as follows:~~
~~$R_{ex} = RR_r + RR_x + RR_c$~~
~~where:~~
~~RR_r = Rating of on-site renewable energy systems required by Section C405.13.1, without exception (W).~~
~~RR_x = Rating of renewable energy resources used to meet any exceptions of this code (W).~~
~~RR_c = Rating of renewable energy resources used to achieve other energy credits in Section C406 (W).~~
~~Where renewable requirements, exceptions, or credits are expressed in annual kWh or Btu rather than Watts of output capacity, they shall be converted as3413 Btu = 1 kWh and converted to W equivalent capacity as follows:~~
~~RR_w = Actual total equivalent rating of renewable energy capacity (W), calculated as follows:~~
~~$RR_w = TRE_x / (REN \times PGFA)$~~
~~where:~~
~~TRE_x = Total renewable energy in kilowatt-hours (kWh) that is excluded from R01 energy credits~~

~~C406.3.2 G01 Lighting Load Management.~~ ~~Luminaires shall have dimming capability and automatic load management controls that shall gradually reduce *general lighting* power during peak periods. The load management controls shall reduce lighting power in 75 percent of the building area by at least 20 percent with *continuous dimming* over a period no longer than 15 minutes. Where less than 75 percent, but at least 50 percent of the project *general lighting* is controlled, the credits from Tables C406.3 shall be prorated as follows:~~

~~(Equation 4-29)~~

> **~~Exception:~~** ~~Warehouse or retail storage building areas shall be permitted to achieve this credit by switching off at least 25 percent of lighting power in 75 percent of the building area without dimming, or as adjusted by Equation 4-29.~~

~~C406.3.3 G02 HVAC Load Management.~~ Automatic load management controls shall be configured:

1. ~~Where electric cooling is in use to gradually increase the cooling setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective cooling capacity to 60% of installed capacity during the peak period.~~
2. ~~Where electric heating is in use to gradually decrease the heating setpoint by at least 3°F (1.7°C) over a minimum of three hours or reduce effective heating capacity to 60% of installed capacity during the peak period.~~
3. ~~Where HVAC systems are serving multiple zones and have less than 70 percent outdoor air required, include controls that provide excess outdoor airpreceding the peak period and reduce outdoor air by at least 30 percent during the peak period, in accordance with ASHRAE Standard 62.1 Section 6.2.5.2 Short Term Conditions or provisions for *approved* engineering analysis in the International Mechanical Code Section 403.3.1.1, Outdoor Airflow Rate.~~

~~**C406.3.4 G03 Automated Shading Load Management.** Where fenestration on east, south, and west exposures exceeds 20 percent of wall area, load management credits shall be achieved as follows:~~

1. ~~Automatic exterior shading devices or dynamic glazing that are capable of reducing solar gain (SHGC) through sunlit fenestration by at least 50 percent when fully closed shall receive the full credits in Tables C406.3(1) through C406.3(9). The exterior shades shall have fully open and fully closed SHGC determined in accordance with AERC 1.~~
2. ~~Automatic interior shading devices with a minimum solar refl ectance of 0.50 for the surface facing the fenestration shall receive 40 percent of the credits in Tables C406.3(1) through C406.3(9).~~
3. ~~All shading devices, dynamic glazing, or shading attachments shall:~~

    ~~3.1 Provide at least 90 percent coverage of the total fenestration on east, south, and west exposures in the *building*.~~

    ~~3.2 Be automatically controlled and shall modulate in multiple steps or continuously the amount of solar gain and light transmitted into the space in response to peak periods and either daylight levels or solar intensity.~~

    ~~3.3 Include a manual override located in the same enclosed space as the shaded vertical fenestration that shall override operation of automatic controls no longer than four hours. Such override shall be locked out during peak periods.~~

~~For this section, directional east, south, or west exposures shall exclude fenestration that is plus or minus 45 degrees of facing true north in the northern hemisphere. In the southern hemisphere, where the south exposure is referred to, it shall be replaced by the north exposure and the referenced south exposure shall be replaced by the north exposure.~~

~~**C406.3.5 G04 Electric Energy Storage.** Electric storage devices shall be charged and discharged by automatic load management controls to store energy during non-peak periods and use stored energy during peak periods to reduce *building* demand. Electric storage devices shall have a minimum capacity of 1.5 Wh/ft^2 (87 Wh/m^2) of gross *building* area. Base credits in Tables C406.3-1 through C406.3-8 are based on installed electric storage of 5 Wh/ft^2 (54 Wh/m^2) and shall be prorated for actual installed storage capacity between 1.5 and 15 Wh/ft^2 (16 to 160 Wh/m^2), as follows:~~

~~**(Equation 4-30)**~~

~~Larger energy storage shall be permitted however, credits are limited to the range of 1.5 to 15 Wh/ft^2 (16 to 160 Wh/m^2).~~

~~**C406.3.6 G05 Cooling Energy Storage.** Automatic load management controls shall be capable of activating ice or chilled water storage equipment to reduced emand during summer peak periods. Storage tank standby loss shall be demonstrated through analysis to be no more than 2 percent of storage capacity over a 24 hour period for the cooling design day.~~
~~Base credits in Section C406.3 are based on storage capacity of the design peak hour cooling load with a 1.15 sizing factor. Credits shall be prorated for installed storage systems sized between 0.5 and 4.0 times the design day peak hour cooling load, rounded to the nearest whole credit. Larger storage shall be permitted but the associated credits are limited to the range above. Energy credits shall be determined as follows:~~

~~**(Equation 4-31)**~~

~~ECs = Cooling Storage credit achieved for Project~~
~~EC1.0 = G05 base energy credit for building use type and climate zone based on 1.0 ton-hours storage per design day ton (kWh/kW) of cooling load~~
~~SR = Storage ratio in ton-hours storage per design day ton (kWh/kW) of cooling load where 0.5 ≤ SR ≤ 4.0~~

~~**C406.3.7 G06 SWH Energy Storage.** Where SHW is heated by electricity, automatic load management controls comply with ANSI/CTA-2045-B shall preheat stored SHW before the peak period and suspend electric water heating during the peak period. Storage capacity shall be provided by either:~~

1. ~~Preheating water above 140°F (60°C) delivery temperature with at least 1.34 kWh of energy storage per kW of water-heating capacity. Tempering valves shall be provided at the water heater delivery location.~~
2. ~~Providing additional heated water tank storage capacity above peak SHW demand with equivalent peak storage capacity to item 1. Where heat pump water heating is used, the credits achieved shall be 1/3 of the credits in Tables C406.3(1) through C406.3(9).~~

~~**C406.3.8 G07 Building Thermal Mass.** The project shall have additional passive interior mass and a night flush control of the HVAC system. The credit is available to projects that have at least 80 percent of gross floor area unoccupied between midnight and 6:00 a.m. The project shall meet the following requirements:~~

1. ~~Interior to the *building envelope* insulation, provide 10 lb/ft(50 kg/m) of project conditioned floor area of passive thermal mass in the *building interior wall*, the inside of the *exterior wall*, or interior floor construction. Mass *construction* shall have mass surfaces directly contacting the air in *conditioned spaces* with directly attached gypsum panels allowed. Mass with carpet or furred gypsum panels or *exterior wall* mass that is on the exterior of the insulation layer (e.g., the portion of CMU block on the exterior of insulation filled cell cavities) shall not be included toward the *building* mass required.~~
2. ~~HVAC units for 80 percent or more of the supply airflow in the project shall be equipped with outdoor air economizers and fans that have variable or low speed capable of operating at 66 percent or lower airflow and be included in the night flush *control* sequence.~~

3. ~~Night flush controls shall be configured with the following sequence or another night flush strategy shall be permitted where demonstrated to be effective, avoids added morning heating, and is approved by the *authority having jurisdiction*.~~

~~3.1. Summer mode shall be activated when outdoor air temperature exceeds 70ºF (21ºC) and shall continue uninterrupted until deactivated when outdoor air temperature falls below 45ºF (7ºC). During summer mode, the occupied cooling *set point* shall be set 1ºF (0.6ºC) higher than normal and the occupied heating *set point* shall be reset 2ºF (1.1ºC) lower than normal.~~

~~3.2. When all the following conditions exist, night flush shall be activated:~~

~~3.2.1. Summer mode is active in accordance with item 3.1.~~

~~3.2.2. Outdoor air temperature is 5ºF (2.8ºC) or more below indoor average zone temperature.~~

~~3.2.3. Indoor average zone temperature is greater than morning occupied heating *set point*.~~

~~3.2.4. In climate zones 0A through 3A, outdoor dewpoint is below 50ºF (10ºC) or outdoor air enthalpy is less than indoor air enthalpy.~~

~~3.2.5. Local time is between 10:00 pm and 6:00 am.~~

~~3.3. When night flush is active, *automatic* night flush controls shall operate outdoor air *economizers* at low fan speed not exceeding 66 percent during the unoccupied period with *mechanical cooling* and heating locked out.~~

Reason:

- The new credit scheme proposed is *ad hoc* and not supported by transparent analysis. The cost of construction associated with the proposal is not supported by examples or analysis that justify the conclusion that the scheme would address the primary objectives of using the credit approach and tabular values in a building performance scheme. The level of detail within the credit tables suggests analytical rigor in developing the proposal, but this detail is not provided and as such cannot be critiqued to determine justification.
- A point related to the above is that when the U. S. Department of Energy (DOE) would go to fulfilling its statutory role to evaluate stringency of the resulting 2024 IECC relative to the 2021, this proposed credit scheme would simply fall into the category of "qualitative benefits" of the 2024 edition. The expansion of the "qualitative benefits" category of IECC outcomes would further pull DOE away from its statutory responsibility to assess stringency of new additions of the IECC and contrary to its statutory role.
- The new Section 406 language and addition of Appendix CD adds unnecessary clutter to an already overly complex range of simulated performance options
- No relationship of the scheme to prescriptive requirements is established by the proponent, likely developing inconsistencies in stringency across the IECC when prescriptive versus performance paths are considered.
- The role of DOE as proponent of this and associated code changes relating to the proposed credits exceeds DOE's legal authority granted under the Energy Policy and Conservation Act (EPCA) to support development of building codes.[1] Historically and lawfully, DOE's role in supporting building costs and standards has involved executing its specified legal responsibility to analysis energy code stringency for national adoption, support of analysis of proposals of other proponents during code cycles, participation in IECC code hearings to provide technical viewpoints and information to inform debate of the proposals of others, and other supporting activities. The emergence of DOE as a formal proponent for IECC code changes over-reaches this historical role and lacks the support of the legislative role of DOE.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Deletion of new text under Section 406 would not increase costs of construction since the proposal itself does not provide substantive information on how it would affect cost of construction.

Workgroup Recommendation

Proposal # 920

CED1-187-22

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.1.1 Additional energy efficiency credit requirements. *Buildings* shall comply with measures from C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone.
Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross *conditioned floor area* to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of SectionC406.

~~**Exceptions**~~ **Exception:**

~~1. Unconditioned parking garages that achieve 50% of the credits required for use groups S-1 and S-2 in Table C406.1.1.~~

~~2.~~ Portions of buildings devoted to manufacturing or industrial use.

C406.1 Compliance. Buildings shall comply as follows:

1. *Buildings* with greater than 2000 square feet (190 m) of *conditioned floor area* shall comply with Section C406.1.1.
2. *Buildings* with greater than 5000 square feet (465 m) of *conditioned floor area* shall comply with Sections C406.1.1 and C406.1.2.
3. Build-out construction greater than 1000 square feet (93 m) of *conditioned floor area* that does not have final lighting or final HVAC systems installed under a prior building permit shall comply with Section C406.1.3.

Exceptions: Core and shell *buildings* where no less than 20 percent of the *net floor area* is without final lighting or final HVAC that comply with all of thefollowing:

1. *Buildings* with greater than 5000 (465 m) of *conditioned floor* area shall comply with Section C406.1.2.
2. Portions of the *building* where the *net floor area* is without final lighting or final HVAC shall comply with Section C406.1.3
3. Portions of the *building* where the *net floor area* has final lighting and final HVAC systems shall comply with C406.1.1.

C406.2 Additional Energy Efficiency Credits Achieved. Each energy effi ciency credit measure used to meet credit requirements for the project shall have efficiency that is greater than the requirements in Sections C402 through C405. Measures installed in the project that meet the requirements in Sections C406.2.1 through C406.2.7 shall achieve the base credits listed for the measure and occupancy type in Tables C406.2(1) through C406.2(9) or, where calculations required by Sections C406.2.1 through C406.2.7 create or modify the table credits, the credits achieved shall be based upon the calculations. Energy credits achieved for measures shall be determined by one of the following, as applicable:

1. The measure's energy credit shall be the base energy credit for the measure where no adjustment factor or calculation is included in the description ofthe measure in Section C406.2.
2. The measure's energy credit shall be the base energy credit for the measure adjusted by a factor or equation as stated in the description of the measure in Section C406.2. Where adjustments are applied, each measure's energy credit shall be rounded to the nearest whole number.
3. The measure's energy credit shall be calculation as stated in the measures description in Section C406.2, where each individual measure credit shall be rounded to the nearest whole number.

Energy credits achieved for the project shall be the sum of the individual measure's energy credits. Credits are available for the measures listed in this Section. Where a project contains multiple building occupancy groups:

1. Credits achieved for each occupancy group shall be summed and then weighted by the *conditioned floor area* of each occupancy group to determine the weighted average project energy credits achieved.
2. Credits for improved envelope efficiency and lighting reduction (L06) shall be determined for the building or permitted *conditioned floor area* as a whole. Credits for other measures shall be taken from applicable tables or calculations weighted by the building occupancy group floor area.

Reason: Because it is impossible for unconditioned spaces to comply the code as written.
Consider an unconditioned parking garage. Tis has no insulation, fenestration, heating, cooling, hot water, or kitchen equipment. L03 is not possible because base code already requires every fixture to have an occupant sensor. P01 is not possible unless the building is smaller than 10,000 square feet (which would be a very small parking garage). The only credits you could achieve are:

L02 Light Dimming

L06 Light Power Reduction

Q01 Efficient Elevator

In Climate Zone 8 this is a maximum of 12 possible points. Per Table 406.1.1 the project would be required to achieve 45 points (50% of 90).

In Climate Zone 5A this is a maximum of 20 possible points. Per Table 406.1.1 the project would be required to achieve 45 points (50% of 90).

This problem is not limited to parking garages. Elevated train platforms, unconditioned warehouses, sports stadiums, etc. will all encounter the same problem.

Finally, the scoring of lighting credits shows much greater energy savings in warmer climates. This would only make sense if the the lights were installed in a conditioned space, and this seems to be the assumption in the modelling. If this is the assumption, then these energy credits should not be applied to unconditioned spaces.

Cost Impact: The code change proposal will decrease the cost of construction.
By eliminating compliance requirements from unconditioned spaces this proposal will reduce the cost of constructing these spaces.

Workgroup Recommendation

Proposal # 804

CED1-188-22

Proponents: Laura Petrillo-Groh, representing AHRI (lpetrillo-groh@ahrinet.org); Vladimir Kochkin, representing NAHB (vkochkin@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C406.1.1 ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

Portions of table not shown remain unchanged.

Building Occupancy Group	Climate Zone																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R-2, R-4, and I-1	~~65~~ 44	~~66~~ 44	~~67~~ 45	~~77~~ 52	~~80~~ 54	~~86~~ 58	~~80~~ 54	~~81~~ 54	~~90~~ 60	~~86~~ 58	~~90~~ 60	~~90~~ 60	~~86~~ 58	~~90~~ 60	~~90~~ 60	~~70~~ 47	~~89~~ 60	~~80~~ 54	~~78~~ 52
I-2	~~43~~ 29	~~42~~ 28	~~38~~ 25	~~37~~ 25	~~36~~ 24	~~38~~ 25	~~32~~ 21	~~32~~ 21	~~30~~ 20	~~36~~ 24	~~36~~ 24	~~35~~ 23	~~43~~ 29	~~43~~ 29	~~44~~ 29	~~46~~ 31	~~47~~ 31	~~50~~ 34	~~53~~ 36
R-1	~~63~~ 42	~~62~~ 42	~~66~~ 44	~~65~~ 44	~~70~~ 47	~~71~~ 48	~~77~~ 52	~~80~~ 54	~~84~~ 56	~~81~~ 54	~~83~~ 56	~~88~~ 59	~~85~~ 57	~~86~~ 58	~~90~~ 60	~~83~~ 56	~~87~~ 58	~~87~~ 58	~~85~~ 57
B	~~62~~ 42	~~62~~ 43	~~64~~ 43	~~66~~ 44	~~66~~ 44	~~65~~ 44	~~64~~ 43	~~64~~ 43	~~68~~ 46	~~70~~ 47	~~72~~ 48	~~74~~ 50	~~71~~ 48	~~73~~ 49	~~77~~ 52	~~71~~ 48	~~74~~ 50	~~74~~ 50	~~71~~ 48
A-2	~~70~~ 47	~~70~~ 47	~~72~~ 48	~~72~~ 48	~~75~~ 50	~~75~~ 50	~~70~~ 49	~~73~~ 49	~~82~~ 55	~~69~~ 46	~~74~~ 50	~~78~~ 52	~~67~~ 45	~~72~~ 48	~~78~~ 52	~~60~~ 40	~~67~~ 45	~~57~~ 38	~~51~~ 34
M	~~80~~ 54	~~79~~ 53	~~83~~ 56	~~79~~ 53	~~81~~ 54	~~84~~ 56	~~67~~ 45	~~74~~ 50	~~87~~ 58	~~80~~ 54	~~66~~ 44	~~65~~ 44	~~79~~ 53	~~62~~ 42	~~50~~ 34	~~75~~ 50	~~67~~ 45	75 50	~~58~~ 39
E	~~56~~ 38	~~57~~ 38	~~55~~ 37	~~58~~ 39	~~58~~ 39	~~57~~ 38	~~59~~ 42	~~62~~ 42	~~59~~ 40	~~61~~ 41	~~66~~ 44	~~62~~ 42	~~64~~ 43	~~67~~ 45	~~67~~ 45	~~65~~ 44	~~67~~ 45	~~63~~ 42	~~58~~ 39
S-1 and S-2	~~61~~ 41	~~60~~ 40	~~61~~ 41	~~60~~ 40	~~58~~ 40	~~57~~ 38	~~44~~ 36	~~54~~ 36	~~62~~ 42	~~85~~ 57	~~68~~ 46	~~75~~ 50	~~90~~ 60	~~82~~ 55	~~72~~ 48	~~90~~ 60	~~89~~ 60	~~90~~ 60	~~90~~ 60
All Other	~~31~~ 21	~~31~~ 21	~~31~~ 21	~~32~~ 21	~~32~~ 21	~~33~~ 22	~~30~~ 21	~~32~~ 21	~~36~~ 24	~~35~~ 23	~~35~~ 23	~~35~~ 23	~~37~~ 25	~~36~~ 24	~~36~~ 24	~~36~~ 24	~~37~~ 25	~~36~~ 24	~~34~~ 23

TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

Building Occupancy Group	Climate Zone																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
R-2, R-4, and I-1	~~64~~ 43	~~59~~ 40	~~70~~ 47	~~69~~ 46	~~73~~ 49	~~89~~ 60	~~72~~ 48	~~90~~ 60	~~90~~ 60	~~63~~ 42	~~90~~ 60	~~70~~ 47	~~51~~ 34	~~75~~ 50	~~66~~ 44	~~48~~ 32	~~48~~ 32	~~50~~ 34	~~42~~ 28
I-2	~~31~~ 21	~~32~~ 21	~~33~~ 22	~~32~~ 21	~~33~~ 22	~~36~~ 24	~~31~~ 21	~~40~~ 27	~~34~~ 23	~~32~~ 21	~~43~~ 29	~~32~~ 21	~~29~~ 19	~~37~~ 25	~~33~~ 22	~~34~~ 23	~~34~~ 23	~~27~~ 18	~~23~~ 15
R-1	~~41~~ 27	~~40~~ 27	~~48~~ 32	~~44~~ 29	~~48~~ 32	~~58~~ 39	~~54~~ 36	~~61~~ 41	~~63~~ 42	~~50~~ 34	~~61~~ 41	~~47~~ 31	~~42~~ 28	~~55~~ 37	~~50~~ 34	~~41~~ 27	~~41~~ 27	~~40~~ 27	~~32~~ 21
B	~~63~~ 42	~~64~~ 43	~~74~~ 50	~~75~~ 50	~~78~~ 52	~~89~~ 60	~~83~~ 56	~~90~~ 60	~~90~~ 60	~~77~~ 52	~~90~~ 60	~~86~~ 58	~~68~~ 46	90 60	~~83~~ 56	~~72~~ 48	~~72~~ 48	~~68~~ 46	~~58~~ 39
A-2	~~12~~ 8	~~12~~ 8	~~13~~ 9	~~13~~ 9	~~12~~ 8	~~17~~ 11	~~13~~ 9	~~17~~ 11	~~17~~ 11	~~12~~ 8	~~17~~ 11	~~13~~ 9	~~12~~ 8	~~12~~ 8	~~12~~ 8	~~12~~ 8	~~12~~ 8	~~8~~ 5	~~7~~ 5
M	~~71~~ 48	~~70~~ 47	~~84~~ 56	~~84~~ 56	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~81~~ 54	~~90~~ 60	~~90~~ 60	~~77~~ 52	~~90~~ 60	~~90~~ 60	~~76~~ 51	~~76~~ 51	~~71~~ 48	~~58~~ 39
E	~~49~~ 33	~~55~~ 37	~~64~~ 43	~~61~~ 41	~~69~~ 46	~~83~~ 56	~~73~~ 49	~~90~~ 60	~~90~~ 60	~~67~~ 45	~~90~~ 60	~~75~~ 50	~~61~~ 41	~~86~~ 58	~~74~~ 50	~~66~~ 44	~~66~~ 44	~~60~~ 40	~~47~~ 31
S-1 and S-2	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~90~~ 60	~~70~~ 47	~~90~~ 60	~~90~~ 60	~~61~~ 41	~~61~~ 41	~~61~~ 41	~~53~~ 36
All Other	~~56~~ 38	~~55~~ 37	~~66~~ 42	~~63~~ 42	~~69~~ 46	~~80~~ 54	~~69~~ 46	~~87~~ 58	~~88~~ 59	~~59~~ 40	~~86~~ 48	~~68~~ 46	~~51~~ 34	~~72~~ 48	~~66~~ 44	~~51~~ 34	~~51~~ 34	~~48~~ 32	~~40~~ 27

Reason: States and localities are expressly preempted from setting energy use regulations for products that DOE regulates, as Advanced Energy Credits almost certainly require.[1] A pathway for minimum efficiency products was not included in the Technical Support Document (TSD for CEPI-193), therefore compliance with federal law cannot be confirmed by stakeholders.
PNNL developed a technical support document to accompany the ASHRAE 90.1 energy credit proposal (approved in 90.1-2022). (R. Hart, et al. 90.1 Energy Credits Analysis Documentation, PNNL-32516. January 2022.) The 90.1 technical support document (TSD) reviewed two demonstration packages--one to evaluate cost effectiveness and the other to show a reasonable package without using efficiency improvements for HVAC and SWH equipment subject to EPACT (42 USC § 6833) minimum federal efficiencies. Changes to Tables 406.1.1 and 406.1.2 (which taken together represent the breadth of energy credits included in 90.1-2022) have a base goal of around 7.5% site Btu savings. In a recent presentation to SSPC 90.1 by R. Hart, the IECC proposal was estimated to be 2.5% more stringent than the ASHRAE 90.1-2022 base goal of around 5% energy savings. The proposed modification is intended to harmonize IECC with 90.1-2022, with the confirmed pathway for minimum efficiency equipment.

The energy code challenged in *AHRI v. City of Albuquerque* specifically included a compliance option that would have required HVAC systems and equipment and water heaters to meet efficiency standards that were more stringent than the specific standards DOE set under Energy Policy and Conservation Act (EPCA or The Act).[2] Thus, the court concluded those provisions were “preempted as a matter of law,”[3] and further ruled that the Albuquerque code was not saved by the fact that there were “viable, non-preempted options” for compliance.[4]

Building codes are not within the scope of EPCA’s regulatory mandates, except where, as in *City of Albuquerque,* those building codes incorporate standards that directly regulate the efficiency of products covered by EPCA (as proposed here via energy credits embedded within the prescriptive pathway).[5] A state regulation does not need to directly prohibit the energy use of covered products to be preempted; state regulations “concerning” the energy efficiency or energy use of a product for which a standard is prescribed or established are sufficient. 42 U.S.C. § 6316(b)(2)(A).

The limited exception for building codes does not permit for states or localities to set efficiency requirements stricter than the Federal minimum. **Congress was deliberate that states could not set back-door energy efficiency standards through building codes that would “expressly or effectively require the installation of covered products whose efficiencies exceed . . . the applicable Federal standard.”**[6] The limited building code exception to preemption in EPCA permits states to create performance-based criteria, *so long as the efficiency minimums promulgated by DOE are not exceeded*. The law is unambiguous: “If a building code requires the installation of covered products with efficiencies exceeding both the applicable Federal standard … and the applicable standard of any State …that has been granted a waiver … such requirement of the building code shall not be applicable….” 42 U.S.C. § 6297 (f)(B).

No analysis has been provided that Tables C406.1.1 and C406.1.2 can be met (and met cost effectively) with minimum efficiency EPCA-covered products and equipment. Therefore, at the levels in Public Draft q, these tables very likely contravene the preemption provisions of EPCA by proposing an energy efficiency standard on a federally regulated product that exceed the Federal minimum. The Act specifies that only the Department of Energy can set energy standards for covered products. While the goal of advancing energy efficiency is laudable, federal law prohibits any regulation of covered products that conflict with existing federal energy regulation.

Lastly, the Energy Credit proposal was discussed in the Modeling Subcommittee. There are credits which involve subcommittees working directly with impacted equipment (for example, the HVACR and WH Subcommittee). Relevant subcommittees should be included in any discussion of proposed changes to Energy Credits.

[1] *Air Conditioning, Heating & Refrigeration Inst. v. City of Albuquerque*, No. 08-633, 2008 WL 5586316, No. 08-633 at *6 (D. N.M. Oct. 3, 2008); *Nat'l Elec. Mfrs. Ass'n v. Calif. Energy Comm'n*, No. 2:17-CV-01625-KJM-AC, 2017 WL 6558134 at *5 (E.D. Ca. Dec. 21, 2017).

[2] *Air Conditioning, Heating & Refrigeration Inst. v. City of* Albuquerque, 835 F.supp.2d 1133, 1133, 1139 (D. N.M. Sept. 30, 2010).

[3] *Id.* at 1137.

[4] *Id.* at 1136-37.

[5] EPCA's preemption provision includes an express, but very limited and narrowly drawn exception for building codes that include standards for covered products. Importantly, the focus of the exception remains on energy efficiency, *i.e.,* how a building code might affect “the ratio of useful output” or “the quantity of energy consumed” of products covered by EPCA.

[6]H.R. Rep. 100-11 at 26.

Cost Impact: The code change proposal will decrease the cost of construction.
AHRI's code change proposal will decrease the cost of construction compared to the energy credit proposal in public draft 1.

Both proposals will increase the cost of construction over the 2021 IECC.

The PNNL ASHRAE 90.1 technical support document reviewed two demonstration packages--one to evaluate cost effectiveness and the other to show a reasonable package without using efficiency improvements for HVAC and SWH equipment subject to EPACT (42 USC 6833) minimum federal efficiencies. (R. Hart, et al. 90.1 Energy Credits Analysis Documentation, PNNL-32516. January 2022.)

PNNL is conducting additional analysis on the IECC proposal.

Workgroup Recommendation

Proposal # 654

CED1-189-22

Proponents: Michael Waite, representing American Council for an Energy-Efficient Economy (mwaite@aceee.org); **co-proponent Diana Burk, representing New Buildings Institute (diana@newbuildings.org)**

2024 International Energy Conservation Code [CE Project]

Revise as follows:

~~TABLE C406.1.1 ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP~~

~~Building Occupancy Group~~	~~Climate Zone~~																		
	~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R-2, R-4, and I-1~~	~~65~~	~~66~~	~~67~~	~~77~~	~~80~~	~~86~~	~~80~~	~~81~~	~~90~~	~~86~~	~~90~~	~~90~~	~~86~~	~~90~~	~~90~~	~~70~~	~~89~~	~~80~~	~~78~~
~~I-2~~	~~43~~	~~42~~	~~38~~	~~37~~	~~36~~	~~38~~	~~32~~	~~32~~	~~30~~	~~36~~	~~36~~	~~35~~	~~43~~	~~43~~	~~44~~	~~46~~	~~47~~	~~50~~	~~53~~
~~R-1~~	~~63~~	~~62~~	~~66~~	~~65~~	~~70~~	~~71~~	~~77~~	~~80~~	~~84~~	~~81~~	~~83~~	~~88~~	~~85~~	~~86~~	~~90~~	~~83~~	~~87~~	~~87~~	~~85~~
~~B~~	~~62~~	~~62~~	~~64~~	~~66~~	~~66~~	~~65~~	~~64~~	~~64~~	~~68~~	~~70~~	~~72~~	~~74~~	~~71~~	~~73~~	~~77~~	~~71~~	~~74~~	~~74~~	~~71~~
~~A-2~~	~~70~~	~~70~~	~~72~~	~~72~~	~~75~~	~~75~~	~~70~~	~~73~~	~~82~~	~~69~~	~~74~~	~~78~~	~~67~~	~~72~~	~~78~~	~~60~~	~~67~~	~~57~~	~~51~~
~~M~~	~~80~~	~~79~~	~~83~~	~~79~~	~~81~~	~~84~~	~~67~~	~~74~~	~~87~~	~~80~~	~~66~~	~~65~~	~~79~~	~~62~~	~~50~~	~~75~~	~~67~~	~~75~~	~~58~~
~~E~~	~~56~~	~~57~~	~~55~~	~~58~~	~~58~~	~~57~~	~~59~~	~~62~~	~~59~~	~~61~~	~~66~~	~~62~~	~~64~~	~~67~~	~~67~~	~~65~~	~~67~~	~~63~~	~~58~~
~~S-1 and S-2~~	~~61~~	~~60~~	~~61~~	~~60~~	~~58~~	~~57~~	~~44~~	~~54~~	~~62~~	~~85~~	~~68~~	~~75~~	~~90~~	~~82~~	~~72~~	~~90~~	~~89~~	~~90~~	~~90~~
~~All Other~~	~~31~~	~~31~~	~~31~~	~~32~~	~~32~~	~~33~~	~~30~~	~~32~~	~~36~~	~~35~~	~~35~~	~~35~~	~~37~~	~~36~~	~~36~~	~~36~~	~~37~~	~~36~~	~~34~~

TABLE C406.1.1 ENERGY CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

Building Occupancy Group	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1	85	85	91	100	100	100	100	100	100	94	100	100	93	100	100	100	100	100	100
I-2	50	49	47	46	46	48	44	44	45	48	48	49	54	55	56	55	56	58	59
R-1	59	57	60	60	62	62	65	67	68	67	70	73	78	75	82	86	82	94	100
B	66	63	65	68	64	63	67	68	68	70	73	74	83	83	84	95	92	94	100
A-2	74	74	75	76	79	79	77	80	87	73	78	82	100	98	100	100	100	100	100
M	95	94	95	93	94	97	87	85	97	82	75	68	79	94	83	100	98	100	87
E	67	68	68	70	72	71	72	76	77	77	83	79	83	86	89	90	89	88	89
S-1 and S-2	90	89	95	92	93	91	66	83	95	38	62	90	100	93	87	100	100	100	98
All Other	37	36	37	38	38	39	37	38	41	34	37	39	42	43	44	47	46	47	47

Reason: The additional energy efficiency credit flexibility is of great value, and the increased requirement for energy savings in this proposal are important. However, he proponent's cost-effectiveness analysis supported higher requirements for energy efficiency credits, as described in a detailed Technical Brief by the Pacific Northwest National Laboratory [1]. The proponent made unexpected changes to the values in Table C406.1.2 after the completion of a working group of the proponent and Modeling, Whole Building Metrics and Zero Energy Subcommittee members. These changes were based on a misreading of the guidance on cost-effectiveness calculations developed by the Construction Cost & LCC Advisory Group and voted on affirmatively by the Commercial Consensus Committee. That guidance stated that cost-effectiveness calculations should consider both 5.33% and 9.33% nominal discount rates (equivalent to 3% and 7% real discount rates with a 2.33% assumed inflation rate). Presumably (and understandably) due to the complexity of the proposal, the energy efficiency credit values in Table C406.1.2 were determined using a single discount rate. The analysis underlying the original proposal used an 8.1% nominal discount rate, itself high in the 5.33%-9.33% range. The credit requirements in the final approved proposal were based on only a 9.33% nominal discount rate; using this discount rate alone in determining cost-effective code criteria is unsupportable. The proposed values in Table C406.1.1 restore the requirements as originally submitted, based on the published cost-effectiveness analysis.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will increase the cost of construction.
The original proponents published cost-effectiveness analysis showed the proposed values to be cost-effective using an 8.1% nominal discount rate, itself high in the 5.33%-9.33% range.

Bibliography: Technical Brief by the Pacific Northwest National Laboratory https://www.energycodes.gov/sites/default/files/2021-07/TechBrief_EnergyCredits_July2021.pdf

Attached Files

- **Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/707/1739/files/download/391/

Workgroup Recommendation

Proposal # 707

CED1-190-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.1.1 Additional energy efficiency credit requirements. *Buildings* shall comply with measures from C406.2 to achieve not less than the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone.
Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of SectionC406.

Exceptions:

1. Unconditioned parking garages that achieve 50% of the credits required for use groups S-1 and S-2 in Table C406.1.1.
2. Portions of buildings devoted to manufacturing or industrial use.
3. Where a building achieves more renewable and load management credits in Section C406.3 than are required in Section C406.1.2, excess credits shall be permitted to reduce required energy efficiency credits as follows:

    3.1. For use groups I-2 and E, the credits required in Table C406.1.1 shall be reduced by the excess renewable and load management credits, limited to a 45 percent reduction

    3.2 For all other use groups, the credits required in Table C406.1.1 shall be reduced by the excess renewable and load management credits, limited to a 30 percent reduction

CD101.1 Prescriptive compliance. Where compliance is demonstrated using the prescriptive compliance option in Section C401.2.1, the number of additional efficiency credits required by Section C406.1 shall be 50 percent higher than that required by Table C406.1.1.
Exception: Where a building achieves more renewable and load management credits in Section C406.3 than are required in Section C406.1.2, excess credits shall be permitted to reduce required energy efficiency credits as follows:

1. For use groups E, R-2, R-4 and I, the credits required in Table C406.1.1, as increased by this section, shall be reduced by the excess renewable and load management credits, limited to a 70 percent reduction
2. For all other use groups, the credits required in Table C406.1.1, as increased by this section, shall be reduced by the excess renewable and load management credits, limited to a 50 percent reduction

CF102.1 Advanced Energy Credit Package requirements. The requirements of this Section ~~supercede~~ supersede the requirements of Section C406.1.1. Projects shall comply with measures from C406.2 to achieve the minimum number of required efficiency credits from Table ~~CD~~ CF102.1 based on building occupancy group and climate zone. Projects with multiple occupancies, unconditioned parking garages, *alterations*, and *buildings* with separate shell-and-core and build-out construction permits shall comply as follows:
Where a project contains multiple occupancies, credits in Table ~~CD~~ CF102.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406 and Appendix CF ~~CD~~.

Exceptions:

1. Unconditioned parking garages that achieve 50 percent of the credits required for use groups S-1 and S-2 in Table CD102.1.
2. Portions of buildings devoted to manufacturing or industrial use.
3. Where a building achieves more renewable and load management credits in Section C406.3 than are required in Section Section C406.1.2, excess credits shall be permitted to reduce required energy efficiency credits as follows:

    3.1. For use groups R-2, R-4 and I, the credits required in Table CF102.1 shall be reduced by the excess renewable and load management credits, limited to a 70 percent reduction

    3.2 For all other use groups, the credits required in Table CF102.1 shall be reduced by the excess renewable and load management credits, limited to a 50 percent reduction

Reason: This proposal allows for excess renewable and load management credits to be applied to the requirements for energy efficiency credits. This change accomplishes two objectives:

1. The change will make the additional credit section more aligned with ASHRAE Standard 90.1, which has a credit requirement and allows up to

a 60% contribution of renewable and load management credits to be mixed with energy efficiency credits to meet the total credit requirement in that standard.

2. By creating more flexibility in the type of credits used, it will be easier to meet the energy efficiency requirement without using any efficiency improvements to federally regulated equipment and appliances.

A cost-effective demonstration credit package was separately published. Where the focus is cost-effectiveness, selecting cost-effective higher efficiency regulated equipment is appropriate. The purpose of this modification and review is to demonstrate that a reasonable package can be assembled that does not rely on improvements to the efficiency of federally regulated equipment. To this end, a package of measures was selected to find how many credits from the renewable and load management category would be necessary to meet the energy efficiency credit requirement. The following measures were selected by use group:

Alternate reasonable measure selections without EPACT regulated equipment efficiency improvements										
Selections without EPACT regulated		R-2/4, I-1	I-2	R-1	B	A-2	M	E	S-1/2	
ID	Measure	MF	Health	Htl	Ofc	Rest	Rtl	Sch	Whse	
E03	Envelope Leakage Reduction	Y	Y	Y	Y	Y	Y	Y	Y	
E04	Add R-5 Roof Insulation	Y	Y	Y	Y	Y	Y	Y	Y	R-10 in CZ 8
E05	Add R-2.5ci Wall Insulation	Y	Y	Y	Y	Y	Y	Y	Y	R-5 in CZ 8
E06	Improve Fenestration	Y	Y	Y	Y	Y	Y	Y	Y	
H04	Residential HVAC control.	Y								
W01	SHW preheat recovery		30%							of SHW load
W02	Heat pump water heater			30%		30%				of SHW load
W04	SHW pipe insulation					Y	Y	Y		
W05	Point of use water heaters				Y			Y		
W06	Thermostatic balancing valves	Y	Y							
W07	SHW heat trace system			Y						
W09	SHW flow reduction	Y		Y						
L03	Increase occupancy sensor								Y	
L04	Increase daylight area				10%		20%		10%	of floor area
L05	Residential light control	Y								
L06	Lighting power reduction	10%	10%	10%	10%	10%	10%	10%	10%	of LPD
Q01	Efficient Elevator		Y	Y	Y	Y				
Q02	Efficient Commercial Kitchen Equipment					Y				
Q04	Fault detection		Y	Y	Y	Y	Y	Y	Y	

While in particular climate zones, all these measures would not need to be applied to meet the credit requirements, the same selections were applied across the board to determine how much extra credits from the renewable and load management category would be needed to meet the energy efficiency credit requirements without higher efficiency EPACT equipment. The needed points were determined as a percentage of the energy efficiency points as follows (a blank cell indicates that no additional points were required):

Carryover excess load management points needed as % of efficiency Requirement with no increases in EPACT regulated equipment efficiency																				
Use group and building type		0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, I-1	Multi-family/Dormitory								1%											
I-2	Healthcare	31%	29%	24%	16%	10%	4%					8%		8%	29%	36%	16%	26%	15%	43%
R-1	Hotel/Motel	1%		2%		14%		3%	13%	10%		11%	9%		3%	9%				
B	Office Buildings	19%	16%	17%	20%	18%	18%	6%	13%	17%	4%	26%	18%		19%	31%		5%	4%	17%
A-2	Restaurant Buildings	23%	20%	17%	18%	15%	7%		1%	10%		3%	2%			6%				
M	Retail Buildings															6%				
E	Education Buildings	19%	18%	29%	23%	26%	20%	7%	28%	39%	11%	36%	18%	7%	19%	11%			10%	
S-1, S-2	Warehouse														6%					13%

Based on this review, the exceptions were expanded to allow excess renewable and load management credits to be applied to the energy efficiency requirement with the following limits:

1. For use groups I-2 and E, up to 45% of carryover credits would be allowed.
2. For other use groups, up to 30% of carryover credits would be allowed.

While yet another table by climate zone could have been added to the code, this simplified limit was thought to be effective, while still preventing all energy efficiency to be replaced with renewable energy or load management. In addition to creating a requirement that can be met without using higher efficiency EPACT equipment, the carryover exceptions allow more flexibility in the energy credit structure. Appendix CF provides for a jurisdiction that has an aggressive energy saving policy to increase the energy credits required. A similar analysis was conducted, with higher requirements in the demonstration package, such as a 20% lighting power reduction, higher insulation levels, larger heat pump water heater load sizing, and some additional measures such as lighting tuning. When the results of this package was compared to the higher requirements in Appendix CF, it was determined that a higher carryover allowance of excess renewable and load management credits to be applied to the energy efficiency requirement with the following limits:

1. For use groups R-2, R-4, I-1 and E, up to 70% of carryover credits would be allowed.
2. For other use groups, up to 50% of carryover credits would be allowed.

Appendix CD provides for a glide path that increases the energy efficiency credit requirements to be 150% of the base code C406.1.1 requirements. This level is between the base and advanced Appendix CF requirements, and similar exceptions are added to Appendix CD to provide for renewable and load management carryover to energy efficiency credits.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The suggested changes relate to optional measures that can be selected in building design. Since there is no specific requirement for a particular measure, there is no impact on the cost of construction. There could be a reduction in cost from this particular proposal, as more flexibility in measure selection is provided, allowing possibly more cost effective renewable and load management measures to replace energy efficiency measures.

Workgroup Recommendation

Proposal # 788

CED1-191-22

Proponents: Michael Waite, representing American Council for an Energy-Efficient Economy (mwaite@aceee.org); Rachael Dorothy, representing self (dorothy.2@osu.edu); Erin Sherman, representing RMI (esherman@rmi.org); Melissa Kops, representing CT Green Building Council (melissa@ctgbc.org); Carlos Augusto Garcia, representing Brooks + Scarpa (garcia@brooksscarpa.com); Andy Woommavovah, representing Healthcare (andy.woommavovah@trinity-health.org); Jenny Hernandez, representing Las Cruces Sustainability (jehernandez@las-cruces.org); Khaled Mansy, representing self (khaled.mansy@okstate.edu); David Goldstein, representing Natural Resources Defense Council (dgoldstein.nrdc@gmail.com); John Bade, representing California Investor Owned Utilities (johnbade@2050partners.com**); co-proponent Diana Burk, representing New Buildings Institute (diana@newbuildings.org)**

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

C406.1.1.1 Buildings without heat pumps. *Buildings* using any energy source other than electricity or *on-site renewable energy*, with electric storage water heaters that are not heat pumps or with total heat pump space heating capacity less than the space heating load at heating design conditions calculated in accordance with Section C403.1.1 shall comply with measures from C406.2 to achieve not less than 1.5 multiplied by the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be multiplied by 1.5 and weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.

Exceptions:

1. *Buildings* complying with all of the following:
   - 1.1 Peak heating load calculated in accordance with Section C403.1.1 greater than peak cooling load calculated in accordance with Section C403.1.1.
   - 1.2 All cooling systems are electric heat pumps.
   - 1.3 Total heat pump space heating capacity not less than 50% of the *building*'s space heating load at heating design conditions calculated in accordance with Section C403.1.1.
   - 1.4 Any energy source other than electricity or *on-site renewable energy* is used for space heating only when a heat pump cannot provide the necessary heating energy to satisfy the thermostat setting.
   - 1.5 Electric resistance heat is used only in accordance with Section C403.4.1.1.
2. Unconditioned parking garages that achieve 75% of the credits required for use groups S-1 and S-2 in Table C406.1.1.
3. Portions of *buildings* devoted to manufacturing or industrial use
4. Low-energy *buildings* complying with Section C402.1.1.1.

Revise as follows:

C406.1.1.2~~1~~ Building Core/Shell and Initial Build-Out Construction. Where separate permits are issued for core and shell buildings and build-outconstruction, compliance shall be in accordance with the following requirements.

1. Core and shell buildings or portions of buildings shall comply with one of the following:
   - 1.1. Where the permit includes a central HVAC system or service water heating system with chillers, heat pumps, boilers, service water heating equipment, or loop pumping systems with heat rejection, the project shall achieve not less than 50 percent of the energy credits required ~~in Table C406.1.1~~ by Sections C406.1.1 and C406.1.1.1 in accordance with Section C406.2.
   - 1.2. Alternatively, the project shall achieve not less than 33 percent of the energy credits required ~~in Table C406.1.1~~by Sections C406.1.1 and C406.1.1.1 .
2. For core and shell *buildings* or portions of *buildings* the energy credits achieved shall be subject to the following adjustments:
   - 2.1. Lighting measure credits shall be determined only for areas with final lighting installed.
   - 2.2. Where HVAC or service water heating systems are designed to serve the entire building, full HVAC or service water heating measure credits shall be achieved.
   - 2.3. Where HVAC or service water heating systems are designed to serve individual areas, HVAC or service water heating measure credits achieved shall be reduced in proportion to the floor area with final HVAC systems or final service water heating systems installed.

3. Build-out construction shall be deemed to comply with Section C406.1 where either:

   3.1. Where heating and cooling generation are provided by a previously installed central system, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 33 percent of the credits required ~~in Table C406.1.1~~by Sections C406.1.1 and C406.1.1.1.

   3.2. Where heating and cooling generation are provided by an HVAC system installed in the build out, the energy credits achieved in accordance with Section C406.2 under the build-out project are not less than 50 percent of the credits required ~~in Table C406.1.1~~by Sections C406.1.1 and C406.1.1.1.

   3.3. Where the core and shell building was approved in accordance with C407 under 2021 IECC or later.

Add new text as follows:

C502.3.7.1 Additions not served by heat pumps. *Additions* using any energy source other than electricity or *on-site renewable energy*, served by electric storage water heaters that are not heat pumps or served by total heat pump space heating capacity less than the peak space heating load at heating design conditions calculated in accordance with Section C403.1.1 shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 75 percent of the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, may be used to achieve the required credits.

Exceptions:

1. *Additions* complying with all of the following:
   - 1.1 *Additions* with peak heating load calculated in accordance with Section C403.1.1 greater than peak cooling load calculated in accordance with Section C403.1.1.
   - 1.2 All cooling systems serving the *addition* are electric heat pumps.
   - 1.3 Total heat pump space heating capacity serving the *addition* not less than 50% of the *addition*'s space heating load at heating design conditions calculated in accordance with Section C403.1.1.
   - 1.4 Any energy source other than electricity or *on-site renewable energy* is used for space heating serving the *addition* only when a heat pump cannot provide the necessary heating energy to satisfy the thermostat setting.
   - 1.5 Electric resistance heat serving the *addition* is used only in accordance with Section C403.4.1.1.
2. *Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
3. *Additions* less than 1,000 ft2 (92 m2) and less than 50 percent of existing floor area.
4. *Additions* that do not include the addition or replacement of equipment covered by Tables C403.3.2(1) through C403.3.2(16) or Section C404.2.
5. *Additions* that do not contain conditioned space.
6. Where the *addition* alone or the existing building and addition together comply with Section C407.
7. Low-energy *buildings* complying with Section C402.1.1.1.

Reason: The additional energy efficiency credit flexibility in the public review draft is of great value, and the increased requirement for energy savings in this draft are important. However, the public review draft does not recognize the differences among buildings primarily relying on efficient electric technologies and buildings that continue to rely on fossil fuels for their space heating, water heating and cooking end uses in either their site energy usage or in the imperative to decarbonize buildings. Electric alternatives to fossil fuel systems require less site energy usage, generally considerably less with heat pump coefficients of performance for space and water heating; electric resistance equipment also requires far more energy than do electric heat pumps. In general, efficient electric technologies are also already the lowest emission option across end uses. However, in some locations, the use of fossil fuels for peak heating requirements at very low outside air temperatures may represent a comparable site energy option and the lowest emission option when compared to electric resistance supplemental heat in the near- or medium-term. Therefore, it is prudent to allow for flexibility in the model code with an exception for buildings with heat pump heating capacity of more than half of the building's peak heating demand, so long as other heating sources are not the primary heating source. The proposed changes set 50% higher energy efficiency requirements for buildings that use fossil fuels for anything other than peak space heating needs or that primarily rely on electric resistance for space or water heating. This same 50% higher level is included in proposed Section C502.3 text for Additions, which require 50% of those for new buildings.
Attached is a letter with others stating the support for this proposal from 50 organizations, 16 of which are from local or state governments and universities, 12 of which are from NGOs, and 22 of which are from the design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The number of credits that the original proponent of these changes (PNNL) set for Section C406 were determined based on a cost-effectiveness

test using an unreasonably high 9.3% nominal discount rate. The Commercial Consensus Committee approved cost-effectiveness criteria of both a 5.3% nominal discount rate and a 9.3% nominal discount rate. The 5.3% discount rate is much more appropriate for this analysis. For PNNL's original submission, they used an 8% nominal discount rate and proposed a set of credit requirements more than 14% higher (area-weighted average by building type and climate zone) than those in the public review draft . A straight line extrapolation would yield 43% higher credit requirements; because the discount rate effect is non-linear, it is reasonable to expect the level of cost-effective credits required to comfortably exceed 50% above those in the public review draft. The public review draft's Appendix CF includes an "Advanced Energy Credits Package" double that of the Section C406 requirements, which PNNL determined to be the maximum credits a jurisdiction could reasonably require.

In addition to the base cost-effectiveness analysis support, the Commercial Consensus Committee provided the option of including a social cost of carbon in cost-effectiveness calculations. PNNL also did not do calculations showing what that high-efficiency cost-effective credit package level would be with a SCC. Further, there is mounting evidence supporting a SCC more than 3X higher than that recommended by the Committee, which warrants further consideration.

This background is somewhat inconsequential as there were indeed cost-effective credit levels with the high discount rate used by PNNL. Under this proposal, anyone can submit a design that meets those low credit levels for a building with electric heat pumps as the primary space heating and water heating equipment. If they choose to use fossil fuel or electric resistance equipment, they would have to meet a higher number of energy efficiency credits. The entire code has separate energy efficiency requirements depending on the fuel and equipment type chosen, so this proposal is consistent with the current code.

The IECC will often allow less efficiency depending on design decisions without consideration of cost-effectiveness (e.g. where a designer chooses to have a window instead of an opaque wall or in relaxing lighting power density requirements to allow for non-essential services such as advertising lighting). The Committee is certainly not precluded from considering higher efficiency requirements following particular design decisions. The Committee is also not precluded from considering the societal benefits of reducing greenhouse gas emissions, such as they did explicitly in the justification for on-site renewable energy requirements in this public review draft.

In summary: (1) this proposal is cost-effective and (2) the Committee does not have to base its decisions on cost-effectiveness alone.

Attached Files

- **Commercial Electrification Sign On Letter 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/825/1726/files/download/386/

Workgroup Recommendation

Proposal # 825

CED1-192-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C406.1.2 Additional renewable and load management credit requirements. Buildings shall comply with measures from C406.3 to achieve not less than the number of required renewable and load management credits from Table C406.1.2 based on building occupancy group and climate zone. Where a project contains multiple occupancies, credits in Table C406.1.2 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of Section C406.

Exception. Where a building achieves more energy efficiency credits in Section C406.2 than are required in Section C406.1.1, the renewable and load management credits required in Table C406.1.2 shall be reduced by the amount of the excess energy efficiency credits, not to exceed a 30 percent reduction.

Delete and substitute as follows:

~~TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP~~

~~Building Occupancy Group~~	~~Climate Zone~~																		
	~~0A~~	~~0B~~	~~1A~~	~~1B~~	~~2A~~	~~2B~~	~~3A~~	~~3B~~	~~3C~~	~~4A~~	~~4B~~	~~4C~~	~~5A~~	~~5B~~	~~5C~~	~~6A~~	~~6B~~	~~7~~	~~8~~
~~R-2, R-4, and I-1~~	~~64~~	~~59~~	~~70~~	~~69~~	~~73~~	~~89~~	~~72~~	~~90~~	~~90~~	~~63~~	~~90~~	~~70~~	~~51~~	~~75~~	~~66~~	~~48~~	~~48~~	~~50~~	~~42~~
~~I-2~~	~~31~~	~~32~~	~~33~~	~~32~~	~~33~~	~~36~~	~~31~~	~~40~~	~~34~~	~~32~~	~~43~~	~~32~~	~~29~~	~~37~~	~~33~~	~~34~~	~~34~~	~~27~~	~~23~~
~~R-1~~	~~41~~	~~40~~	~~48~~	~~44~~	~~48~~	~~58~~	~~54~~	~~61~~	~~63~~	~~50~~	~~61~~	~~47~~	~~42~~	~~55~~	~~50~~	~~41~~	~~41~~	~~40~~	~~32~~
~~B~~	~~63~~	~~64~~	~~74~~	~~75~~	~~78~~	~~89~~	~~83~~	~~90~~	~~90~~	~~77~~	~~90~~	~~86~~	~~68~~	~~90~~	~~83~~	~~72~~	~~72~~	~~68~~	~~58~~
~~A-2~~	~~12~~	~~12~~	~~13~~	~~13~~	~~12~~	~~17~~	~~13~~	~~17~~	~~17~~	~~12~~	~~17~~	~~13~~	~~12~~	~~12~~	~~12~~	~~12~~	~~12~~	~~8~~	~~7~~
~~M~~	~~71~~	~~70~~	~~84~~	~~84~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~81~~	~~90~~	~~90~~	~~77~~	~~90~~	~~90~~	~~76~~	~~76~~	~~71~~	~~58~~
~~E~~	~~49~~	~~55~~	~~64~~	~~61~~	~~69~~	~~83~~	~~73~~	~~90~~	~~90~~	~~67~~	~~90~~	~~75~~	~~61~~	~~86~~	~~74~~	~~66~~	~~66~~	~~60~~	~~47~~
~~S-1 and S-2~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~90~~	~~70~~	~~90~~	~~90~~	~~61~~	~~61~~	~~61~~	~~53~~
~~All Other~~	~~56~~	~~55~~	~~66~~	~~63~~	~~69~~	~~80~~	~~69~~	~~87~~	~~88~~	~~59~~	~~86~~	~~68~~	~~51~~	~~72~~	~~66~~	~~51~~	~~51~~	~~48~~	~~40~~

TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

Building Occupancy Group	Climate Zone																		
	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
R-2, R-4, and I-1	34	37	31	46	48	56	49	56	38	31	42	32	26	33	34	23	27	25	25
I-2	23	24	25	25	25	28	26	30	22	25	32	24	25	28	29	26	28	22	20
R-1	30	28	35	30	34	36	34	37	41	32	37	27	28	33	32	25	29	22	18
B	38	39	45	42	45	49	47	56	57	44	55	42	38	47	46	38	45	38	31
A-2	8	8	9	9	8	9	9	11	13	8	11	9	8	10	9	8	9	8	3
M	32	32	42	37	39	47	44	58	57	42	54	46	38	48	5	42	45	38	34
E	27	34	38	37	39	47	44	58	57	42	54	46	38	48	50	42	45	38	34
S-1 and S-2	89	90	90	90	90	90	90	90	90	90	90	90	90	90	90	84	86	71	54
All Other	35	39	46	42	46	52	49	56	56	40	52	42	37	44	44	36	39	32	28

Reason: The requirements for renewable and load management credits were generally reduced to better align with other code changes for the reasons listed below. The average of all individual building type and climate zone requirements drops from 60 to 40 points or to 4% cost savings.

- In the as modified May 2022 version of CEPI-193, a new analysis of the renewable & load management credits available was conducted; however the requirements were not updated pending review of the other base code changes that were still pending. This new analysis expanded the analysis from selected prototypes to all PNNL prototype buildings and then weighted results based on the individual prototype construction weights in each use group. As a result, the available credits better reflect annual savings under a time of use electric pricing schedule.
- The base code added a renewable requirement for installation of 0.75 watts per square foot of solar generation or acquisition of equivalent off site power.
- A base code requirement for the capability of lighting load management, HVAC load management, and service water heating load management were required. These base requirements get controls in place to acheive these credits in larger buildings, but do not require the controls be activated. Where these controls are required, the related energy credits are reduced in a separate public comment.
- The revised table requirements proposed here are based on the available credits for 0.2 W/square foot of solar generation (R01) plus the lighting load management credit (G01). To acknowlege the base code addition of a solar requirement, this is reduced from the original proposed requirement based on the original available credits and 0.4 W/square foot of solar generation (R01) plus the lighting load management credit (G01). In both cases the credits for an individual building type and climate zone were limited to 90 points or 9% energy cost reduction. In the new schema, this limit only impacted the warehouse (s-1/S-2) use group.

Where site-based solar generation or lighting load management is not practical, or has reduced credits due to base requirements, off-site solar, or other load management measures can be implemented to achieve the required credits.

In addition, to enhance flexibility, allow credit for all measures implemented, and better align with the way energy efficiency and load management credits interact in ASHRAE Standard 90.1, an exception is added that allows the renewable and load management credits to be reduced by as much as 30% when the building achieves energy efficiency credits that are greater than the requirement.

Cost Impact: The code change proposal will decrease the cost of construction.
The requirements for renewable and load management credits are generally lowered across the board, so the cost to implement these credits will be reduced.

Workgroup Recommendation

Proposal # 717

CED1-193-22

Proponents: Alex Smith, representing NAHB (asmith@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C406.1.2 RENEWABLE AND LOAD MANAGEMENT CREDIT REQUIREMENTS BY BUILDING OCCUPANCY GROUP

Building Occupancy Group	Climate Zone																		
	0A	**0B**	**1A**	**1B**	**2A**	**2B**	**3A**	**3B**	**3C**	**4A**	**4B**	**4C**	**5A**	**5B**	**5C**	**6A**	**6B**	**7**	**8**
~~R-2, R-4, and I-1~~	~~64~~	~~59~~	~~70~~	~~69~~	~~73~~	~~89~~	~~72~~	~~90~~	~~90~~	~~63~~	~~90~~	~~70~~	~~51~~	~~75~~	~~66~~	~~48~~	~~48~~	~~50~~	~~42~~
I-2	31	32	33	32	33	36	31	40	34	32	43	32	29	37	33	34	34	27	23
R-1, R-2, R-4, and I-1	41	40	48	44	48	58	54	61	63	50	61	47	42	55	50	41	41	40	32
B	63	64	74	75	78	89	83	90	90	77	90	86	68	90	83	72	72	68	58
A-2	12	12	13	13	12	17	13	17	17	12	17	13	12	12	12	12	12	8	7
M	71	70	84	84	90	90	90	90	90	81	90	90	77	90	90	76	76	71	58
E	49	55	64	61	69	83	73	90	90	67	90	75	61	86	74	66	66	60	47
S-1 and S-2	90	90	90	90	90	90	90	90	90	90	90	90	70	90	90	61	61	61	53
All Other	56	55	66	63	69	80	69	87	88	59	86	68	51	72	66	51	51	48	40

Reason: There is no clear reason for the disparity in values between R-1 uses and R-2 and R-4 uses.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal would decrease the cost of construction for R-2, R-4, and I-1 occupancies.

Workgroup Recommendation

Proposal # 780

CED1-194-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory
(**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C406.2(1) BASE ENERGY CREDITS FOR GROUP R-2, R-4, AND I-1 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	**Energy Credit Measure**	**Section**	**Climate Zone**																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~8~~	~~13~~	~~7~~	~~11~~	~~6~~	~~8~~	~~9~~	~~6~~	1	~~24~~	~~8~~	~~9~~	~~30~~	~~15~~	~~5~~	32	~~28~~	~~31~~	~~36~~
E02	UA reduction (15%)	C406.2.1.2	7	6	2	4	1	1	4	1	1	22	1	3	29	10	1	32	27	30	39

a. "x" indicates credit is not available in that climate zone for that measure.

TABLE 406.2(2) BASE ENERGY CREDITS FOR GROUP I-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~6~~	~~11~~	~~6~~	~~11~~	~~7~~	~~9~~	~~6~~	~~6~~	~~2~~	~~3~~	3	~~3~~	~~4~~	~~3~~	~~7~~	~~5~~	~~5~~	~~17~~	~~3~~
E02	UA reduction (15%)	C406.2.1.2	<u>1</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>2</u>	<u>1</u>	<u>1</u>	<u>1</u>	<u>3</u>	<u>1</u>	3	<u>11</u>	<u>27</u>	<u>7</u>	<u>10</u>	<u>3</u>	<u>3</u>	<u>2</u>	<u>10</u>

a. "x" indicates credit is not available <u>in that climate zone</u> for that measure.

TABLE 406.2(3) BASE ENERGY CREDITS FOR GROUP R-1 OCCUPANICES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~4~~	~~7~~	~~4~~	~~7~~	~~3~~	~~4~~	~~7~~	~~2~~	~~1~~	~~7~~	~~2~~	~~3~~	~~10~~	~~6~~	~~4~~	~~12~~	~~9~~	~~19~~	~~11~~
E02	UA reduction (15%)	C406.2.1.2	2	3	1	2	1	3	3	2	1	5	2	2	7	4	2	9	7	9	11

a. "x" indicates credit is not available in that climate zone for that measure.

TABLE 406.2(4) BASE ENERGY CREDITS FOR GROUP B OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~4~~	~~7~~	~~4~~	~~7~~	~~3~~	~~4~~	7	~~2~~	~~0~~	~~7~~	~~2~~	~~3~~	~~10~~	~~6~~	~~4~~	~~12~~	~~9~~	~~19~~	~~11~~
E02	UA reduction (15%)	C406.2.1.2	7	8	3	6	5	3	7	3	1	13	4	8	21	15	11	13	24	37	43

a. "x" indicates measure is not available ~~for building occupancy~~ in that climate zone for that measure.

TABLE 406.2(5) BASE ENERGY CREDITS FOR GROUP A-2 OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	**Energy Credit Measure**	**Section**	**Climate Zone**																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	1	1	1	1	~~2~~	~~2~~	~~9~~	2	1	~~19~~	4	5	~~26~~	~~7~~	~~3~~	~~33~~	~~23~~	~~29~~	~~13~~
E02	UA reduction (15%)	C406.2.1.2	1	1	1	1	13	1	3	2	1	4	4	5	5	5	6	6	6	6	6

a. "x" indicates measure is not available in that climate zone for that measure.

TABLE 406.2(6) BASE ENERGY CREDITS FOR GROUP M OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																	
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~2~~	~~2~~	~~2~~	~~2~~	~~2~~	~~3~~	~~15~~	~~2~~	1	~~36~~	~~5~~	~~9~~	~~45~~	~~11~~	~~5~~	~~51~~	~~36~~	~~35~~	~~15~~
E02	UA reduction (15%)	C406.2.1.2	14	14	8	13	7	9	20	15	1	35	18	28	41	37	40	43	44	46	31

a. "x" indicates credit is not available in that climate zone for that measure.

TABLE 406.2(7) BASE ENERGY CREDITS FOR GROUP E OCCUPANCIES[a]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~9~~	~~22~~	~~8~~	~~20~~	~~9~~	~~12~~	~~5~~	~~11~~	~~3~~	~~4~~	~~9~~	~~2~~	~~3~~	~~6~~	~~0~~	~~4~~	~~3~~	~~4~~	~~3~~
E02	UA reduction (15%)	C406.2.1.2	8	18	7	19	12	13	20	17	11	24	20	17	33	32	29	40	38	46	44

a. "x" indicates measure is not available in that climate zone for that measure.

TABLE 406.2(8) BASE ENERGY CREDITS FOR GROUP S-1 AND S-2 OCCUPANCIES[a]

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~1~~	~~2~~	1	~~1~~	1	~~2~~	~~25~~	~~2~~	~~1~~	~~62~~	~~11~~	~~14~~	~~74~~	~~21~~	~~6~~	~~75~~	~~57~~	~~58~~	~~21~~
E02	UA reduction (15%)	C406.2.1.2	14	14	1	12	1	9	27	16	2	37	29	39	44	47	50	43	52	55	74

a. "x" indicates measure is not available ~~for building occupancy~~ in that climate zone for that measure.

TABLE 406.2(9) BASE ENERGY CREDITS FOR OTHER OCCUPANCIES[a,b]

Portions of table not shown remain unchanged.

ID	Energy Credit Measure	Section	Climate Zone																		
			0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
E01	Envelope Performance	C406.2.1.1	Determined in accordance with Section C406.2.1.1																		
E02	UA reduction (15%)	C406.2.1.2	~~5~~	~~9~~	~~5~~	~~8~~	5	~~6~~	~~10~~	~~5~~	2	~~20~~	~~6~~	~~6~~	~~25~~	~~10~~	~~4~~	~~28~~	~~22~~	~~26~~	~~16~~
E02	UA reduction (15%)	C406.2.1.2	7	8	3	7	5	5	11	7	2	18	10	14	26	20	19	24	25	29	32

a. "x" indicates measure is not available in that climate zone for that measure.

b. Other occupancy groups include all Groups except for Groups A-2, B, E, I, M, S, and R.

Reason: After CEPI-193 received the first vote, the credits for E02, UA reduction, were reanalyzed based on feedback. The reanalysis was also undertaken so that the analysis procedure was the same as it was for the alternative discrete envelope fenestration and insulation measures.

The result was an overall increase in credits by 130% as an unweighted average. There is a great deal of variation between climate zones and between building use groups. This is due to the fact that the credits are based on a percentage of total building use and not a fixed change in energy use. Often insulation savings impacts in the same numerical climate zone are different in each humidity regime, as the total base building use can vary quite a bit based on humidity. There is also a variation in heating type between prototypes. The average credits across climate zones (before/after/New%) is shown by building use in the table below: with the percentage new vs. prior on average shown.

E02 Envelope Improvement, 15% UA reduction

Compare average credits across climate zones

Building Use	New	Prior	New
Apartment	11.6	15.1	77%
Health	4.4	6.2	72%
Hotel	3.9	9.6	40%
Office	12.2	6.4	189%
Restaurant	4.0	9.6	42%
Retail	24.4	14.7	166%
Education	23.6	7.2	327%
Warehouse	29.7	22.9	130%
Other	14.3	11.5	125%
Average	14.2	11.5	130%

The two basis of analysis were different and the new analysis is expected to both be more accurate and better match the other discrete envelope measures in the credit section.

- The original analysis for this measure was from the 2021 IECC energy credit results adjusted to the 2024 credit metric. The original analysis was based on one representative building prototype for each use group.
- The improved analysis used baseline building parameters that were more up to date. It also used an automated measure parametric replacement approach and included all the prototypes relevant to that use group. Then the results from each prototype were averaged for the group by relative national construction weight.

In addition, the table footnotes were edited to be more consistent with each other.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
As an optional credit there is no direct requirement to implement particular measures, so a change in measure credits will not impact construction cost.

Workgroup Recommendation

Proposal # 728

CED1-195-22

Proponents: Thomas Culp, representing Aluminum Extruders Council (culp@birchpointconsulting.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C406.2.1.6 Vertical Fenestration Requirements for Energy Credit E06

Portions of table not shown remain unchanged.

Applicable Climate Zone	Maximum U-Factor		Maximum SHGC[a]	Minimum VT
	Fixed	Operable		

a. Where vertical fenestration is located under a permanently attached shading projection with a projection factor PF not less than 0.2 as determined in accordance with Equation 4-4, the required maximum SHGC shall be multiplied by 1.2.

Reason: Credit E06 adds an efficiency credit for improved vertical fenestration, listing the required maximum U-factor, maximum SHGC, and minimum VT by climate zone. We agree with the intent of this credit, but note that the SHGC requirement forgot to include the ability to account for shading projection factor like in the main Table C402.5 or in ASHRAE 90.1. This proposal adds a footnote that clarifies that the maximum SHGC requirement shall be multiplied by 1.2 when there is permanently attached shading projection with PF >= 0.2 as calculated in accordance with Equation 4-4 in Section C402.5.3. Rather than listing separate SHGC values for different projection factors like in Table C402.5, this uses the same multiplier of 1.2 consistent with what is used in Table C402.5 for the PF >= 0.2 line. (We don't feel it is necessary to include an additional multiplier from the PF >= 0.5 line; as such, this accounts for some shading but is still conservative.)

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal only makes the SHGC requirement consistent with how Table C402.1.5 accounts for shading projection factor, but does not require shading. As such, there is no cost impact.

Workgroup Recommendation

Proposal # 876

CED1-196-22

Proponents: Amy Boyce, representing Energy Efficient Codes Coalition (amy.boyce@imt.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C407.2 Mandatory requirements. Compliance based on total building performance requires that a proposed design meet all of the following:

1. The requirements of the sections indicated within Table C407.2(1).
2. An annual energy cost that is less than or equal to the percent of the annual energy cost (PAEC) of the *standard reference design* calculated in Equation 4-32. Energy prices shall be taken from a source *approved* by the *code official*, such as the Department of Energy, Energy Information Administration's *State Energy Data System Prices and Expenditures* reports. *Code officials* shall be permitted to require time-of-use pricing in energy cost calculations. The reduction in energy cost of the proposed design associated with *on-site renewable energy* shall be not more than 5 percent of the total energy cost. The amount of renewable energy purchased from off-site sources shall be the same in the *standard reference design* and the *proposed design*.

Exceptions:

1. Jurisdictions that require site energy (1 kWh = 3413 Btu) rather than energy cost as the metric of comparison.
2. Where energy use based on source energy expressed in Btu or Btu per square foot of conditioned floor area is substituted for the energy cost, the energy use shall be calculated using source energy factors from Table C407.2(2) For electricity, U.S. locations shall use values eGRID subregions. Locations outside the United States shall use the value for "All other electricity" or locally derived values.

(Equation 4-32)

$$PAEC = 100 \times (0.85 + 0.025 - ECr/1000)$$

PAEC = Percentage of annual energy cost applied to standard reference design
EC_r= Energy efficiency credits required for the building in accordance with Section C406.1 (do not include load management and renewable credits)

3. The U-factors, C-factors, and F-factors of *building envelope* assemblies other than spandrel panels shall be no greater than the values in Tables C402.1.4 and C402.4, with the following modifications to values in each table:

   a. For opaque assemblies, each U-factor, C-factor, and F-factor in Table C402.1.4 shall be permitted to be increased by no more than 15% (on an area-weighted average basis).

   b. For vertical fenestration and skylights, each U-factor in Table C402.4 shall be permitted to be increased by no more than 15% (on an area-weighted average basis).

   Exception: The U-factor, C-factor, or F-factor shall not be modified where the requirement in the table is "NR" (no requirement).

4. The area-weighted average fenestration SHGCs in climate zones 0-3 shall be no greater than 0.05 plus the applicable values in Table C402.4.

   Exception : Vertical fenestration oriented within 45 degrees of true south with a projection factor of ≥ 0.5.

TABLE C407.2(1) REQUIREMENTS FOR TOTAL SIMULATED BUILDING PERFORMANCE

Portions of table not shown remain unchanged.

SECTION [a]	TITLE
Envelope	
C401.3	Thermal envelope certificate
C402.2.1.1	Joints staggered
C402.2.1.2	Skylight curbs
C402.2.6	Insulation of radiant heating system
C402.6	Air leakage—thermal envelope
Mechanical	
C403.1.1	Calculation of heating and cooling loads
C403.1.2	Data centers
C403.2	System design
C403.3	Heating and cooling equipment efficiencies
C403.4	Thermostatic controls
C403.4.2	Off-hour controls
C403.4.7	HVAC system controls for operable openings to the outdoors
C403.5.5	Economizer fault detection and diagnostics
C403.7, except C403.7.4.1	Ventilation and exhaust systems
C403.8, except C403.8.6	Fan and fan controls
C403.9	Large-diameter ceiling fans
C403.12, except C403.12.3	Refrigeration equipment performance
C403.13	Construction of HVAC system elements
C403.14	Mechanical systems located outside of the building thermal envelope
C404	Service water heating
C405, except C405.3	Electrical power and lighting systems
C406.1.2	Additional renewable and load management credit requirements
C407.2(3), C407.2(4)	Building Envelope Performance
C408	Maintenance information and system commisioning

a. Reference to a code section includes all the relative subsections except as indicated in the table.

Reason: The purpose of this public comment is to improve the commercial performance path by incorporating a reasonable minimum level of envelope performance similar to the residential envelope minimum in Section R405.2 of the 2021 IECC. Although several Consensus Committee members and other stakeholders expressed support for CEPI-204 (the predecessor to this public comment), and for the general idea of an envelope backstop, there were concerns raised about issues specific to commercial buildings. This public comment maintains the simplicity of CEPI-204, but with modifications intended to address various concerns. Specifically:

- Because of concerns raised about the performance of spandrel panels in comparison to other opaque assemblies, this public comment exempts spandrel panels from the envelope backstop. While we believe that some minimum level of efficiency should apply to spandrel panels, we recognize that the regulation of these components in the IECC is still evolving.
- Fenestration SHGC trade-off maximums are limited to climate zones 0-3. Although the commercial fenestration table establishes a prescriptive SHGC maximum in all climate zones, and we believe a broader SHGC trade-off limit is justified, this comment focuses on climate zones where the impact will be most significant.
- The maximum trade-off limit for SHGC is set at an additional 0.05 plus the value in table C402.4. This is similar to the maximum SHGC trade-off allowance approved in the residential provisions of the 2021 IECC (which applies a 0.30 SHGC trade-off limit to a 0.25 prescriptive SHGC requirement in climate zones 0-3), but with a recognition that there are different SHGC requirements for fixed and operable fenestration and for varying projection factors in the commercial fenestration table. An adder of 0.05 to each SHGC value is easily understood and effective (note that this value, for example, is 20% higher than the base 0.25 SHGC required for fixed fenestration in climate zones 2-3).
- In buildings designed for passive solar benefits, south-facing glazing would be exempt from the SHGC requirement so long as an adequate projection factor is incorporated into the design.
- A reference to this backstop in Table C407.2 would help ensure that buildings constructed to above-code programs would also be constructed with the same minimum reasonable level of envelope efficiency, so that all buildings would embody such efficiency.

We continue to believe that an efficient thermal envelope is at the core of the nation’s efforts to reduce energy waste and to maintain the comfort and health of building occupants. Without a trade-off limit in place, the performance path will continue to allow buildings to be constructed with a poor-performing thermal envelopes, which will not only cost building owners more over the useful life of the building but will also complicate the nation's efforts to reduce energy consumption and carbon emissions. While alternative values could also be considered, a 15% trade-off limit is a reasonable starting place and it still allows flexibility for building envelopes to be constructed well below levels of efficiency that have been approved and confirmed as cost-effective in the IECC and ASHRAE Standard 90.1 for several cycles.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This public comment does not increase the baseline stringency of the IECC, but merely limits trade-offs under a voluntarily chosen alternate compliance path. The mandatory minimum values proposed are 15% less stringent than prescriptive values of the IECC and only apply if an alternative compliance path is chosen. As a result, whether costs of construction increase or decrease ultimately depends on choices made by the code user.

Cost-Effectiveness

This public comment does not increase the stringency of the code or result in increased costs, so a cost-effectiveness analysis does not apply. These backstops serve only as a consumer protection against excessive trade-offs and do not require anything more than what would be required for base code prescriptive compliance, which values are already considered cost-effective. Thus, a cost-effectiveness analysis would be difficult to apply and would not be useful or informative.

Workgroup Recommendation

Proposal # 864

CED1-197-22

Proponents: Aaron Phillips, representing Asphalt Roofing Manufacturers Association (aphillips@asphaltroofing.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

TABLE C407.4.1(1) SPECIFICATIONS FOR THE STANDARD REFERENCE AND PROPOSED DESIGNS

BUILDING COMPONENT CHARACTERISTICS	STANDARD REFERENCE DESIGN	PROPOSED DESIGN
Space use classification	Same as proposed	The space use classification shall be chosen in accordance with Table C405.3.2(1) or C405.3.2(2) for all areas of the building covered by this permit. Where the space use classification for a building is not known, the building shall be categorized as an office building.
Roofs	Type: insulation entirely above deck	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
	Solar reflectance~~absorptance~~: 0.25~~0.75~~ , except as specified in Section C402.4 and Table C402.4 for Climate Zones 0, 1, 2, and 3	As proposed
	Emittance: 0.90, except as specified in Section C402.4 and Table C402.4 for Climate Zones 0, 1, 2, and 3	As proposed
Walls, above-grade	Type: same as proposed	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
	Thermal bridges: Account for heat transfer consistent with compliant *psi*- and *chi*-factors from Table C402.1.4 for *thermal bridges* as identified in Section C402.7 that are present in the proposed design.	As proposed; *psi*- and *chi*-factors for proposed *thermal bridges* shall be determined in accordance with requirements in Section C402.1.4.
	Solar reflectance~~absorptance~~: 0.25~~0.75~~	As proposed
	Emittance: 0.90	As proposed
Walls, below-grade	Type: mass wall	As proposed
	Gross area: same as proposed	As proposed
	U-Factor: as specified in Table C402.1.2 with insulation layer on interior side of walls	As proposed
Floors, above-grade	Type: joist/framed floor	As proposed
	Gross area: same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
Floors, slab-on-grade	Type: unheated	As proposed
	F-factor: as specified in Table C402.1.2	As proposed
Opaque doors	Type: swinging	As proposed
	Area: Same as proposed	As proposed
	U-factor: as specified in Table C402.1.2	As proposed
Vertical fenestration other than opaque doors	Area 1. The proposed vertical fenestration area; where the proposed vertical fenestration area is less than 40 percent of above-grade wall area. 2. 40 percent of above-grade wall area; where the proposed vertical fenestration area is 40 percent or more of the above-grade wall area.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used	As proposed
	External shading and PF: none	As proposed
	Area	

Skylights	1. The proposed skylight area; where the proposed skylight area is less than that permitted by Section C402.1. 2. The area permitted by Section C402.1; where the proposed skylight area exceeds that permitted by Section C402.1.	As proposed
	U-factor: as specified in Table C402.5	As proposed
	SHGC: as specified in Table C402.5 except that for climates with no requirement (NR) SHGC = 0.40 shall be used.	As proposed
Lighting, interior	The interior lighting power shall be determined in accordance with Section C405.3.2. Where the occupancy of the building is not known, the lighting power density shall be 1.0 watt per square foot based on the categorization of buildings with unknown space classification as offices.	As proposed
Lighting, exterior	The lighting power shall be determined in accordance with Tables C405.5.2(1), C405.5.2(2) and C405.5.2(3). Areas and dimensions of surfaces shall be the same as proposed.	As proposed
Internal gains	Same as proposed	Receptacle, motor and process loads shall be modeled and estimated based on the space use classification. End-use load components within and associated with the building shall be modeled to include, but not be limited to, the following: exhaust fans, parking garage ventilation fans, exterior building lighting, swimming pool heaters and pumps, elevators, escalators, refrigeration equipment and cooking equipment.
Schedules	Same as proposed **Exception:** Thermostat settings and schedules for HVAC systems that utilize radiant heating, radiant cooling and elevated air speed, provided that equivalent levels of occupant thermal comfort are demonstrated by means of equal Standard Effective Temperature as calculated in Normative Appendix B of ASHRAE Standard 55.	Operating schedules shall include hourly profiles for daily operation and shall account for variations between weekdays, weekends, holidays and any seasonal operation. Schedules shall model the time-dependent variations in occupancy, illumination, receptacle loads, thermostat settings, mechanical ventilation, HVAC equipment availability, service hot water usage and any process loads. The schedules shall be typical of the proposed building type as determined by the designer and approved by the jurisdiction.
Outdoor airflow	Where the proposed design specifies mechanical ventilation: 1. For systems 1-4 as specified in Tables C407.4.1(2) and C407.4.1(3), the outdoor airflow rate shall be determined in accordance with Section C403.7 and *International Mechanical Code* Section 403.3.1.1.2.3.4 Equation 4-8, using a system ventilation efficiency (Ey) of 0.75._ 2.For systems 5-11 as specified in Tables C407.4.1(2) and C407.4.1(3), the outdoor airflow rate shall be determined in accordance with Section C403.7 and *International Mechanical Code* Section 403.3._ Where the proposed design specifies natural ventilation, as proposed.	As proposed, in accordance with Section C403.2.2.
Heating systems	Fuel type: same as proposed design	As proposed
	Equipment type[a]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in the tables in Section C403.3.2.	As proposed
	Capacity[b]: sized proportionally to the capacities in the	

	proposed design based on sizing runs, and shall be established such that no smaller number of unmet heating load hours and no larger heating capacity safety factors are provided than in the proposed design.	As proposed
Cooling systems	Fuel type: same as proposed design	As proposed
	Equipment type[c]: as specified in Tables C407.4.1(2) and C407.4.1(3)	As proposed
	Efficiency: as specified in Tables C403.3.2(1), C403.3.2(2) and C403.3.2(3)	As proposed
	Capacity[b]: sized proportionally to the capacities in the proposed design based on sizing runs, and shall be established such that no smaller number of unmet cooling load hours and no larger cooling capacity safety factors are provided than in the proposed design.	As proposed
	Economizer[d]: same as proposed, in accordance with Section C403.5.	As proposed
Service water heating[e]	Fuel type: same as proposed	As proposed
	Efficiency: as specified in Table C404.2	For Group R, as proposed multiplied by SWHF. For other than Group R, as proposed multiplied by efficiency as provided by the manufacturer of the DWHR unit.
	Capacity: same as proposed	As proposed
	Where no service water hot water system exists or is specified in the proposed design, no service hot water heating shall be modeled.	
Energy Recovery	Where the proposed design specifies mechanical ventilation, as specified in Section C403.7.4 based on the *standard reference design* airflows._ Where the proposed design specifies natural ventilation, as proposed.	As proposed
Fan power	As specified in Section C403.8 for the proposed design. **Exceptions:** 1. Where the fan power of the proposed design is exempted from the requirements of Section C403.8, as proposed._ 2. Fan systems addressed by Section C403.8.1: Fan system BHP power shall be as proposed or to the limits specified in Section C403.8.1, whichever is smaller. If the limit is reached, the power or each fan shall be reduced proportionally until the limit is met._ 3. Fan systems serving areas where the mechanical ventilation is provided in accordance with an engineered ventilation system design of Section 403.2 of the *International Mechanical Code* shall not use the particulate filtration or air cleaner pressure drop adjustment available in Table C403.8(1) when calculating the fan system BHP limit for the portion of the airflow being treated to comply with the engineered ventilation system design.	As proposed
	Where a system providing on-site renewable energy has been modeled in the proposed design the same system shall be modeled identically in the *standard reference design* except the rated capacity shall meet the requirements of Section C405.15.1_	

On-site Renewable Energy	Where no system is designed or included in the proposed design, model an unshaded photovoltaic system with the following characteristics: **Size:** Rated capacity per Section C405.15.1 **Module Type**: Crystalline Silicone Panel with glass cover, 19.1% nominal efficiency and temperature coefficient of -0.35%/°C, Performance shall be based on a reference temperature of 77°F (25°C), airmass of 1.5 atmosphere and irradiance of 317 Btu/h x ft^2 (1000 W/m^2). **Array Type:** Rack mounted array with installed nominal operating cell temperature (INOCT) of 103°F (45°C). Total System Losses (DC output to AC output): 11.3%. **Tilt:** 0-degrees (mounted horizontally). **Azimuth:** 180 degrees.	As proposed

For SI: 1 watt per square foot = 10.7 w/m^2.

SWHF = Service Water Heat Recovery factor, DWHR = Drain Water Heat Recovery.

a. Where no heating system exists or has been specified, the heating system shall be modeled as fossil fuel. The system characteristics shall be identical in both the standard reference design and proposed design.
b. The ratio between the capacities used in the annual simulations and the capacities determined by sizing runs shall be the same for both the standard reference design and proposed design.
c. Where no cooling system exists or no cooling system has been specified, the cooling system shall be modeled as an air-cooled single-zone system, one unit per thermal zone. The system characteristics shall be identical in both the standard reference design and proposed design.
d. If an economizer is required in accordance with Table C403.5(1) and where no economizer exists or is specified in the proposed design, then a supply-air economizer shall be provided in the standard reference design in accordance with Section C403.5.
e. The SWHF shall be applied as follows:

1. Where potable water from the DWHR unit supplies not less than one shower and not greater than two showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.36)].
2. Where potable water from the DWHR unit supplies not less than three showers and not greater than four showers, of which the drain water from the same showers flows through the DWHR unit then SWHF = [1 – (DWHR unit efficiency × 0.33)].
3. Where potable water from the DWHR unit supplies not less than five showers and not greater than six showers, of which the drain water from the same showers flows through the DWHR unit, then SWHF = [1 – (DWHR unit efficiency × 0.26)].
4. Where Items 1 through 3 are not met, SWHF = 1.0.

C409.6.1.4.1 Roofs. Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single block, an area weighted U-factor shall be used. Roof solar reflectance~~absorptance~~ shall be modeled at 0.30~~0.70~~ and emittance at 0.90.

Reason: Within the IECC commercial provisions of the 1st Public Comment Draft, there are only three instances where "solar absorptance" is used. In contrast, there are eighteen uses of "solar reflectance." This comment changes those three instances, and the associated values, to make all uses consistent throughout the commercial provisions. The end result will be less confusion in understanding roof and wall radiative property requirements in different sections of the IECC.
ARMA submitted a separate comment that changes the solar absorptance value in Section C409.6.1.4.1. If both comments are accepted, the value of solar reflectance in C409.6.1.4.1 will need to be updated to properly correlate the two comments.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The changes proposed in this comment align language across sections of the code without making technical modifications. Therefore, there is no impact on cost of construction.

CED515

Workgroup Recommendation

Proposal # 754

CED1-198-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory (**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C403.1 General. Mechanical systems and equipment serving the building heating, cooling, ventilating or refrigerating needs shall comply with one of the following:

1. Sections C403.1.1 and Sections C403.2 through Section C403.14
2. Data Centers shall comply with Section C403.1.1, Section C403.1.2 and Section C403.6 through Section C403.14
3. Section C409 ~~C403.1.3 and sections within Section C403 that are listed in Table C407.2(1)~~.

C406.2.2.1 H01 HVAC Performance (TSPR). H01 energy credits shall be achieved ~~for~~ where systems are permitted ~~allowed~~ to use Section C409 ~~C403.1.3, HVAC total system performance ratio,~~ and where the proposed TSPR exceeds the minimum TSPR requirement by 5 percent or more. If improvement is greater than 5 percent, ~~base energy credits from Table C406.2(1) through C406.2(9) are permitted to be prorated up to a 20 percent improvement~~ determine H01 achieved credits using Equation 4-17. Energy credits for H01 ~~may~~ shall not be combined with energy credits from HVAC measures H02, H03 ~~and~~ or H05.

(Equation 4-17)

H01 energy credit = H01 base energy credit x TSPRs / 0.05

where:

TSPRs = TSPRa x [the lessor of 0.20 and (1-(TSPRp/TSPRt))]

where:
TSPRa = [floor area served by systems permitted to use TSPR] / [total building conditioned floor area]
~~TSPRt = TSPRr / MPF~~
TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.
TSPRt = TSPRr / MPF
where:
TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.
MPF = Mechanical Performance Factor from Table C409.4 based on climate zone and building use type
Where a building has multiple building use types, MPF shall be area weighted in accordance with Section C409.4

SECTION 409
CALCULATION OF HVAC TOTAL SYSTEM PERFORMANCE RATIO

Revise as follows:

C409.1 Applicability ~~Purpose~~. ~~Section 409 establishes criteria for demonstrating compliance with the requirements of C403.1.1,~~ Use of the HVAC Total System Performance Ratio ~~total system performance ratio~~ (~~HVAC~~ TSPR) method shall comply with this section.

C409.2 ~~Scope~~ Permitted Uses. ~~Section C409 applies to new~~ Only HVAC systems that serve buildings~~s~~ occupancies and uses in ~~Section C403.1.3.1 and are not excluded from using HVAC TSPR by Section C403.1.3. All applicable HVAC systems shall comply with Section C409.~~ Table C409.4 and not excluded by Section C409.2.1 shall be permitted to use the TSPR method.

Delete without substitution:

~~**C403.1.3 HVAC total system performance ratio (HVAC TSPR).** HVAC systems serving buildings or portions of buildings listed in Section C403.1.3.1 that are not served by systems listed in Section C403.1.3.2 shall have an HVAC total system performance ratio (HVAC TSPR) of the proposed design HVAC systems that is greater than or equal to the HVAC TSPR of the standard reference design divided by the applicable mechanical performance factor (MPF) from Table C409.4. HVAC TSPR shall be calculated in accordance with Section C409, Calculation of HVAC Total System Performance Ratio. Systems using the HVAC TSPR method shall also meet requirements in Section C403.1.3.3.~~

~~**C403.1.3.1 Included Building Types.** Only HVAC systems that serve the following building use types are allowed to use the TSPR Method:~~

1. ~~Office (including medical office) (occupancy group B)~~
2. ~~Retail (occupancy group M),~~

3. ~~Library (occupancy group A-3),~~

4. ~~Education (occupancy group E),~~

5. ~~Hotel/motel occupancies (occupancy group R-1),~~

6. ~~The *dwelling units* and *common areas* within occupancy group R-2 multifamily buildings.~~

Revise as follows:

C409.2.1 ~~C403.1.3.2 Excluded~~ Systems Not Permitted. The following HVAC systems are not permitted to use Section C403.1(3): ~~excluded from using the TSPR Method:~~

1. HVAC Systems using

   1.1 District heating water, chilled water or steam

   1.2 Small duct high velocity air cooled, space constrained air cooled, single package vertical air conditioner, single package vertical heat pump, or double-duct air conditioner or double-duct heat pump as defined in subpart F to 10CFR part 431

   1.3 Packaged terminal air conditioners and packaged terminal heat pumps that have cooling capacity greater than 12,000 Btu/hr (3500 kW)

   1.4 A common heating source serving both HVAC and service water heating equipment~~, or~~

2. HVAC systems that provide recovered heat for service water heating

3. HVAC systems not specified ~~included~~ in Table C409.6.1.10.1

4. HVAC systems specified ~~included~~ in Table C409.6.1.10.1 with characteristics or parameters in Table C409.6.1.10.2(1), not identified as applicable to that HVAC system type.

5. HVAC systems with chilled water supplied by absorption chillers, heat recovery chillers, water to water heat pumps, air to water heat pumps, or a combination of air- and water-cooled chillers on the same chilled water loop.

6. HVAC systems served by heating water plants that include air to water or water to water heat pumps.

7. Underfloor air distribution and displacement ventilation HVAC systems.

8. Space conditioning systems that do not include mechanical cooling.

9. HVAC systems serving laundry rooms, elevator rooms, mechanical rooms, electrical rooms, data centers, and computer rooms.

10. *Buildings* or areas of medical office buildings ~~that comply fully with~~ required to use ASHRAE Standard 170 . ~~, including but not limited to surgical centers, or~~

11. *Buildings* or areas that are required by ~~other applicable codes or standards~~ regulation to ~~provide 24/7~~ have continuous air handling unit operation

12. HVAC systems serving laboratories with fume hoods

13. Locker rooms with more than 2 showers

14. Natatoriums and rooms with saunas

15. Restaurants and commercial kitchens with total cooking capacity greater than 100,000 Btu/h (29 kW)

16. Areas of *buildings* with commercial refrigeration equipment exceeding 100 kW of power input.

17. Cafeterias and dining rooms

C409.3 ~~C403.1.3.3~~ HVAC TSPR Compliance ~~Method Partial Prescriptive Requirements~~. HVAC systems permitted to use TSPR shall comply with Section C409.4 and the following:~~HVAC systems using the HVAC Performance Rating Method shall meet relevant prescriptive requirements in Section C403 as follows:~~

1. HVAC systems shall comply with the applicable requiremts of Section C403 as follows:

1.1. Air economizers shall meet the requirements of Section C403.5.3.4 Relief of excess outdoor air and Section C403.5.5 Economizer fault detection and diagnostics.

1.2. Variable-air-volume system systems shall meet requirements of Sections C403.6.5, C403.6.6, and C403.6.9.

1.3. Hydronic systems shall meet the requirements of Section C403.4.4.

1.4. Plants with multiple chillers or boilers shall meet the requirements of Section C403.4.5.

1.5. Hydronic (Water Loop) Heat Pumps and Water-Cooled Unitary Air Conditioners shall meet the requirements of Section C403.4.3.3.

1.6. Cooling tower turndown shall meet requirements of Section C403.11.4.

1.7. Heating of unenclosed spaces shall meet the requirements of Section C403.14.1.

1.8. Hot-gas bypass shall meet the requirements of Section C403.3.3.

1.9. Systems shall meet the operable openings interlock requirements of Section C402.5.11.10 (*staff note Section C402.5.11.10 removed by CECPI-3-21 and CEPI-65-21*). Refrigeration systems shall meet the requirements of Section C403.12.

2. Systems shall comply with the applicable provisions of Sections of Section C403 required by Table C407.2

C409.4 Performance Target ~~HVAC TSPR Compliance~~. For HVAC Systems serving uses or portions of uses listed in Section C409.2 that are not served by systems listed in Section C409.2.1, the ~~allowed to use HVAC TSPR in accordance with Section C403.1.3 shall comply with all of the following:~~

~~1.~~	~~Systems shall meet the applicable provisions of Section C403.1.3.3 and Sections within Section C403 that are listed in Table C407.2~~

~~The~~ HVAC TSPR of the proposed design shall be greater than or equal to the HVAC TSPR of the standard reference design divided by the mechanical performance factor (MPF)using Equation 4-33.

(Equation 4-33)

$$TSPRp > TSPRr / MPF$$

where:

TSPRp = HVAC TSPR of the proposed design calculated in accordance with Sections C409.4, C409.5 and C409.6.

TSPRr = HVAC TSPR of the reference building design calculated in accordance with Sections C409.4, C409.5 and C409.6.
MPF = Mechanical Performance Factor from Table C409.4 ~~based on climate zone and building use type~~

Where a building has multiple building use types, MPF shall be area weighted using Equation 4-34

$$MPF = (A1 \times MPF1 + A2 \times MPF2 + ... + An \times MPFn)/(A1 + A2 + ... + An)$$

(Equation 4-34)

where:

MPF1, MPF2 through MPFn= Mechanical Performance Factors from Table C409.4 based on ~~climate zone and~~ building use types 1,2, through n

A1, A2 through An= Conditioned floor areas for building use types 1, 2, through n

TABLE C409.4 Mechanical Performance Factors

Climate Zone: Building ~~type~~ Use	Occupancy Group	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
~~Office (small and medium)[a]~~	~~B~~	~~0.72~~	~~0.715~~	~~0.70~~	~~0.705~~	~~0.685~~	~~0.65~~	~~0.71~~	~~0.68~~	~~0.645~~	~~0.805~~	~~0.70~~	~~0.78~~	~~0.845~~	~~0.765~~	~~0.805~~	~~0.865~~	~~0.835~~	~~0.875~~	~~0.895~~
Office (Large)[a]	B	0.83	0.83	0.84	0.84	0.79	0.82	0.72	0.81	0.77	0.67	0.76	0.63	0.71	0.72	0.63	0.73	0.71	0.71	0.71
Office (all others)[a]	B	0.72	0.715	0.70	0.705	0.685	0.65	0.71	0.68	0.645	0.805	0.70	0.78	0.845	0.765	0.805	0.865	0.835	0.875	0.895
Retail	M	0.60	0.57	0.50	0.55	0.46	0.46	0.43	0.51	0.40	0.45	0.57	0.68	0.46	0.68	0.67	0.50	0.45	0.44	0.38
Hotel/Motel	R-1	0.62	0.62	0.63	0.63	0.62	0.68	0.61	0.71	0.73	0.45	0.59	0.52	0.38	0.47	0.51	0.35	0.38	0.31	0.26
Multi-family/Dormitory	R-2	0.64	0.63	0.67	0.63	0.65	0.64	0.59	0.72	0.55	0.53	0.50	0.44	0.54	0.47	0.38	0.55	0.50	0.51	0.47
School/Education and Libraries	E (A-3)	0.82	0.81	0.80	0.79	0.75	0.72	0.71	0.72	0.67	0.73	0.72	0.68	0.82	0.73	0.61	0.89	0.80	0.83	0.77

a. Large office ~~gross~~ conditioned floor area ~~>~~ more than 150,000 ft^2 (14,000 m^2) or ~~>~~ more than 5 stories ~~floors; all other offices are small or medium~~

C409.4.1 HVAC TSPR. HVAC TSPR is calculated according to Equation 4-35.

$$\text{HVAC TSPR} = \text{Heating and cooling load/Building HVAC system energy}$$

(Equation 4-35)

where:

Building HVAC system energy = Sum of the annual site energy consumption for heating, cooling, fans, energy recovery, pumps, and heat rejection in thousands of Btus (kWh)

Heating and cooling load = Sum of the annual heating and cooling loads met by the building HVAC system in thousands of Btus (kWh)

C409.5 General. Projects shall ~~comply with the requirements~~ use the procedures of this Section when calculating compliance using HVAC Total System Performance Ratio.

C409.5.1 Simulation Program. Simulation tools used to calculate HVAC TSPR of the Standard Reference Design shall comply with the following:

1. The simulation program shall calculate the HVAC TSPR based only on the input for the proposed design and the requirements of Section 409. The calculation procedure shall not allow the user to directly modify the building component characteristics of the standard reference design.
2. Performance analysis tools shall meet ~~ing~~ the applicable subsections of Section 409 and be tested ~~according to~~ in accordance with ASHRAE Standard 140, except for Sections 7 and 8 of Standard 140~~, shall be permitted to be approved~~. The required tests shall include building thermal envelope and fabric load test (Sections 5.2.1, 5.2.2, and 5.2.3), ground coupled slab-on-grade analytical verification tests (Section 5.2.4), space-cooling equipment performance tests (Section 5.3), space-heating equipment performance tests (Section 5.4), and air-side HVAC equipment analytical verifi-cation test (Section 5.5), along with the associated reporting (Section 6). ~~Tools are permitted to be approved based on meeting a specified threshold for a jurisdiction. The code official shall be permitted to approve tools for a specified application or limited scope.~~
3. The test results and modeler reports shall be ~~posted on a~~ publicly available ~~website~~ and shall include the test re-sults of the simulation programs and input files used for generating the results along with the results of the other simulation programs included in ASHRAE Standard 140 Annexes B8 and B16. The modeler report in Standard 140 Annex A2 Attachment A2.7 shall be completed for results exceeding the maximum or falling below the minimum of the reference values and for omitted results.
4. The simulation program shall have the ability to ~~explicitly~~ model part-load performance curves or other part-load adjustment methods based on manufacturer's part-load performance data for mechanical equipment.
5. The *code official* shall be permitted to approve specific software deemed to meet these requirements in accordance with Section C101.5.1.

C409.5.2 Climatic Data. C409.5.2 The simulation program shall perform the simulation using hourly values of climatic data for a full calendar year

(8,760 hours) and shall reflect approved coincident hourly data for temperature, solar radiation, humidity and wind speed for the building location. ~~, such as temperature and humidity, using TMY3 data for the site as specified here: https://buildingenergyscore.energy.gov/resources~~

C409.5.3 Documentation. Documentation or web links to documentation conforming to the provisions of this section shall be provided to the *code official*.

C409.5.3.1 Compliance Report. Building permit submittals shall include:

1. A report produced by the simulation software that includes the following:

   1.1 Address of the building.

   1.2 Name of individual completing the compliance report.

   1.3 Name and version of the compliance software tool

   1.4 The dimensions, floor heights and number of floors for each block.

   1.5 By block, the U-factor, C-factor, or F-factor for each simulated opaque envelope component and the U-factor and SHGC for each fenestration component.

   1.6 By block or by surface for each block, the fenestration area.

   1.7 By block, a list of the HVAC equipment simulated in the proposed design including the equipment type, fuel type, equipment efficiencies and system controls.

   1.8 Annual site HVAC energy use by end use for the proposed and baseline building.

   1.9 Annual sum of heating and cooling loads for the baseline building.

   1.10 The HVAC ~~total system performance ratio~~ TSPR for both the standard reference design and the proposed design.

2. A mapping of the actual building HVAC component characteristics and those simulated in the proposed design showing how individual pieces of HVAC equipment identified above have been combined into average inputs as required by Section C409.6.1.10 including:

   2.1 Fans

   2.2 Hydronic pumps

   2.3 Air handlers

   2.4 Packaged cooling equipment

   2.5 Furnaces

   2.6 Heat pumps

   2.7 Boilers

   2.8 Chillers

   2.9 Heat rejection equipment (open and closed-circuit cooling towers; dry coolers)

   2.10 Electric resistance coils

   2.11 Condensing units

   2.12 Motors for fans and pumps

   2.13 Energy recovery devices

3. For each piece of equipment identified above include the following as applicable:

   3.1 Equipment name or tag consistent with that found on the design documents.

   3.2 Rated Efficiency level.

   3.3 Rated Capacity.

   3.4 Where not provided by the simulation program report in item a, documention of the calculation of any weighted equipment efficiencies input into the program.

   3.5 Electrical input power for fans and pumps (before any speed or frequency control device) at design condition and calculation of input value (W/cfm(W/Lps) or W/gpm (W/Lps)).

4. Floor plan of the building identifying:

    4.1 How portions of the buildings are assigned to the simulated blocks.

    4.2 Areas of the building that are not covered under the requirements of Section C403.1.1.

C409.6 Calculation Procedures. Except as specified by this Section, the standard reference design and proposed design shall be configured and analyzed using identical methods and techniques

C409.6.1 Simulation of the proposed building design. The proposed design shall be configured and analyzed as specified in this section.

C409.6.1.1 Block Geometry. The geometry of buildings shall be configured using one or more blocks. Each block shall define attributes including block dimensions, number of floors, floor to floor height and floor to ceiling height. Simulation software may allow the use of simplified shapes (such as rectangle, L shape, H Shape, U shape or T shape) to represent blocks. Where actual building shape does not match these pre-defined shapes, simplifications are permitted providing the following requirements are met:

1. The conditioned floor area and volume of each block shall match the proposed design within 10 percent.
2. The area of each exterior envelope component from Table C402.1.4 is accounted for within 10 percent of the actual design.
3. The area of vertical fenestration and skylights is accounted for within 10 percent of the actual design.
4. The orientation of each component in 2 and 3 above is accounted for within 45 degrees of the actual design.

The creation of additional blocks may be necessary to meet these requirements. A more complex zoning of the building shall be allowed where all thermal zones in the reference and proposed model are the same and rules related to block geometry and HVAC system assignment to blocks are met with appropriate assignment to thermal zones.

Exception: Portions of the building that are unconditioned or served by systems not covered by the requirements of Section C403.1.1 shall be omitted.

Revise as follows:

C409.6.1.1.1 Number of Blocks. One or more blocks may be required per building based on the following restrictions:

1. Each *block* ~~can~~ shall have ~~only~~ no more than one building use ~~occupancy type (multifamily *dwelling unit*, multifamily common area, office, library, education, hotel/motel or retail). Therefore, at least one single *block* shall be created for each unique use type.~~
2. Each block ~~can~~ shall be served by ~~only~~ no more than one type of HVAC system. ~~Therefore, a~~ A single block shall be created for each unique HVAC system and building use ~~type~~ combination and ~~. Multiple HVAC units of the same type may be represented in one block. Table D601.10.2 provides directions for combining~~ multiple HVAC units or components of the same type shall be combined in accordance with Section C409.6.1.10.2 . ~~of the same type into a single block~~.
3. Each block ~~can~~ shall have no more than a single defin ed ~~ition of~~ floor~~-to-~~ -to-floor or floor~~-to-~~ -to-ceiling height~~s~~. Where floor heights differ by more than two feet, ~~unique~~ separate blocks ~~should~~ shall be created f~~or the floors with varying heights~~.
4. Each block ~~can~~ shall include either above grade or below grade stories ~~floors~~. For buildings with both above grade and below grade stories ~~floors~~, separate blocks ~~should~~ shall be created for each. Where blocks have exterior walls partially below grade, if greater than 50 percent of the exterior wall surface is below grade, then simulate the block as below grade; otherwise simulate as above grade . ~~For buildings with stories floors partially above grade and partially below grade, if the total wall area of the floor(s) in consideration is greater than or equal to 50 percent above grade, then it should be simulated as a completely above grade block, otherwise it should be simulated as a below grade block.~~
5. ~~Each wall on a façade of a block shall have similar vertical fenestration.~~ Where a block includes multiple stories, separate blocks shall be created, if needed, to comply with both the following fenestration modeling requirements:

    5.1. The product of the proposed design U-factor times the area of windows (U•A) on a given story of each façade ~~of a given~~ shall not ~~floor cannot~~ differ by more than 15 percent of the average U •A for that modeled façade in each block.

    5.2 The product of the proposed design SHGC times the area of windows (SHGC•A) on a given story of each façade ~~of a given~~ shall not ~~floor cannot~~ differ by more than 15 percent of the average SHGC •A for that modeled façade in each block.

    ~~If either of these conditions are not met, additional blocks shall be created consisting of floors with similar fenestration.~~

6. For a building model with multiple blocks, the blocks ~~should~~ shall be configured together to have the same adjacencies as the actual building design.

C409.6.1.2 Thermal Zoning. Each ~~floor~~ story in a block shall be modeled ~~a single thermal zone or as five thermal zones consisting of four perimeter zones and a core zone.~~ as follows:

1. Below grade ~~floor~~ stories shall be modeled as a single thermal zone ~~block~~.
2. Where ~~If~~ any façade in the block is less than 45 feet in length, it shall be modeled as ~~there shall only be~~ a single thermal zone per ~~floor~~ story.
3. Otherwise, each ~~floor~~ story shall be modeled with five thermal zones. A perimeter zone shall be created extending from each façade to a depth of 15 feet. Where facades intersect, the zone boundary shall be formed by a 45 degree angle with the two facades. The remaining area or each ~~floor~~ story shall be modeled as a core zone with no exterior walls.

C409.6.1.2.1 ~~C409.3~~ Core & Shell, ~~/ Initial~~ Build-Out, and Future System Construction Analysis. Where the building permit applies to only a portion of the HVAC system in a *building* and the remaining components will be designed under a future building permit or were previously installed, ~~the future or previously installed~~ such components shall be modeled as follows:

1. ~~Where the HVAC zones that do not include~~ Blocks including existing or future HVAC zones ~~systems in the current permit will be or are~~ served by independent systems and not part of the construction project shall not be modeled~~, then the block including those zones shall not be included in the model~~.
2. Where the HVAC zones that do not include complete HVAC systems in the permit are intended to receive HVAC services from systems that are part of the construction project ~~in the permit~~, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.
3. Where existing HVAC systems serve permitted ~~the~~ zone equipment ~~in the permit receives HVAC services from previously installed systems that are not in the permit,~~ the ~~previously installed~~ existing systems shall be modeled with equipment matching the manufacturer's stated efficiency for the ~~certified~~ ~~value of what is~~ installed equipment or equipment that meets, but does not exceed the requirements of complying with Section C403.
4. Where the central plant heating and cooling equipment is completely replaced and HVAC zones with existing systems receive HVAC services from systems in the permit, their proposed zonal systems shall be modeled with equipment that meets, but does not exceed, the requirements of Section C403.

C409.6.1.3 Occupancy. Building occupancies modeled in the standard reference design and the proposed design shall comply with the following requirements.

Revise as follows:

C409.6.1.3.1 Occupancy Type. The occupancy type for each block shall be consistent with the building occupancy and uses specified in Table C409.4 ~~area type as determined in accordance with Section C405.4.2.1.~~ Portions of the building that are building occupancy and uses other than those specified in Table C409.4 ~~area types multifamily dwelling unit, multifamily common area, office, school (education), library, or retail~~ shall not be included in the simulation. Surfaces adjacent to such excluded building portions shall be modeled as adiabatic in the simulation program.

C409.6.1.3.2 Occupancy schedule, density, and heat gain. The occupant density, heat gain, and schedule shall be for multifamily, office, retail, library, hotel/motel or school as specified by ASHRAE Standard 90.1 Normative Appendix C.

C409.6.1.4.1 Roofs. ~~Roofs will be modeled with insulation above a steel roof deck.~~ The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single block, an area weighted U-factor shall be used. Roofs shall be modeled with insulation above a steel roof deck, with ~~Roof~~ solar absorptance ~~shall be modeled at~~ of 0.70 and emittance ~~at~~ of 0.90.

C409.6.1.4.2 Above grade walls. ~~Walls will be modeled as steel frame construction.~~ The U-factor and area of above grade walls shall be modeled as in the proposed design. If different wall constructions exist on the façade of a block an area-weighted U-factor shall be used. Walls shall be modeled as steel frame construction.

C409.6.1.4.3 Below grade walls. The C-factor and area of below grade walls shall be modeled as in the proposed design. If different ~~slab on grade floor~~ below grade wall constructions exist in a block, an area-weighted C- factor shall be used.

C409.6.1.4.4 Above grade exterior floors. ~~Exterior floors shall be modeled as steel frame.~~ The U-factor and area of floors shall be modeled as in the proposed design. If different ~~wall~~ floor constructions exist in the block an area-weighted U-factor shall be used. Exterior floors shall be modeled as steel frame.

C409.6.1.4.5 Slab on grade floors. The F-factor and ~~area~~ perimeter of slab on grade floors shall be modeled as in the proposed design. If different ~~below grade wall~~ slab on grade floor constructions exist in a *block*, ~~an area~~ perimeter-weighted F- factor shall be used.

C409.6.1.4.6 Vertical Fenestration. The window area and area weighted U-factor and SHGC shall be modeled for each façade based on the proposed design. Each exterior surface in a block must comply with Section C409.6.1.1.1 item 5. Windows ~~will~~ shall be combined into a single window centered on each façade based on the area and sill height input by the user. When different U values, SHGC or sill heights exist on a single facade in a block, the area weighted average for each shall be input by the user.

C409.6.1.4.7 Skylights. The skylight area and area weighted U-factor and SHGC shall be modeled for each roof ~~floor~~ based on the proposed design. Skylights ~~will~~ shall be combined into a single skylight centered on the roof of each zone based on the area input by the user.

C409.6.1.4 Envelope Components. Building envelope components modeled in the standard reference design and the proposed design shall comply with the requirements of this Section.

C409.6.1.4.8 Exterior Shading. Permanent window overhangs shall be modeled. When windows with and without overhangs or windows with different overhang projection factors exist on a façade, window width weighted projection factors shall be input by the user as follows:

$$P_{avg} = (A1 \times L_{o1} + A2 \times L_{o2} ... + An \times L_{on})/(Lw_1 + Lw_2 ... + L_{wn})$$

C409.6.1.5 Lighting. Interior lighting power density shall be equal to the allowance in Table C405.4.2(1) for multifamily, office, retail, library, or school. The lighting schedule shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of lighting controls is assumed to be captured by the lighting schedule and no explicit controls shall be modeled. Exterior lighting shall not be modeled.

C409.6.1.6 Miscellaneous equipment. The miscellaneous equipment schedule and power shall be for multifamily, office, retail, library, or school as specified by ASHRAE Standard 90.1 Normative Appendix C. The impact of miscellaneous equipment controls is assumed to be captured by the equipment schedule and no explicit controls shall be modeled.
Exceptions:

1. Multifamily dwelling units shall have a miscellaneous load density of 0.42 W/ft^2
2. Multifamily common areas shall have a miscellaneous load density of 0 W/ft^2

C409.6.1.7 Elevators. Elevators shall not be modeled.

C409.6.1.8 Service water heating equipment. Service water heating shall not be modeled.

C409.6.1.9 On-site renewable energy systems. On-site Renewable Energy Systems shall not be modeled.

Revise as follows:

C409.6.1.10 HVAC equipment. Where proposed or reference system parameters are not specified in Section C409, HVAC systems shall be modeled to meet the minimum requirements of Section C403 Mechanical Systems.

C409.6.1.10.1 Supported HVAC systems. At a minimum, the HVAC systems shown in Table C409.6.1.10.1 ~~CD105.2.10~~.1 shall be supported by the simulation program.

Reason: The changes here are the result of several SEHPCAC meetings with the CEPI-76 proponents to improve clarity of the new section. There are no changes in intended requirements as a result of these changes.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Proposed changes are clarification and editorial only.

Workgroup Recommendation

Proposal # 839

CED1-199-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

~~**C502.3.7 Additional energy efficiency credits.** *Additions* shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 50 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. *Alterations* to the existing building that are not part of an *addition*, but permitted with an *addition*, may be used to achieve the required credits.~~

~~**Exceptions**~~**:**

1. ~~*Buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.~~
2. ~~*Additions* less than 1,000 ft^2 (92 m^2) and less than 50 percent of existing floor area.~~
3. ~~*Additions* that do not include the addition or replacement of equipment covered by Tables C403.3.2(1) through C403.3.2(16) or Section C404.2.~~
4. ~~*Additions* that do not contain conditioned space.~~
5. ~~Where the *addition* alone or the existing building and *addition* together comply with Section C407.~~

Reason:

- No quantitative basis for this credit scheme is provided by the proponent in his original proposal. While the proponent's reason statement provides an association with the economic analysis of PNNL on prior editions of the 2021 IECC, he applies in an *ad hoc* manner logic that credits here "…should be higher for alterations in particular since the baselines for alterations include many below-code existing building features." No analysis is provided to either justify this assessment or the appropriate escalation of efficiency to compensate for this perceived problem with the baseline efficiency.
- While the analysis appropriately acknowledges that the credit approach would increase costs of construction, no economic analysis of costs versus benefits of the credit scheme is provided and appears to have never been developed or evaluated by the Consensus Committee.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
There is no evidence that the section, as proposed or as deleted, would affect cost of construction.

Workgroup Recommendation

Proposal # 898

CED1-200-22

Proponents: Sean Denniston, representing New Buildings Institute (sean@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

Add new definition as follows:

SUBSTANTIAL ENERGY ALTERATION.
An *alteration* that includes replacement of two or more of the following:

1. 50% or more of the area of interior wall-covering material of the *building thermal envelope*.
2. 50% or more of the area of the exterior wall-covering material of the *building thermal envelope* or fenestration.
3. Space-conditioning equipment constituting 50% or more of the total input capacity of the space heating or space cooling equipment serving the building.
4. Water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the *building*.
5. 50% or more of the luminaires in the *building*.

Revise as follows:

C503.6 Additional energy efficiency credits. ~~*Alterations*~~ *Substantial energy alterations* shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. Credits shall be achieved when all of the *alteration* complies with the credit requirements. Portions of the *alteration* that represent less than 50% of the interior or exterior wall covering of the *thermal envelope*, less than 50% of the input capacity of the space heating or cooling equipment, less than 50% of the input capacity of water heating equipment or less than 50% of the lighting power of the *building* shall not be eligible to achieve credits for compliance with this section.

Exceptions:

~~1. *Alterations* that include replacement of no more than one of the following:~~

~~1.1 HVAC unitary systems or HVAC central heating or cooling equipment serving the *work area* of the *alteration*.~~

~~1.2 Water heating equipment serving the *work area* of the alteration.~~

~~1.3 50 percent or more of the lighting fixtures in the *work area* of the alteration.~~

~~1.4 50 percent or more of the area of interior surfaces of the thermal envelope in the *work area* of the alteration.~~

~~1.5 50 percent or more of the building's *exterior wall envelope*, including fenestration.~~

1~~2~~. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.

2~~3~~. *Alterations* that do not contain conditioned space.

3~~4~~. Portions of *buildings* devoted to manufacturing or industrial use.

4~~5~~. *Buildings* in Climate Zone 0A.

5~~6~~. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.

6~~7~~. *Alterations* that comply with Section C407.

Reason: During the committee hearing process, this new code section received substantial support, but there were three major concerns: the clarity of the language, the alteration threshold for the requirement and compliance criteria.
Clarity of the Language: The original language was structured so that only "substantial" alterations would be subject to the requirements. This was done by creating an exception that effectively defined an alteration that was not substantial and exempted those alterations. During the committee process, concerns were raised about how this was a confusing way to structure the requirement even if the language itself was reasonably clear. In order to increase clarity, the language was reconfigured so that the threshold would not be defined through the exception. This public comment defines a new term: "substantial energy alteration" and only makes this specific kind of alteration subject to the requirements. The definition of the term is largely the same as the exception, except expressed in terms of what it is instead of what it isn't. This is more clear since alterations that are not substantial energy alterations will not even need to look at the section. This term was chosen because it follows an approach to substantial alterations that is already in the code. The IEBC has a definition for "substantial structural alteration" that sets a threshold for alterations to the structure that are considered substantial enough for special requirements. This definition does the same thing, it creates a threshold for alterations to the energy systems that are substantial enough for special requirements.

Threshold: The other concern raises was that the original language defined the substantial alteration as one that impact more that 50% of the systems serving the alteration area. Concerns were raised that the area of an alteration is difficult to define. Concerns were also raised that even if the alteration area is defined, it could be easy for substantial alterations to a limited part of the building to meet the threshold but hard for them to achieve points, particularly areas of the building served by central systems. To address this issue, this public comment changes the threshold for the alteration from just the alteration area to the entire building. While there is some loss in stringency, this will be much easier to understand, much clearer to enforce, and much easier to comply with.

Compliance Criteria: The third concern was related to clarity about what portion of the building would have to comply with the credit criteria to achieve the credit. It was not entirely clear whether the entire building would have to comply with the credit criteria or only the alteration. This was of special concern for multi-tenant buildings where portions of the building that are not part of the alteration may be inaccessible. The public comment edits adds language to make it clear that only the alteration needs to comply with the credits. But it also includes language to ensure that only portions of the alteration that cross that 50% impact threshold are able to be used.

Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will decrease the cost of construction.
This changes the threshold for the requirement from just the area of the alteration to the whole building, which will make fewer projects subject to the requirements.

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/638/1665/files/download/369/

Workgroup Recommendation

Proposal # 638

CED1-201-22

Proponents: Aaron Phillips, representing Asphalt Roofing Manufacturers Association (aphillips@asphaltroofing.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C503.6 Additional energy efficiency credits. *Alterations* shall comply with measures from Section~~s~~ C406.2~~ and~~ , Section C406.3 , or both to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.

Exceptions:

1. *Alterations* that include replacement of no more than one of the following:

   1.1 HVAC unitary systems or HVAC central heating or cooling equipment serving the *work area* of the *alteration*.

   1.2 Water heating equipment serving the *work area* of the alteration.

   1.3 50 percent or more of the lighting fixtures in the *work area* of the alteration.

   1.4 50 percent or more of the area of interior surfaces of the thermal envelope in the *work area* of the alteration.

   1.5 50 percent or more of the building's *exterior wall envelope*, including fenestration.

2. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
3. *Alterations* that do not contain conditioned space.
4. Portions of *buildings* devoted to manufacturing or industrial use.
5. *Buildings* in Climate Zone 0A.
6. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.
7. *Alterations* that comply with Section C407.
8. *Alterations* that involve only one of the types of alterations in Section C503.2.

Reason: This comment offers two changes to Section C503.6. First, it clarifies that credits to meet the 10% requirement may be obtained from either or both of Sections C406.2 and C406.3. I believe that is the intent of the existing language, so this modification should not constitute a technical change. Second, a new exception is added to address less complex alterations for which satisfying the 10% additional energy efficiency credits requirement would expand the project scope beyond the purpose of the alteration and could present significant compliance challenges for many projects.

Cost Impact: The code change proposal will decrease the cost of construction.
The clarification of section references in C503.6 will not impact cost of construction. For projects that fall under new exception 8, the total project cost may be lower because implementation of additional energy efficiency options as part of a limited scope alteration is not required.

Workgroup Recommendation

Proposal # 752

CED1-202-22

Proponents: Thomas Culp, representing Glazing Industry Code Committee and Aluminum Extruders Council (culp@birchpointconsulting.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C503.6 Additional energy efficiency credits. *Alterations* shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.

Exceptions:

1. *Alterations* that ~~include replacement of no more than one~~ do not include replacement of two or more of the following:
   - 1.1 HVAC unitary systems or HVAC central heating or cooling equipment serving the *work area* of the *alteration*.
   - 1.2 Water heating equipment serving the *work area* of the alteration.
   - 1.3 50 percent or more of the lighting fixtures in the *work area* of the alteration.
   - 1.4 50 percent or more of the area of interior surfaces of the thermal envelope in the *work area* of the alteration.
   - 1.5 50 percent or more of the building's *exterior wall envelope*, including fenestration.
2. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
3. *Alterations* that do not contain conditioned space.
4. Portions of *buildings* devoted to manufacturing or industrial use.
5. *Buildings* in Climate Zone 0A.
6. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.
7. *Alterations* that comply with Section C407.

Reason: This section came from CEPI-217. I support the intent of CEPI-217 but there are wording errors that need to be corrected.
The intent in the reason statement of CEPI-217 was clear that "Only alterations that include replacement of more than 50% of two or more of the major energy systems of the building – envelope, HVAC, water heating, lighting - would be subject to the requirement." However, the actual text in Exception 1 to the new C503.6 is not clear. Take the example of replacing a single window. That's a small alteration that needs to meet new window requirements per other language in chapter 5, but not intended to trigger the credits requirement here. However, that is not "50 percent or more of the *building's exterior wall envelope*, including fenestration" so the exception is not met. The language needs to be fixed. This proposal offers one possible suggestion, although this could be improved further.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal is just a wording correction, so no impact on cost.

Workgroup Recommendation

Proposal # 861

CED1-203-22

Proponents: Jack Bailey, representing INTERNATIONAL ASSOCIATION OF LIGHTING DESIGNERS (jbailey@oneluxstudio.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

~~**C406.1.3 Substantial Alterations to Existing Buildings.**~~ ~~The *building envelope*, *equipment*, and *systems* in *alterations* to *buildings* exceeding 5000 square feet (46.5 m²) of *gross conditioned floor area* shall comply with the requirements of Section C406.1.1 and C406.1.2 where the alteration includes replacementof two or more of the following:~~

1. ~~HVAC unitary systems or HVAC central heating or cooling equipment serving the alteration area, not including ductwork or *piping*.~~
2. ~~80% or more of the lighting fixtures in the *alteration* area.~~
3. ~~Building envelope components in the *alteration* area including new exterior cladding, fenestration, or insulation.~~

C503.6 Additional energy efficiency credits. ~~*Alterations* shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and *climate zone*. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the gross floor area to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section.~~ Where an *alteration* includes the substantial modification of two or more of the systems identified in Table 503.6, the alteration shall comply with measures from Sections C406.2 and C406.3 to achieve not less than 10 percent the number of required efficiency credits from Table C406.1.1 based on building occupancy group and climate zone. Credits are permitted to be achieved from energy credits listed in Table 503.6 for the systems undergoing substantial modification. Where a project contains multiple occupancies, credits in Table C406.1.1 from each building occupancy shall be weighted by the *conditioned floor area* to determine the weighted average project energy credits required. Accessory occupancies shall be included with the primary occupancy group for purposes of this section. Credits shall be achieved based on the scope of the alteration only (i.e. existing systems which are not altered are not considered).

Exceptions:

~~1. *Alterations* that include replacement of no more than one of the following:~~

~~1.1 HVAC unitary systems or HVAC central heating or cooling equipment serving the *work area* of the *alteration*.~~

~~1.2 Water heating equipment serving the *work area* of the alteration.~~

~~1.3 50 percent or more of the lighting fixtures in the *work area* of the alteration.~~

~~1.4 50 percent or more of the area of interior surfaces of the thermal envelope in the *work area* of the alteration.~~

~~1.5 50 percent or more of the building's *exterior wall envelope*, including fenestration.~~

1. *Alterations* to *buildings* in Utility and Miscellaneous Group U, Storage Group S, Factory Group F, High-Hazard Group H.
2. *Alterations* that do not contain conditioned space.
3. Portions of *buildings* devoted to manufacturing or industrial use.
4. *Buildings* in Climate Zone 0A.
5. *Alterations* that are permitted with an *addition* complying with Section C502.3.7.
6. *Alterations* that comply with Section C407.

Add new text as follows:

503.6 ENERGY CREDITS FOR ALTERATION OF BUILDING SYSTEMS

Substantial Modification Consists Of	**Energy Credit Measures Which Are Permitted To Be Achieved**
Replacement of 50% or more of the area of interior wall-covering material of the building thermal envelope	E01, E02, and E05, subject to compliance with C406.2.1
Replacement of 50% or more of the area of the exterior wall-covering material of the building thermal envelope or fenestration	E01, E02, E05, and E06, subject to compliance with C406.2.1
Replacement of space-conditioning equipment constituting 50% or more of the total input capacity of the space heating equipment serving the building	H01, H02, and H04, subject to compliance with C406.2.2
Replacement of space-conditioning equipment constituting 50% or more of the total input capacity of the space cooling equipment serving the building	H01, H03, H04, and H05, subject to compliance with C406.2.2
Replacement of water-heating equipment constituting 50% of more of the total input capacity of all the water heating equipment serving the building	W01, W02, W03, W04, W05, W06, W07, W08, W09, and W10, subject to compliance with C406.2.3
Replacement of 50% or more of the lights in the building	L02, L03, L05, and L06, subject to compliance with C406.2.5

Reason: To ensure that this section of the code is usable and enforceable.
There are several problems which are fixed by this proposed revision:

1. This proposal assumes that compliance is not required unless the specified conditions are met. This limits the risk of unusual project types not being able to comply with the code just because the authors of the code didn't think of them when a list of exceptions was created.

2. This proposal requires that only substantial alterations will be required to achieve efficiency credits. This is important because the vast majority of alterations are truly small-scale projects without sophisticated design teams to wade through the compliance requirements.

3. This proposal specifies that credits are achieved only from work being done as part of the alteration. This allows projects to be completed that upgrade only part of inefficient buildings without adding to the scope of the project, and also requires that alterations of inefficient parts of otherwise efficient buildings will have to do more.

4. This proposal specifies which credits are achievable for each type of alteration. Some credits (for example L04 increase daylight area, or E03 envelop leak reduction) really should not be allowed unless the entire building is being modified.

5. This proposal indicates that the restrictions on credit combinations identified in C406.2.1, C406.2.2, C406.2.3, and C406.2.5 will apply to alterations as well.

6. This proposal deletes C406.1.3, which is redundant.

Cost Impact: The code change proposal will decrease the cost of construction.
This proposal will significantly reduce the burden of cost and complexity for small alterations.

Workgroup Recommendation

Proposal # 933

CED1-204-22

Proponents: Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

CC101.1 Purpose. The purpose of this appendix is to supplement the *International Energy Conservation Code* and require renewable energy systems of adequate capacity to achieve net zero operational energy.

GREEN RETAIL PRICING. A program by the retail electricity provider to provide 100-percent renewable energy to the building project owner.

Revise as follows:

OFF-SITE RENEWABLE ENERGY SYSTEM. Renewable energy system which serves the building project and is not an on-site renewable energy system, including contracted purchases of renewable energy and renewable energy certificates.

ON-SITE RENEWABLE ENERGY SYSTEM.
Renewable energy systems located on any of the following:
1. The *building*.
2. The property upon which the *building* is located.
3. A property that shares a boundary with and is under the same ownership or control as the property on which the *building* is located, or
4. A property that is under the same ownership or control as the property on which the *building* is located and is separated only by a public right-of way ~~on which the *building* is located~~ from the building being served by the renewable energy system.

RENEWABLE ENERGY SYSTEM. Photovoltaic, solar thermal, geothermal energy extracted from hot fluid or steam, wind, or other approved ~~renewable energy production~~ systems used to generate renewable energy.

CC103.1 Renewable energy. On-site renewable energy systems shall be installed, or adjusted off-site renewable energy shall be procured to ~~offset the building energy as calculated in Equation CC-1~~ meet the minimum renewable energy requirement in accordance with Section CC103.1.1.

$$RE_{onsite} + RE_{offsite} \geq RE_{min}$$

where: **(Equation CC-1)**

RE_{onsite} = Annual site energy production from on-site renewable energy systems ~~(see Section CC103.2)~~, including installed on-site renewable energy systems used for compliance with C405.13.1 and C406.5.
$RE_{offsite}$ = Adjusted annual energy production from off-site renewable energy systems that ~~may~~ is permitted to be credited against the minimum renewable energy requirement ~~(see Section CC103.3).~~ This includes ~~including~~ off-site renewable energy purchased for compliance with C405.13.2.
RE_{min} = Minimum renewable energy requirement.

When Section C401.2.1(1) is used for compliance with the *International Energy Conservation Code*, the minimum renewable energy requirement shall be determined by multiplying the gross *conditioned floor area* plus the gross semiheated floor area of the proposed building by the prescriptive renewable energy requirement from Table CC103.1. An area weighted average shall be used for mixed-use buildings.
When Section C401.2.1, Item 2 or Section C401.2.2 is used for compliance with the *International Energy Conservation Code*, the minimum renewable energy requirement shall be equal to the building energy as determined from energy simulations.

Add new text as follows:

CC103.2 Procurement Factors for Renewable Energy System Compliance Alternatives

Renewable Energy Systems	**Procurement Factors**
Onsite renewable energy with a capacity of not less than 7.5 W/ft^2	1.0
Offsite renewable energy complying with Section CC103.3.1	0.90
Unbundled renewable energy certificates	0.75
Offsite renewable energy systems used to comply where the building site is located where an unshaded flat plate collector oriented toward the equator and tilted at an angle from horizontal equal to the latitude receives an annual daily average incident solar radiation less than 1.1 kBtu/ft^2 - day (3.5 kWh/m^2 - day).	1.0
Offsite renewable energy systems used to comply where more than 80 percent of the roof area is covered by any combination of permanent obstructions such as, but not limited to, mechanical equipment, vegetated space, access, pathways, or occupied roof terrace.	1.0
Offsite renewable energy systems used to comply where more than 50 percent of the roof area is shaded from direct-beam sunlight by natural objects or by structures that are not part of the building more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.	1.0

Revise as follows:

CC103.2.1 Renewable energy certificates. ~~r~~ *Renewable energy certificates* *(RECs)* ~~and other environmental attributes~~ associated with the *on-site renewable energy system* shall be assigned to the initial and subsequent building owner(s) for a cumulative period of not less than 15 years. The building owner(s) ~~may~~ are permitted to transfer ~~*renewable energy certificates*~~ *RECs* to building tenants ~~while they are~~ occupying the building.

CC103.3.1 ~~Qualifying off-site~~ Offsite procurement methods.. ~~The following are considered qualifying off-site~~ Offsite renewable energy systems used to comply with Section CC103.1 shall be one or more of the following ~~procurement methods~~:

1. *Community renewables energy facility*
2. *Renewable energy investment fund*
3. *Financial renewable energy power purchase agreement*
4. *Direct ownership*
5. *Direct access to wholesale market*
6. *Green retail pricing*
7. Unbundled *Renewable Energy Certificates (RECs*)
8. *Physical renewable energy power purchase agreement.*

CC103.3.2 Requirements for all procurement methods. ~~The following requirements shall apply to all *off-site renewable energy* procurement methods:~~ Offsite renewable enregy systems used to comply with Section CC103.1 shall comply with one or more of the following:

~~1. The building owner shall sign a legally binding contract or other approved agreement to procure qualifying off-site renewable energy.~~

~~2~~ 1. The procurement contract shall have duration of not less than 15 years and shall be structured to survive a partial or full transfer of ownership of the property.

~~3~~ 2. RECs ~~and other environmental attributes~~ associated with the procured ~~*off-site*~~ *offsite renewable energy* shall ~~meet all of~~ comply with the following requirements:

~~3~~ 2.1 The RECs shall be ~~Are~~ retained or retired by or on behalf of the property owner or tenant for a period of not less than 15 years.

~~3~~ 2.2 The RECs shall be ~~Are~~ created within a 12-month period of use of the REC; and

~~3~~ 2.3 The RECs shall be ~~Are~~ from a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.

~~4~~ 3. The generating source shall be a renewable energy system.

~~5~~ 4. The generation source shall be located where the energy can be delivered to the building site by any of the following:

~~5~~ 4.1 Direct ~~By direct~~ connection to the *off-site renewable energy facility*.

~~5~~ 4.2 The ~~By the~~ local utility or distribution entity.

~~5~~ 4.3 An By an interconnected electrical network where energy delivery capacity between the generator and the building site is available.

~~6~~ 5. Records on power sent to or purchased by the building shall be retained by the building owner and made available for inspection by the code official upon request.

CC103.3.3 Adjusted off-site renewable energy. The ~~process for calculating the~~ adjusted *off-site renewable energy* ~~is shown in~~ shall be calculated in accordance with Equation CC-2.

$$RE_{offsite} = \sum_{i=1}^{n} PF_i \times RE_i = PF_1 \times RE_1 + PF_2 \times RE_2 + \ldots + PF_n \times RE_n$$

(Equation CC-2)

where:

$RE_{offsite}$ = Adjusted off-site renewable energy.

PF_i = Procurement factor for the i^{th} renewable energy procurement method per specified by Table CC103.2 ~~Section CC103.3.3.1.~~

RE_i = Annual energy production for the i^{th} renewable energy procurement method .

n = The number of renewable energy procurement methods ~~considered~~ used for compliance with Section CC103.1.

CC103.3.3.1 Procurement factors. ~~When installed on-site renewable energy capacity is 7.5 W/ft² (80.7 W/m²) of roof area or greater, the procurement factor is 1.00, otherwise, the procurement factor is 0.75, except for unbundled *renewable energy certificates* which shall have a procurement factor of 0.20. A procurement factor of 1.0 may also be used when the conditions of exceptions 1, 2, or 3 to Section C405.13.1 are satisfied.~~

The procurement factors for renewable energy system compliance alternatives shall be as specified in Table CC103.2 .

Exception: The procurement factor for R-2 occupancies shall be 1.0.

CC103.2 Calculation of on-site renewable energy. The annual energy production from on-site renewable energy systems shall be determined using approved software approved ~~by the code official~~.

Reason: An exception permitting a procurement factor of 1 for R-2 occupancies is provided. R-2 occupancies need the flexibility provided with procurement of offsite renewable energy generation, including compliance through the purchase of renewable energy certificates, without the 'location' penalties. This incentivizes 'more sustainable building locations (urban areas) where renewable onsite options are limited.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Eliminates the renewable energy location penalty for R-2 occupancies.

Workgroup Recommendation

Proposal # 744

CED1-205-22

Proponents: Reid Hart, representing Pacific Northwest National Laboratory
(**reid.hart.pe@gmail.com**)

2024 International Energy Conservation Code [CE Project]

Delete and substitute as follows:

~~**TABLE CC103.1 PRESCRIPTIVE RENEWABLE ENERGY REQUIREMENT FOR BUILDING TYPES AND CLIMATES (kWh/ft^2-yr)**~~

~~Building Area Type~~

~~Climate Zone~~	~~Multifamily (R-2)~~	~~Healthcare/hospital (I-2)~~	~~Hotel/motel (R-2)~~	~~Office (B)~~	~~Restaurant (A-2)~~	~~Retail (M)~~	~~School (E)~~	~~Warehouse (S)~~	~~Grocery Store (M)~~	~~Laboratory (B)~~	~~Assembly (A)~~	~~All others~~
~~0A~~	~~13~~	~~35~~	~~23~~	~~10~~	~~129~~	~~17~~	~~16~~	~~3~~	~~27~~	~~41~~	~~5~~	~~17~~
~~0B~~	~~12~~	~~34~~	~~22~~	~~10~~	~~123~~	~~17~~	~~15~~	~~3~~	~~26~~	~~40~~	~~5~~	~~16~~
~~1A~~	~~11~~	~~32~~	~~20~~	~~9~~	~~113~~	~~14~~	~~13~~	~~3~~	~~24~~	~~36~~	~~4~~	~~15~~
~~1B~~	~~11~~	~~32~~	~~20~~	~~9~~	~~118~~	~~15~~	~~14~~	~~3~~	~~24~~	~~37~~	~~5~~	~~15~~
~~2A~~	~~11~~	~~32~~	~~20~~	~~8~~	~~114~~	~~13~~	~~12~~	~~3~~	~~22~~	~~34~~	~~4~~	~~14~~
~~2B~~	~~11~~	~~30~~	~~18~~	~~8~~	~~108~~	~~12~~	~~11~~	~~3~~	~~22~~	~~33~~	~~4~~	~~13~~
~~3A~~	~~11~~	~~30~~	~~18~~	~~8~~	~~117~~	~~13~~	~~11~~	~~3~~	~~21~~	~~31~~	~~4~~	~~13~~
~~3B~~	~~10~~	~~29~~	~~18~~	~~8~~	~~110~~	~~12~~	~~10~~	~~3~~	~~20~~	~~31~~	~~4~~	~~13~~
~~3C~~	~~9~~	~~28~~	~~18~~	~~7~~	~~100~~	~~10~~	~~9~~	~~2~~	~~18~~	~~27~~	~~3~~	~~12~~
~~4A~~	~~12~~	~~31~~	~~18~~	~~8~~	~~123~~	~~15~~	~~11~~	~~6~~	~~21~~	~~32~~	~~4~~	~~14~~
~~4B~~	~~11~~	~~29~~	~~18~~	~~7~~	~~113~~	~~12~~	~~10~~	~~4~~	~~20~~	~~30~~	~~4~~	~~13~~
~~4C~~	~~10~~	~~28~~	~~17~~	~~7~~	~~111~~	~~13~~	~~10~~	~~4~~	~~18~~	~~28~~	~~3~~	~~13~~
~~5A~~	~~12~~	~~31~~	~~19~~	~~8~~	~~133~~	~~17~~	~~11~~	~~8~~	~~22~~	~~34~~	~~4~~	~~15~~
~~5B~~	~~11~~	~~29~~	~~18~~	~~8~~	~~125~~	~~14~~	~~11~~	~~5~~	~~21~~	~~31~~	~~4~~	~~14~~
~~5C~~	~~10~~	~~29~~	~~17~~	~~7~~	~~116~~	~~13~~	~~10~~	~~4~~	~~18~~	~~27~~	~~3~~	~~13~~
~~6A~~	~~14~~	~~33~~	~~20~~	~~10~~	~~151~~	~~20~~	~~13~~	~~11~~	~~26~~	~~39~~	~~5~~	~~17~~
~~6B~~	~~13~~	~~33~~	~~19~~	~~8~~	~~137~~	~~17~~	~~11~~	~~7~~	~~22~~	~~34~~	~~4~~	~~16~~
~~7~~	~~14~~	~~37~~	~~21~~	~~9~~	~~164~~	~~20~~	~~13~~	~~10~~	~~25~~	~~37~~	~~5~~	~~18~~
~~8~~	~~15~~	~~40~~	~~22~~	~~11~~	~~190~~	~~23~~	~~16~~	~~10~~	~~28~~	~~43~~	~~5~~	~~20~~

TABLE CC103.1 PRESCRIPTIVE RENEWABLE ENERGY REQUIREMENT FOR BUILDING TYPES AND CLIMATES (kWh/ft^2-yr)

Building Area Type

Climate Zone	Multifamily (R-2)	Healthcare/hospital (I-2)	Hotel/motel (R-2)	Office (B)	Restaurant (A-2)	Retail (M)	School (E)	Warehouse (S)	Grocery Store (M)	Laboratory (B)	Assembly (A)	All others
0A												
0B												
1A												
1B												
2A												
2B												
3A												
3B												
3C												
4A												
4B												
4C												
5A												
5B												
5C												
6A												
6B												
7												
8												

[Note to reviewers and staff: Table values to be replaced with new values currently undergoing analysis]

Reason: Appendix CC should be updated to match the expected energy use of buildings compliant with the 2024 IECC, considering both improvements in energy efficiency and renewable energy requirements. The expected energy use of IECC compliant buildings can be taken from PNNL's upcoming Progress Indicator analysis when available.
In addition, the committee should consider increasing the efficiency required when following either the prescriptive or performance approaches. Prescriptive efficiency improvements could be achieved by requiring additional efficiency credits and performance efficiency improvements could be achieved by requiring a lower performance target than that required by Section C407.1.2.

These changes are particularly important considering the citing of the IECC Zero Energy Appendix by the Inflation Reduction Act.

Cost Impact: The code change proposal will decrease the cost of construction.
Updating the table values to account for reductions in energy use in the last few code cycles will reduce the amount of renewable generation needed to achieve net zero.

Workgroup Recommendation

Proposal # 928

CED1-206-22

Proponents: Laura Petrillo-Groh, representing AHRI (lpetrillo-groh@ahrinet.org); Vladimir Kochkin, representing NAHB (vkochkin@nahb.org); Greg Johnson, representing National Multifamily Housing Council (gjohnsonconsulting@gmail.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

CD101.1 Prescriptive compliance. ~~Where compliance is demonstrated using the prescriptive compliance option in Section C401.2.1, the number of additional efficiency credits required by Section C406.1 shall be 50 percent higher than that required by Table C406.1.1.~~

CD101.2 Total building performance compliance . ~~Where compliance is demonstrated using the total building performance option of Section C401.2.1, the percentage of annual energy cost (PAEC), applied to the standard reference design referenced in Equation 4-23, shall be multiplied by 0.98.~~

Reason: Appendices of IECC are intended to be ready for state adoption; however, Appendix CD is not. States and localities are expressly preempted from setting energy use regulations for products that DOE regulates, as Enhanced Energy Credits outlined in CD101.1 almost certainly require (and CD101.2, by performance proxy).[1] No pathway for minimum efficiency products was included in the Technical Support Document for the base energy credits (Tables C406.1.1 and C406.1.2) (TSD for CEPI-193) therefore compliance with federal law cannot be confirmed for the base credits or in the Glide Path enhanced energy credits (CD101.1) by stakeholders.

PNNL developed a technical support document to accompany the ASHRAE 90.1 energy credit proposal (approved in 90.1-2022). (R. Hart, et al. 90.1 Energy Credits Analysis Documentation, PNNL-32516. January 2022.) The 90.1 technical support document (TSD) reviewed two demonstration packages--one to evaluate cost effectiveness and the other to show a reasonable package without using efficiency improvements for HVAC and SWH equipment subject to EPACT (42 USC 6833) minimum federal efficiencies. While the credits and the baselines are not the same, in a recent presentation to SSPC 90.1 by R. Hart, the IECC base energy credit package was estimated to be 2.5% more stringent than the ASHRAE 90.1-2022 base goal of around 5% energy savings. In the TSD for CEPI-193, PNNL estimated that the advanced package of practical measures achieves an average of 16.8% energy cost savings. While this edition of the Glide Path is not quite as stringent as CF102.1, for some climate zones and building types, the Glide Path is even more stringent than the Advanced Energy Package. The calculated increase in CF102.1 over C406.1.1 (as proposed in public draft 1) is included in the table, below. Highlighted cells show for which climate zones and building types the Glide Path is even more stringent than Table C102.1.

Increase in of CD102.1 stringency over Table C406.1.1 (in PD1)

		Climate Zone																		
90.1	Building Occu	0A	0B	1A	1B	2A	2B	3A	3B	3C	4A	4B	4C	5A	5B	5C	6A	6B	7	8
Multifamily	R-2, R-4, I-1	175%	164%	181%	156%	150%	133%	150%	147%	122%	133%	122%	122%	124%	122%	122%	186%	125%	150%	156%
Medical	I-2	81%	79%	92%	92%	122%	137%	213%	166%	200%	169%	131%	157%	130%	109%	118%	133%	126%	160%	121%
Hotel	R-1	68%	61%	67%	62%	56%	72%	60%	56%	56%	69%	55%	55%	85%	62%	63%	106%	82%	107%	107%
Office	B	84%	77%	75%	74%	64%	65%	81%	73%	68%	80%	64%	66%	90%	71%	62%	114%	92%	107%	99%
Restaurant	A-2	19%	16%	14%	14%	17%	15%	48%	25%	18%	83%	34%	42%	119%	63%	45%	167%	113%	186%	196%
Retail	M	41%	43%	46%	49%	52%	46%	57%	57%	53%	36%	52%	42%	25%	116%	150%	128%	118%	100%	136%
Education	E	63%	67%	65%	72%	66%	68%	69%	68%	71%	85%	67%	77%	88%	75%	82%	102%	97%	100%	126%
Warehouse	S-1 and S-2	77%	77%	82%	82%	82%	89%	65%	96%	74%	58%	47%	73%	122%	74%	71%	122%	113%	110%	64%
	Other	74%	71%	77%	75%	78%	73%	91%	88%	75%	94%	71%	86%	97%	89%	92%	133%	114%	133%	129%

The figure, below, modified from the 90.1 TSD, compares the increase in stringency of the IECC base package and advanced energy credit package over the 90.1 energy credit package. (R. Hart, et al, 2021) It's clear that if a jurisdiction in certain climate zones adopt The Glide Path, there may no longer be any pathways to build any restaurants (for example), as these buildings may not have enough potential energy credits available to reach the necessary threshold. If that is the case, these buildings certainly cannot meet requirements with minimum efficiency equipment. As it is not clear that the number of credits required in The Glide Path are even possible. AHRI has requested that PNNL analyze potential energy credit points by building and measure type for the IECC proposed base energy credits, advanced energy credits, and glide path.

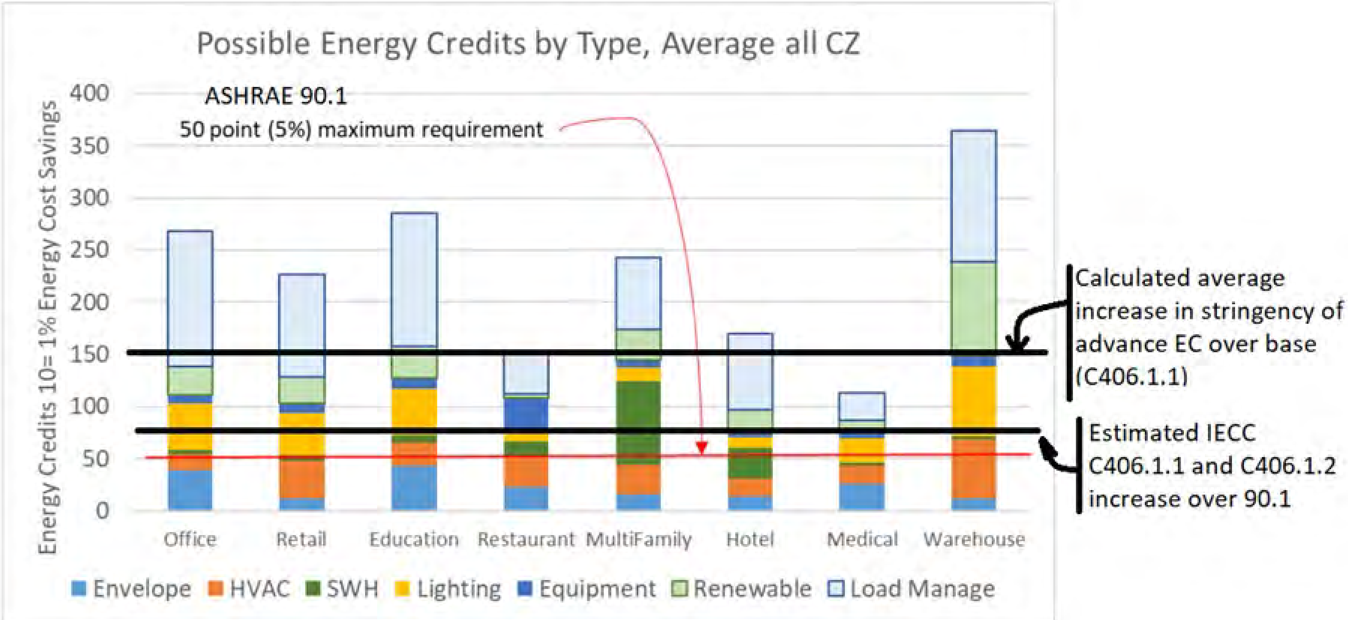

Figure 1. Potential Energy Credit Points by Building and Measure Type

Regarding the legal concerns with this proposal, states cannot adopt a building energy code effectively requiring the installation of federally covered products above federal minimum efficiencies. Until it is clear that the base package levels (and the advanced package) can be met with a cost-effective package with minimum efficiency equipment, AHRI has proposed deleting section CD101.1 (and CD101.2 by proxy) in entirety.

AHRI notes the energy code challenged in *AHRI v. City of Albuquerque* specifically included a compliance option that would have required HVAC systems and equipment and water heaters to meet efficiency standards that were more stringent than the specific standards DOE set under Energy Policy and Conservation Act (EPCA to The Act).[2] Thus, the court concluded those provisions were "preempted as a matter of law,"[3] and further ruled that the Albuquerque code was not saved by the fact that there were "viable, non-preempted options" for compliance.[4]

Building codes are not within the scope of EPCA's regulatory mandates, except where, as in *City of Albuquerque* and those building codes incorporate standards that directly regulate the efficiency of products covered by EPCA (as proposed here via energy credits embedded within the prescriptive pathway).[5] A state regulation does not need to directly prohibit the energy use of covered products to be preempted; state regulations "concerning" the energy efficiency or energy use of a product for which a standard is prescribed or established are sufficient. 42 U.S.C. § 6316(b)(2)(A).

The limited exception for building codes does not permit for states or localities to set efficiency requirements above the Federal minimum. **Congress was deliberate that states could not set back-door energy efficiency standards through building codes that would "expressly or effectively require the installation of covered products whose efficiencies exceed . . . the applicable Federal standard."**[6] The limited building code exception to preemption in EPCA permits states to create performance-based criteria, *so long as the efficiency minimums promulgated by DOE are not exceeded*. The law is unambiguous: "If a building code requires the installation of covered products with efficiencies exceeding both the applicable Federal standard … and the applicable standard of any State …that has been granted a waiver … such requirement of the building code shall not be applicable…." 42 U.S.C. 6297 (f)(B).

No analysis has been provided that Sections CD101.1 and CD101.2 can be met (and met cost effectively) with minimum efficiency EPCA-covered products and equipment. Therefore, at the levels in Public Draft, these tables contravene the preemption provisions of EPCA by proposing an energy efficiency standard on a federally regulated product that exceed the Federal minimum. The Act specifies that only the Department of Energy can set energy standards for covered products. While the goal of advancing energy efficiency is laudable, federal law prohibits any regulation of covered products that conflict with existing federal energy regulation.

Lastly, the Glide Path was not assigned to a particular subcommittee, but like the base and advanced energy credits proposals, there are credits which involve subcommittees working directly with impacted equipment (for example, the HVACR and WH Subcommittee). Relevant subcommittees should be included in any discussion of proposed changes to The Glide Path.

[1] *Air Conditioning, Heating & Refrigeration Inst. v. City of Albuquerque*, No. 08-633, 2008 WL 5586316, No. 08-633 at *6 (D. N.M. Oct. 3, 2008);

Nat'l Elec. Mfrs. Ass'n v. Calif. Energy Comm'n, No. 2:17-CV-01625-KJM-AC, 2017 WL 6558134 at *5 (E.D. Ca. Dec. 21, 2017).

[2] Id at 1133, 1139.

[3] *Id.* at 1137.

[4] *Id.* at 1136.

[5] EPCA's preemption provision includes an express, but very limited and narrowly drawn exception for building codes that include standards for covered products. Importantly, the focus of the exception remains on energy efficiency, *i.e.,* how a building code might affect "the ratio of useful output" or "the quantity of energy consumed" of products covered by EPCA. .

[6] *Id.* at 26.

Cost Impact: The code change proposal will decrease the cost of construction.
AHRI's code change proposal will decrease the cost of construction compared to the Glide Path (Appendix CD) in public draft 1.

Workgroup Recommendation

Proposal # 884

CED1-207-22

Proponents: Ted Williams, representing ONE Gas (ngdllc@outlook.com)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

~~CD101~~
~~COMPLIANCE~~

~~CD101.1 Prescriptive compliance.~~ ~~Where compliance is demonstrated using the prescriptive compliance option in Section C401.2.1, the number of additional efficiency credits required by Section C406.1 shall be 50 percent higher than that required by Table C406.1.1.~~

CD101.2 **~~Total building performance compliance~~ .** ~~Where compliance is demonstrated using the total building performance option of Section C401.2.1, the percentage of annual energy cost (PAEC), applied to the standard reference design referenced in Equation 4-23, shall be multiplied by 0.98.~~

~~CD101.3 On-site renewable electricity systems.~~ ~~In addition to any renewable energy generation equipment provided to comply with Section C406.3, buildings shall install equipment for on-site renewable energy generation with a direct current (DC) nameplate capacity rating of not less than that computed using Equation CD-2.~~

~~CD-1~~

~~AA = Adjusted area, in ft~~^{2} ~~(m~~^{2}~~)~~
~~CA = Conditioned area, in ft~~^{2} ~~(m~~^{2}~~)~~
~~SNA = Semi-heated and nonconditioned area, in ft~~^{2} ~~(m~~^{2}~~)~~

~~CD-2~~

~~REQ = Required on-site capacity, in DC watts~~
~~AA = Adjusted area from Equation CD-1, in ft~~^{2} ~~(m~~^{2}~~)~~
~~CF = Capacity factor from Table CD101.3, in watts/ft~~^{2} ~~(m~~^{2}~~)~~

Exceptions:

1. ~~Any required renewable energy generation capacity in excess of 10 W/ft~~^{2} ~~(108 W/m~~^{2}~~) of net available roof area is permitted to be provided using an off-site renewable energy system in accordance with Section CD101.4. For the purposes of this section, net available roof area is the gross roof area minus the roof area occupied by any combination of skylights, mechanical equipment, vegetated areas, required access pathways, vehicle parking, and occupied roof terrace area.~~
2. ~~The following buildings are permitted to provide off-site renewable energy generation in accordance with Section CD101.4 in lieu of all or part of the on-site renewable energy generation capacity required by Section CD101.3.~~

   ~~2.1 Any *building* where more than 50 percent of roof area would be shaded from direct-beam sunlight by existing natural objects or by structures that are not part of the building for more than 2500 annual hours between 8:00 a.m. and 4:00 p.m.~~

   ~~2.2 Any *building* with gross conditioned floor area less than 1,000 square feet (93 m~~^{2}~~).~~

   ~~2.3 Any *building* whose primary roof slope is greater than 2 in 12.~~
3. ~~Alternate forms of renewable energy generation capacity are permitted where the annual energy generation is not less than that produced by the required solar capacity, and where annual energy generation is calculated using an *approved* methodology.~~
4. ~~All or part of the required renewable energy generation capacity is permitted to be replaced by other efficiency measures provided such measures will reduce the annual energy consumption of the *building* by an amount no less than that which would otherwise be produced annually by the required renewable energy capacity, as calculated using the total building performance compliance path in Section C407 and an approved calculation methodology for solar production.~~

~~**TABLE CD101.3 ON-SITE RENEWABLE ELECTRICITY**~~

~~Climate Zone~~	~~Capacity Factor~~
~~1A, 2B, 3B, 3C, 4B, and 5B~~	~~2.0 W/ft² (22 W/m²)~~
~~0A, 0B, 1B, 2A, 3A, and 6B~~	~~2.3 W/ft² (25 W/m²)~~
~~4A, 4C, 5A, 5C, 6A, 7, and 8~~	~~2.6 W/ft² (29 W/m²)~~

~~**CD101.4 Off-site renewable energy.** *Buildings* that qualify for one or more of the exceptions to Section CD101.3 and that do not have on-site renewable energy systems sufficiently sized to fully comply with Section CD101.3 shall procure off-site renewable energy in accordance with Sections CD101.4.1 through CD101.4.3. Such procured energy shall provide not less than the total annual required off-site renewable energy determined in accordance with Equation CD-4 and shall be provided in addition to any renewable energy provided to comply with Section C406.3.~~

~~**CD-3**~~

~~DEF = Renewable capacity deficit, in DC watts~~
~~REQ = Required on-site capacity in DC watts, from Equation CD-2~~
~~INSTL = Installed on-site capacity, in DC watts~~

~~**CD-4**~~

~~OFF = Off-site renewable energy to be procured, in kWh/year~~

~~**CD101.4.1 Off-site procurement.** The *building owner* shall procure and be credited for the total amount of off-site renewable energy required by Equation CD-4. Procured off-site renewable energy shall comply with the requirements applicable to not less than one of the following:~~

1. ~~*Community renewables energy facility.*~~
2. ~~*Financial renewable energy power purchase agreement.*~~
3. ~~*Physical renewable energy power purchase agreement.*~~
4. ~~*Direct ownership.*~~
5. ~~*Renewable Energy Investment Fund.*~~

~~**CD101.4.2 Off-site contract.** The renewable energy shall be delivered or credited to the building site under an energy contract with a duration of not less than 10 years. The contract shall be structured to survive a partial or full transfer of ownership of the building property. The total required off-site renewable energy shall be procured in equal installments over the duration of the off-site contract.~~

~~**CD101.4.3 Renewable energy certificate (REC) documentation.** The property *owner* or *owner's* authorized agent shall demonstrate that where RECs are associated with on-site and off-site renewable energy production required by Sections CD101.3 and CD101.4, the following criteria shall be met:~~

1. ~~The RECs shall be retained and retired by or on behalf of the property *owner* or tenant for a period of not less than 10 years or the duration of the contract in Section CD101.4.2, whichever is less;~~
2. ~~The RECs shall be created within a 12-month period of the use of the REC; and~~
3. ~~The RECs represent a generating asset constructed no more than 5 years before the issuance of the certificate of occupancy.~~

Reason:

- Appendix CD is an augmentation of Section 406 and therefore suffers the same problems from its *ad hoc* credit scheme. The new credit scheme proposed is *ad hoc* and not supported by transparent analysis. The cost of construction associated with the proposal is not supported by examples or analysis that justify the conclusion that the scheme would address the primary objectives of using the credit approach and tabular values in a building performance scheme. The level of detail within the credit tables suggests analytical rigor in developing the proposal, but this detail is not provided and as such cannot be critiqued to determine justification.
- A point related to the above is that when the U. S. Department of Energy (DOE) would go to fulfilling its statutory role to evaluate stringency of the resulting 2024 IECC relative to the 2021, this proposed credit scheme would simply fall into the category of "qualitative benefits" of the 2024 edition. The expansion of the "qualitative benefits" category of IECC outcomes would further pull DOE away from its statutory responsibility to assess stringency of new additions of the IECC and contrary to its statutory role.
- The new Section 406 language and addition of Appendix CD adds unnecessary clutter to an already overly complex range of simulated performance options
- No relationship of the scheme to prescriptive requirements is established by the proponent, likely developing inconsistencies in stringency across the IECC when prescriptive versus performance paths are considered.
- The role of DOE as proponent of this and associated code changes relating to the proposed credits exceeds DOE's legal authority granted under the Energy Policy and Conservation Act (EPCA) to support development of building code. Historically and lawfully, DOE's role in supporting building costs and standards has involved executing its specified legal responsibility to analysis energy code stringency for national adoption, support of analysis of proposals of other proponents during code cycles, participation in IECC code hearings to provide technical viewpoints and information to inform debate of the proposals of others, and other supporting activities. The emergence

of DOE as a formal proponent for IECC code changes over-reaches this historical role and lacks the support of the legislative role of DOE.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Since the proposed deletion of Appendix CD would eliminate requirements that themselves are insufficiently documented to either increase or decrease cost of construction, the proposed deletion would not change the cost of construction calculation.

Workgroup Recommendation

Proposal # 932

CED1-208-22

Proponents: Charles Eley, representing Architecture 2030 (charles@eley.com)

2024 International Energy Conservation Code [CE Project]

Update standard(s) as follows:

CD101.4.1 Off-site procurement. The *building owner* shall procure and be credited for the total amount of off-site renewable energy required by Equation CD-4. Procured off-site renewable energy shall comply with the requirements applicable to not less than one of the following:

1. *Community renewables energy facility*.
2. *Financial renewable energy power purchase agreement.*
3. *Physical renewable energy power purchase agreement.*
4. *Direct ownership.*
5. *Renewable Energy Investment Fund.*
6. *Green retail tariff*

Add new definition as follows:

GREEN RETAIL TARIFF. An electricity-rate structure qualified under applicable statutes or rules contracted by an electricity service provider to the *building project* owner to provide electricity generated with 100% *renewable energy resources.*

Reason: A green retail tariff is a special program offered by electric service providers (utilities) whereby they acquire 100% renewable energy to meet the electricity demands of a participating customer. The customer typically pays a premium in the range of one to two cents per kilowatt-hour (similar to participation in a community solar program). The delivered renewable energy is in addition to that required to meet applicable renewable portfolio standards and the RECs associated with the renewable energy are retired on behalf of the participating customer (as required by C405.15.3).
Section C405.15.2.2 would apply to green retail tariffs as it does to all off-site procurement options. A contract is required: (1) with a duration of at least 10 years, (2) that is structured to survive a transfer of ownership, and (3) and that acquires renewable energy in concert with energy consumption.

Retail green pricing is the most common method for procuring off-site renewable energy and the only option available to many building owners/managers. This is the option most widely used in Boston, San Francisco and other cities where the purchase of off-site renewable energy is already required for some building types and sizes.

Off-site renewable energy purchases are recognized in three places in the standard and this code change proposal strives to make the methods more consistent in section C405.15, Appendix CC and Appendix CD.

Not including this option will limit the ability of building owners to purchase off-site renewable energy and undermine the effectiveness of the Glide Path.

Cost Impact: The code change proposal will increase the cost of construction.
Increasing the number of options will create more competition and reduce compliance cost.

Workgroup Recommendation

Proposal # 702

CED1-209-22

IECC: C409.6.1.4.1

Proponents: Aaron Phillips, representing Asphalt Roofing Manufacturers Association (aphillips@asphaltroofing.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C409.6.1.4.1 Roofs. Roofs will be modeled with insulation above a steel roof deck. The roof U-factor and area shall be modeled as in the proposed design. If different roof thermal properties are present in a single block, an area weighted U-factor shall be used. Roof solar absorptance shall be modeled at 0.75 ~~0.70~~ and emittance at 0.90.

Exception: For Climate Zones 0, 1, 2, and 3, solar absorptance and emittance shall be as specified in Section C402.4 and Table C402.4.

Reason: Roof solar absorptance in section C409.6.1.4.1 is adjusted from 0.70 to 0.75 to align with the roof solar absorptance of the Standard Reference Design in the Simulated Building Performance provisions as shown in Table C407.4.1(1). The exception recognizes new provisions in Table C407.4.1(1) that are specific to Climate Zones 0, 1, 2, and 3. By reference to Section C402.4, those new provisions require solar reflectance of 0.55 (solar absorptance of 0.45) and thermal emittance of 0.75 for Climate Zones 0 to 3. In communications during the initial phase of deliberations, the proponents of CEPI-76 (which added section C409.6.1.4.1) indicated their intention was to have the HVAC Total System Performance Ratio standard design roof solar absorptance match the value in C407. Acceptance of this minor modification will establish equivalent parameters between C407 and C409.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
The proposed change creates consistency between different options. It is not expected to increase or decrease the cost of construction because parity between alternatives is the intent.

CEPC1-1-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

C402.7 Thermal bridges in above-grade walls. Thermal bridges in above-grade walls shall comply with the section or an approved design.
Exceptions:

1. *Buildings* and structures located in Climate Zones 0 through 3.
2. Any *thermal bridge* with a material thermal conductivity not greater than 3.0 Btu/h-ft-°F.
3. Blocking, coping, flashing, and other similar materials for attachment of roof coverings.
4. *Thermal bridges* accounted for in the *U*-factor or *C*-factor for a *building thermal envelope*.

Reason: The requirements for overall assembly insulation have been well addressed in the 2021 IECC. However, the 2021 IECC does little to address the issue of thermal bridges, which can have an oversized impact on the performance of the thermal envelope and thus a building's energy use. Thermal bridging can reduce the thermal performance of the opaque building envelope by between 20-70%. Non-thermally broken cladding attachments can degrade the thermal performance of opaque panel assemblies by 50%. [1] The proposed addition of thermal bridging requirements to the 2024 IECC is therefore crucial to improving the performance of buildings and ensuring the energy code can eventually achieve net-zero performance to meet climate goals.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No changes are proposed.

Bibliography: [1] BC Housing, Thermal Bridging Guide, Version 1.5, 2020, https://www.bchousing.org/research-centre/library/residential-design-construction/building-envelope-thermal-bridging-guide

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/815/1671/files/download/367/

Workgroup Recommendation

Proposal # 815

CEPC1-2-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

C404.10 Demand responsive water heating. Electric storage water heaters with a rated water storage volume of 40 gallons (150L) to 120 gallons (450L) and a nameplate input rating equal to or less than 12kW shall be provided with demand responsive controls in accordance with Table C404.10 or another equivalent approved standard.
Exceptions:

1. Water heaters that provide a hot water delivery temperature of 180°F (82°C) or greater.
2. Water heaters that comply with Section IV, Part HLW or Section X of the ASME Boiler and Pressure Vessel Code.
3. Water heaters that use 3-phase electric power.

Reason: Demand responsive water heating controls can signal water heaters to heat water when renewable energy generation is high and energy prices are low. As electricity systems transform to include more variable renewable energy, from 20% of electricity supply in 2020 to an estimated 67% by 2035 due to the passage of the Inflation Reduction Act, demand flexibility is increasingly critical to both grid operation and further transformation. [1] The provisions in the 2024 IECC that require demand responsive controls for electric water heaters are one of the most cost effective methods to deliver substantial reliable energy flexibility. Water heaters that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend. Requiring buildings to have demand responsive water heating controls is an important requirement in the 2024 IECC.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No changes are proposed.

Bibliography: [1] Seiple, Chris. “US Inflation Reduction Act set to make climate history.” Wood Mackenzie. 19 Aug. 2022, https://www.woodmac.com/news/opinion/us-inflation-reduction-act-set-to-make-climate-history/

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/814/1679/files/download/363/

Workgroup Recommendation

Proposal # 814

CEPC1-3-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

C405.13 Energy monitoring. Buildings shall be equipped to measure, monitor, record and report energy consumption data in compliance with Sections C405.13.1 through C405.13.5.A plan for quantifying annual energy type and use disclosure in compliance with Sections C405.13.1 through C405.13.8 shall be submitted with the construction documents. **Exceptions:**

1. *Buildings* less than 10,000 square feet (929 m^2).
2. Existing buildings
3. R-2 occupancies with less than 10,000 square feet (929 m^2) of *common area*.
4. Individual tenant spaces less than 5,000 square feet (464.5 m^2) with their own utility service and meter.

Reason: There are currently over 40 benchmarking regulations across the U.S. (38 local jurisdictions and four states) – with size thresholds as low as 10,000 sf. These regulations require the reporting of energy use and are being used as a steppingstone toward regulation of building performance – either through audit and retro-commissioning requirements or building performance standards. The proposed requirement in the 2024 IECC which ensures that buildings are equipped to comply with these policies is a critical function of the code.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This proposal does not suggest any change to the requirement.

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/817/1678/files/download/370/

Workgroup Recommendation

Proposal # 817

CEPC1-4-22

Proponents: Payam Bozorgchami, representing California Energy Commission (payam.bozorgchami@energy.ca.gov)

2024 International Energy Conservation Code [CE Project]

C405.14 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with electric vehicle power transfer infrastructure in compliance with Sections C405.14.1 through C405.14.6.

Reason: I support this section as transportation sector is one of the larger sources of GHG Emissions in the nation and with the rapidly growing electric vehicle market, it only makes sense to support the requirement to accommodation of electric vehicle spaces in parking facilities during construction of the facility. The upfront cost of installing the Electric vehicle infrastructure is reasonable for newly constricted facility while is can be cost prohibitive to upgrade an existing parking facility.

Cost Impact: The code change proposal will increase the cost of construction.
It is cheaper to have it done now vs. later.

Bibliography: Common Fact

Workgroup Recommendation

Proposal # 769

CEPC1-5-22

Proponents: David Hochschild, representing California Energy Commission

2024 International Energy Conservation Code [CE Project]

C405.14 Electric Vehicle Power Transfer Infrastructure. New parking facilities shall be provided with electric vehicle power transfer infrastructure in compliance with Sections C405.14.1 through C405.14.6.

Reason: I support the proposed requirements. The ever growing announcements from major passenger vehicle manufacturers and the recently passed incentives from the Inflation Reduction Act make it clear the US is headed to a mostly electrified future. The requirement to accommodation electric vehicle spaces in parking facilities during construction of the facility is smart policy that will add a critical amenity that otherwise would cost many folds more in retrofit.

Cost Impact: The code change proposal will increase the cost of construction.
See Reason

Bibliography: See Reason

Workgroup Recommendation

Proposal # 784

CEPC1-6-22

Proponents: Noelani Derrickson, representing Tesla (nderrickson@tesla.com); Rick Tempchin, representing Alliance for Transportation Electrification (rick@evtransportationalliance.org); Emily Kelly, representing ChargePoint (emily.kelly@chargepoint.com); Steven Douglas, representing Alliance for Automotive Innovation (sdouglas@autosinnovate.org); Steven Rosenstock, representing Edison Electric Institute (srosenstock@eei.org)

2024 International Energy Conservation Code [CE Project]

Revise as follows:

C405.14.5.1 Circuit Capacity Management. The capacity of each branch circuit serving multiple EVSE spaces, EV ready spaces or EV capable spaces designed to be controlled by an energy management system providing load management in accordance with NFPA 70, shall comply with one of the following:

1. Have a minimum capacity of 4.1 kVA per space.
2. Have a minimum capacity of 2.7 kVA per space when serving EV ready spaces or EVSE spaces for a building site when all (100%) of the automobile parking spaces are designed to be EV ready or EVSE spaces.

Reason: CECPI-1-21 C405.14.5.1 subsection 2 provides an option for R-2 occupancies to reduce the minimum required kVA when 100% of the automobile parking spaces are designated as EV ready or EVSE spaces. Subsection 2 should be removed as it is duplicative of subsection 3, which provides the same allowance for all occupancy types. Additionally, the proponents provide the below reasons in support of CECPI-1-21 C405.14.1 through C405.14.6 in the 2024 IECC.

Electric Vehicle Transition

The transition to electric vehicles (EV) is accelerating and inevitable. President Biden's Executive Order 14037 set a target that 50% of all new vehicle sales will be EVs by 2030 [1], and California adopted legally binding requirements that 68% of all new vehicle sales are EVs by 2030 [2]. Achieving these targets and requirements would result in 50 to 80 million EVs on the road by 2035. Conservative forecasts suggest that by 2030 10% of passenger vehicles on the road will be electric [3], with others projecting closer to 50% by 2050 [4], well within the lifetime of buildings constructed to the IECC. Unlike combustion engine vehicles, most electric vehicle refueling (i.e., "charging") will occur where the vehicle is parked for many hours at a time. Most commonly EV charging will occur at home, in the workplace, or in commercial centers. Importantly, all buildings with parking will require EV charging in some form, either to support vehicle charging for residents, employees, or customers. However, buildings that have not been properly future proofed with adequate EV charging infrastructure will face much greater renovation costs than new construction featuring such future proofing.

Code Standardization

Several states and numerous local jurisdictions have already adopted codes to require make ready infrastructure in new buildings to prepare for electric vehicle charging (CA, OR, WA, CO, NJ, MD, Chicago, Atlanta, Miami). The definitions and requirements can vary, often lacking specificity for each occupancy type or alignment with National Electrical Code (NEC). This inconsistency can result in varied code requirements even within the same county, making it challenging for builders and building code officials. CECPI-1-21 provides standardized code language, robustly developed by code specialists, with definitions consistent with the NEC and technical requirements which align with vehicle charging needs and variation in occupancy type.

Locating Requirements in the Main Body of the Code

It is paramount that CECPI-1-21 be adopted in the main body of the IECC commercial code and not in the appendix. This will provide clarity to policy makers of the importance of including EV charging infrastructure in new construction. Moreover, many local governments are restricted from adopting an appendix if a state has elected not to adopt it. To ensure that the greatest number of state and local jurisdictions benefit from the structure, definitions, and requirements of CECPI-1-21, inclusion in the body of the IECC commercial code is paramount to its wide-spread effectiveness.

CECPI-1-21 was purposefully structured to enable states and local jurisdictions with lesser ambition to support EV adoption to easily amend the percentages of EV charging infrastructure required for their jurisdiction. It will be a simple matter for these jurisdictions to make edits to Table C405.14.1 to adjust the amount of parking for different occupancies that must feature EV charging infrastructure.

Variation Between Occupancy Type

Table C405.14.1 includes the required percentages for EV Power Transfer Infrastructure at each occupancy type. The variation between occupancy type reflects how common vehicle charging will be for residents, employees, and customers. For example, vehicle charging will be more common at Group B (offices), Group B (mercantile), and Group R (residential) occupancies where vehicles are parked for many hours at a time, and which include large parking structures based on occupancy structure. Groups F (industrial), Group S (storage), and Group U (utility), for example, will typically require less vehicle charging based on fewer parking stalls and occupancy usage outside of employees.

Multi-family Retrofits

This code proposal is most essential for R-2 occupancies, or large multi-family housing, where vehicles are parked overnight for many hours at a time and retrofitting existing parking spots to provide EV charging is complex and costly. Unlike residents of single-family homes, multi-family tenants are commonly renters without the authority to retrofit parking spaces to install charging equipment. When retrofitting to provide EV charging is possible, tenants and owners can face costs of 4-6 times higher than if done during new construction [5]. The ability to charge an EV overnight is additionally important for multifamily tenants who are rural, low-income, and in disadvantaged communities, who typically have longer commutes and drive older EVs with shorter ranges.

We support proposal CECPI-1-21 C405.14.1 through C405.14.6 and strongly recommend inclusion in the 2024 IECC Commercial Code.

Sincerely,

Tesla, Inc. is an American multinational automotive and clean energy company headquartered in Austin, Texas. Tesla designs and manufactures electric vehicles, battery energy storage from home to grid-scale, solar panels and solar roof tiles, and related products and services.

The Alliance for Automotive Innovation is a trade association representing car companies that produce about 97% of new cars and light trucks sold in the U.S. as well as original equipment suppliers, technology, and other automotive-related companies.

ChargePoint is creating a new fueling network to move people and goods on electricity. Since 2007, ChargePoint has been committed to making it easy for businesses and drivers to go electric with one of the largest EV charging networks and a comprehensive portfolio of charging solutions available today. The ChargePoint cloud-based subscription platform and software-defined charging hardware are designed to include options for every charging scenario from home and multifamily to workplace, parking, hospitality, retail and transport fleets of all types. Today, one ChargePoint account provides access to hundreds of thousands of places to charge in North America and Europe. To date, more than 133 million charging sessions have been delivered, with drivers plugging into the ChargePoint network on average every second.

The Alliance for Transportation Electrification is a nonprofit trade association uniting a broad coalition of electric utilities, automobile manufacturers, electric vehicle supply equipment vendors, engineering firms and others to promote electric vehicles in state-level policy across North America. As believers in the public benefits of electric transportation, our core mission is to educate and advocate, speeding the adoption of electric vehicles. We are inclusive, inviting a very wide range of stakeholders to the table, because experience teaches us that collective action is very necessary in this policy realm. Members share information widely to establish and refine best practices, and to educate policy makers. We also bring an international perspective gleaned from careful study of trends abroad.

The Edison Electric Institute (EEI) is the association that represents all U.S. investor-owned electric companies. Our members provide electricity for more than 235 million Americans, and operate in all 50 states and the District of Columbia. As a whole, the electric power industry supports more than 7 million jobs in communities across the United States. In addition to our U.S. members, EEI has more than 65 international electric companies as International Members, and hundreds of industry suppliers and related organizations as Associate Members.

The Smart Electric Power Alliance (SEPA) is dedicated to helping electric power stakeholders address the most pressing issues they encounter as they pursue the transformation to a carbon-free energy system. We are a trusted partner providing education, research, standards, and collaboration to help utilities, electric customers, and other industry players across three pathways: Regulatory and Business Innovation, Grid Integration, Electrification. Through educational activities, working groups, peer-to-peer engagements and custom projects, SEPA convenes interested parties to facilitate information exchange and knowledge transfer to offer the highest value for our members and partner organizations.

The Zero Emission Transportation Association (ZETA) is an industry-backed coalition of member companies spanning the entire EV supply chain. Together with our members, we advocate for 100% EV sales by 2030. We are committed to enacting policies that drive EV adoption, create hundreds of thousands of jobs, drastically improve public health, and significantly reduce carbon pollution.

The American Council for an Energy-Efficient Economy is a nonprofit research organization that develops transformative policies to reduce energy waste and combat climate change. With our independent analysis, we aim to build a vibrant and equitable economy – one that uses energy more productively, reduces costs, protects the environment, and promotes the health, safety, and well-being of everyone.

The Coastal Conservation League has worked since 1989 to protect the health of the natural resources of the South Carolina coastal plain and ensure a high quality of life for all of the people who live in and love this special place. The Coastal Conservation League is a 501(c)3 charitable organization.

The Electrification Coalition (EC) is a nonpartisan, not-for profit organization committed to promoting policies and actions that facilitate the deployment of electric vehicles on a mass scale in order to combat economic, environmental, and national security dangers caused by our dependence on oil.

The Southern Alliance for Clean Energy (SACE) is a nonprofit organization that promotes responsible and equitable energy choices to ensure clean, safe, and healthy communities throughout the Southeast. As a leading voice for energy policy in our region, SACE is a regional organization focused on transforming the way we produce and consume energy in the Southeast.

Rocky Mountain Institute (RMI) is an independent non-profit organization of experts working to accelerate the clean energy transition. RMI's mission is to transform the global energy system to secure a clean, prosperous, zero-carbon future for all. We work with businesses, policymakers, communities, and other organizations to identify and scale energy system interventions that will cut greenhouse gas emissions at least 50% by 2030.

Advanced Energy Economy (AEE) is a national association of businesses that are making the energy we use secure, clean, and affordable. We work to accelerate the move to 100% clean energy and electrified transportation in the U.S. AEE represents more than 100 companies in the $238 billion U.S. advanced energy industry, which employs 3.2 million U.S. workers. We educate, engage, and advocate in more than a dozen states, in wholesale electricity markets, and at the federal level, for executive actions, legislation, and regulations that expand the size and value of markets for advanced energy products and service. We also offer business intelligence products and select business development opportunities to help advanced energy companies grow.

The Sierra Club is America's largest and most influential grassroots environmental organization, with millions of members and supporters. In addition to protecting every person's right to get outdoors and access the healing power of nature, the Sierra Club works to promote clean energy, safeguard the health of our communities, protect wildlife, and preserve our remaining wild places through grassroots activism, public education, lobbying, and legal action.

The Midwest Energy Efficiency Alliance (MEEA) is a collaborative network, promoting energy efficiency to optimize energy generation, reduce consumption, create jobs and decrease carbon emissions in all Midwest communities. MEEA seeks an achievable pathway for all people and communities in the Midwest to receive the economic, environmental and societal benefits of energy efficiency and the larger clean energy economy. MEEA oversees a 13-state region including Ohio, Kentucky, Michigan, Indiana, Illinois, Missouri, Wisconsin, Minnesota, Iowa, North Dakota, South Dakota, Nebraska and Kansas.

Sven Thesen & Associates is a boutique electric vehicle consulting firm focusing on EV charging policy.

Project Green Home is one of the nation's first beyond LEED Platinum, Zero Net-Energy, Passive House. It is an electric vehicle and electrification education center and has been toured by over 4,000 people since 2010. It has the nation's first residential curbside charger and has provided over 250,000 free miles of EV driving to the public.

DTE Energy (DTE) is a Detroit-based diversified energy company involved in the development and management of energy-related businesses and services nationwide. Its operating units include an electric company serving 2.2 million customers in Southeast Michigan and a natural gas company serving 1.3 million customers in Michigan. The DTE portfolio includes energy businesses focused on power and industrial projects, renewable natural gas, and energy marketing and trading. As an environmental leader, DTE utility operations will reduce carbon dioxide and methane emissions by more than 80% by 2040 to produce cleaner energy while keeping it safe, reliable and affordable. DTE Electric and Gas aspire to achieve net zero carbon and greenhouse gas emissions by 2050. DTE is committed to serving with its energy through volunteerism, education and employment initiatives, philanthropy and economic progress.

The Michigan Energy Innovation Business Council (Michigan EIBC) is a business trade association representing approximately 150 advanced energy companies doing business in Michigan. Michigan EIBC's mission is to grow Michigan's advanced energy economy by fostering opportunities for innovation and business growth and offering a unified voice in creating a business-friendly environment for the advanced energy industry in Michigan. Michigan EIBC serves the objectives of our member companies by strengthening Michigan's network of advanced energy businesses, engaging the public and policymakers around policy and regulatory initiatives, creating partnerships to expand business opportunities, and advancing energy innovation.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.

Bibliography:

1. https://www.whitehouse.gov/briefing-room/presidential-actions/2021/08/05/executive-order-on-strengthening-american-leadership-in-clean-cars-and-trucks/

2. https://ww2.arb.ca.gov/news/california-moves-accelerate-100-new-zero-emission-vehicle-sales-2035

3. https://www.eei.org/-/media/Project/EEI/Documents/Issues-and-Policy/Electric-Transportation/EV-Forecast--Infrastructure-Report.pdf

4. https://graphics.reuters.com/AUTOS-ELECTRIC/USA/mopanyqxwva/

5. https://caletc.aodesignsolutions.com/assets/files/CALGreen-2019-Supplement-Cost-Analysis-Final-1.pdf

CEPC8

Workgroup Recommendation

Proposal # 682

CEPC1-7-22

Proponents: Payam Bozorgchami, representing California Energy Commission (payam.bozorgchami@energy.ca.gov)

2024 International Energy Conservation Code [CE Project]

C405.15 Renewable energy systems. *Buildings* in Climate Zones 0-7 shall comply with C405.15.1 through C405.15.4

Reason: I support the proposed renewable energy system requirement. As states are transitioning away from fossil fuel combustion in favor of renewable energy generation. The single largest element of this transition to-date is the use of solar photovoltaic technology for electricity generation, both at the grid level and installed as an on-site component of new and existing buildings.
Use of photovoltaics for electricity generation provides recognized benefits in avoiding the carbon dioxide and criteria pollutant emissions that result from fossil fuel combustion. Locating some fraction of this generation on-site has several additional advantages: moving the generation of electricity closer to its point of use avoids transportation losses and installing equipment that allows a building to meet some of its own energy needs reduces the demand and associated stress it adds to energy grid. Lastly, on-site equipment can be configured to continue providing power to the building during a grid outage, reducing or eliminating the impacts of both planned and unplanned outages.

Cost Impact: The code change proposal will increase the cost of construction.
The equipment costs are low after a decade of solid decline, and remain affordable

Bibliography: N/A

Workgroup Recommendation

Proposal # 771

CEPC1-8-22

Proponents: Shannon Corcoran, representing American Gas Association

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

<u>101</u>
<u>New Code Section</u>

<u>101.1</u>
<u>New Code Section</u>

Reason: During IECC Consensus Committee Meetings, proposals to include electric-ready provisions in the base of the code and all-electric buildings did not reach the 2/3's required majority. AGA supports the action of the Consensus Committee.
The IECC codes, both residential and commercial, should be fuel neutral and provide energy savings from all appliances that meet technical availability and economic justification to ensure a consumer's right to choose their energy source.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Maintaining fuel neutrality in the code does not increase or decrease the cost of construction.

Workgroup Recommendation

Proposal # 773

CEPC1-9-22

Proponents: David Hochschild, representing California Energy Commission (ken.rider@energy.ca.gov)

2024 International Energy Conservation Code [CE Project]

C405.15 Renewable energy systems. *Buildings* in Climate Zones 0-7 shall comply with C405.15.1 through C405.15.4

Reason: I support the proposed renewable energy system requirement. Distributed photovoltaics, particularly in new construction, provide both economic and environmental benefit, particularly in reduction of GHG emissions. The equipment costs are low after a decade of solid decline, and remain affordable even with global supply chain concerns. With the recent long-term extension of the Solar Investment Tax Credit it is clear these costs will remain inexpensive. Incorporation of solar has shown to increase property value as well as improve time on the market.
States are transitioning away from fossil fuel combustion in favor of renewable energy generation. However, the scale of new projects needed to meet these goals is vast and photovoltaics in new construction can form a major component of it, as it has in California. Locating some fraction of this generation on-site has several additional advantages: moving the generation of electricity closer to its point of use avoids transmission losses and installing equipment that allows a building to meet some of its own energy needs reduces the demand and associated stress it adds to energy grid. Lastly, on-site equipment can be configured to continue providing power to the building during a grid outage, reducing or eliminating the impacts of both planned and unplanned outages.

Cost Impact: The code change proposal will increase the cost of construction.
See Reasons

Workgroup Recommendation

Proposal # 786

CEPC1-10-22

Proponents: Payam Bozorgchami, representing California Energy Commission (payam.bozorgchami@energy.ca.gov)

2024 International Energy Conservation Code [CE Project]

C405.16 Electrical energy storage system. *Buildings* shall comply with the one of C405.16.1 or C405.16.2.

Reason: support the electrical energy storage system. Energy storage systems have become a popular complement to PV systems in commercial buildings. The key benefits of on-site storage are the ability to limit exports to the grid from on-site PV generation, reduce demand and energy use during peak periods, and improve resilience by providing backup power during grid outages.
A properly sized energy storage system can have enough storage to sustain multiple building end-uses for a few hours. This is an important potential benefit that is not directly factored into the cost-effectiveness analysis. These storage systems have the potential to continue operating several building systems, such as building exterior and interior lighting and ventilation, especially during power outages such as the Public Safety Power Shutoffs (PSPS) like the ones instituted during wildfire season in California.

Cost Impact: The code change proposal will increase the cost of construction.
See Reason

Bibliography: See Reason

Workgroup Recommendation

Proposal # 772

CEPC1-11-22

Proponents: David Hochschild, representing California Energy Commission (ken.rider@energy.ca.gov)

2024 International Energy Conservation Code [CE Project]

C405.16 Electrical energy storage system. *Buildings* shall comply with the one of C405.16.1 or C405.16.2.

Reason: I support the electrical energy storage system provisions. Energy storage systems have become a popular complement to PV systems in commercial buildings. The key benefits of on-site storage are the ability to limit exports to the grid from on-site PV generation, reduce demand and energy use during peak periods, and improve resilience by providing backup power during grid outages. The ability to shed load or serve on-site load when the grid is abnormal is an important potential benefit that is not directly factored into the cost-effectiveness analysis. The systems, even if not paired with PV, can also be used to take advantage of excess renewable generation or times when access to electricity is very inexpensive.

Cost Impact: The code change proposal will increase the cost of construction.
See Reasons

Bibliography: See Reasons

Workgroup Recommendation

Proposal # 787

CEPC1-12-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

C409.1 Purpose. Section 409 establishes criteria for demonstrating compliance with the requirements of C403.1.1, HVAC total system performance ratio (HVAC TSPR)

Reason: This proposed addition of HVAC Total System Performance Ratio (TSPR) in Section C409 to the 2024 IECC is an important tool for the energy code to continue to drive the energy performance of commercial buildings and help communities meet their climate goals. The addition of the TSPR metric, which evaluates overall system efficiency instead of individual component efficiency, allows one to incentivize buildings to install HVAC system types that can cost-effectively reduce the total energy consumption of a building. The additional stretch code option provided in the proposal will allow jurisdictions that want to cost-effectively meet their climate goals to take advantage of TSPR metric to mandate more efficient HVAC system choices in their energy code.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No changes are proposed.

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/816/1670/files/download/368/

Workgroup Recommendation

Proposal # 816

CEPC1-13-22

Proponents: Stacy Miller, representing City of Minneapolis (stacy.miller@minneapolismn.gov)

2024 International Energy Conservation Code [CE Project]

C401.1 Scope. The provisions in this chapter are applicable to commercial *buildings* and their *building sites*.

Reason: October 21, 2022
Commercial Consensus Committee Members

International Code Council

500 New Jersey Avenue, NW, 6th Floor

Washington, DC 20001

Re: Public Comment Draft #1 of the IECC-Commercial Code

Dear Commercial Consensus Committee Members:

The City of Minneapolis thanks the Commercial Consensus Committee ("Committee") for developing the draft Commercial 2024 International Energy Conservation Code (IECC-C).

The City of Minneapolis has municipal goals for greenhouse gas reductions consistent with the Paris Agreement and is committed to doing our share to mitigate climate change. However, we are constrained by the IECC-based Minnesota Energy Code, which local government requirements may not exceed. It is imperative that the final 2024 IECC-C result in high-performing and affordable buildings and multifamily homes.

The Minneapolis Sustainability Division joined their peers in the Community Planning and Economic Development Department in becoming members of ICC in 2019 because modern, climate-responsive energy codes are a health and safety priority. While the IECC development has been moved to a committee process, we maintain our ICC membership to support the organization's mission to protect people, including protection from climate change.

The advances proposed in Public Comment Draft #1 will help align the 2024 code with federal, state, and local energy and climate policy goals. **Specifically, we commend the Committee for the inclusion of renewable energy requirements, energy storage-readiness, electric vehicle charging requirements, HVAC total system performance ratio, thermal bridging requirements, and energy monitoring in Draft #1.** We ask that future drafts preserve these measures that will enhance building comfort and performance, reduce operating costs and help all levels of government achieve climate, health, and safety goals that are necessary to protect the people we serve.

We also support requiring existing buildings undergoing major renovations to meet the standards proposed in the 2024 IECC-C as a reasonable time to make energy and resiliency improvements to existing buildings in a cost-effective manner.

The City of Minneapolis appreciates the energy monitoring requirements proposed will assist Minneapolis's commercial building owners with reporting requirements for the city's commercial benchmarking ordinance.

However, we are concerned that the draft IECC-C 2024 does not yet address the following priorities and ask that they be included in the next version:

· Electric-ready requirements and an all-electric Appendix

Thoughtfully integrating electric infrastructure and heating into new construction can drive down energy costs, reduce greenhouse gas emissions, and future-proof buildings.

· Reflective roof requirements for Climate Zones 4, 5, and cities in Zone 6.

White roofs are an easy way to improve resiliency and reduce urban heat island impacts from dark roofs while reducing the costs to operate them.

- Firm building envelope requirements.

The IECC-C must preserve the enhanced building envelope requirements. Retrofitting at the time of construction is a cost-effective, no-regrets value that will save generations of occupants money and avoid expensive retrofitting in the future. This must not be a tradeoff when considering building performance standards as it is a health and safety priority.

- Improved multi-family performance and efficiency requirements for four+ unit housing.

The City of Minneapolis has thousands of multifamily housing (MFH) units constructed every year. It is imperative that residents of MFH not be left out of the benefits that come with living in efficient, high-performing buildings. Differences between the requirements for three- and four-story MFHs are unnecessary and inequitable as it leads to residents paying more while feeling less comfortable in their homes. Further, substandard requirements unnecessarily jeopardize the health and safety of our residents.

Thank you for the opportunity to comment on the Commercial 2024 International Energy Conservation Code and for your consideration of our comments. We are available for questions should the Committee wish to discuss any of our recommendations further.

Sincerely,

Ken Staloch

Building Official

City of Minneapolis

Kenneth.Staloch@minneapolismn.gov

Kim W. Havey, AICP, LEED AP

Director, Division of Sustainability

City of Minneapolis

kim.havey@minneapolismn.gov

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
This will not increase costs.

Workgroup Recommendation

Proposal # 915

CEPC1-14-22

Proponents: Renee Lani, representing American Public Gas Association (rlani@apga.org)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

A
New Appendix

Reason: During the IECC-C consensus committee meetings, proposals to include electric-ready provisions in the base of the code, as well as all-electric buildings, were discussed at length. However, neither reached the necessary 2/3 majority. APGA, which represents community-owned, not-for-profit pubic gas utilities, supports this outcome. Such provisions do not guarantee energy savings, nor GHG reductions, and sometimes may be counter to such efforts. The only guarantee, if any such provisions were included in the base code, would be increased cost for code compliance. Furthermore, we do not believe that such provisions would meet the necessary scope and intent of the IECC-C, as presented in C101.3 and further expounded on in the IECC Committee Procedures and other supporting documents, to be included in the base code.
All I-Codes, including the IECC-C, should be fuel neutral and provide energy savings from all appliances that meet technical availability and economic justification to ensure a consumer's right to choose their energy source.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
Because the provisions were not included in the code, a decision APGA supports, there is no cost impact.

Workgroup Recommendation

Proposal # 936

CEPC1-15-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

TABLE C405.13.2 ELECTRICAL ENERGY USE CATEGORIES

Reason: In 2022, the electric vehicles market grew by over 60%, making up almost 5 percent of vehicle purchases. [1] The passage of the Inflation Reduction Act, which reduces the price of electric vehicles by up to $7,500 and new regulations in California that plan to ban the sale of gas-powered vehicles by 2035, will further transform the auto-industry in the U.S. As electric vehicle charging infrastructure becomes more common place to match the growing demand for electric vehicles, the electricity supplied to these chargers will increase the overall energy use of buildings when compared to similar buildings without charging infrastructure. Combined with new regulations from jurisdictions on benchmarking and building performance, it is important that owners know and understand the energy use of electric vehicle charging infrastructure separate from the base building uses. It is far more cost-effective to submeter these loads during new construction than to try to isolate them and add additional submeters as part of a retrofit. The provisions proposed to require monitoring of electric vehicles in the 2024 IECC will help owners cost effectively manage their building's energy use and meet current or future benchmarking and building performance standards requirements, as well as future-proof buildings for the electric vehicle charging infrastructure needs of the evolving transportation sector.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
No changes are proposed.

Bibliography: [1] Blanco, Sebastian. Electric Cars' Turning Point May Be Happening as U.S. Sales Numbers Start Climb. Car and Driver, 7 Sept. 2022, https://www.caranddriver.com/news/a39998609/electric-car-sales-usa/.

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/818/1676/files/download/371/

Workgroup Recommendation

Proposal # 818

CEPC1-16-22

Proponents: Ingrid Malmgren, representing Plug In America (imalmgren@pluginamerica.org)

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

1
New Chapter

Reason:
The electric vehicle market is growing rapidly. Recent passage of the Infrastructure, Investment and Jobs Act and the Inflation Reduction Act created $100 billion of funds to support electric vehicle technology and infrastructure buildout. EVs have lower fueling, maintenance, and operation costs and should be available for all drivers.

Building codes can be a powerful mechanism to expand equity. Charging at home is the safest, most reliable, and least expensive way to power an electric vehicle. The ability to charge at home and pay the utility directly is key to ensuring that residents of multifamily housing have access to the same infrastructure at the same cost as residents of single family homes. This will expand access to the benefits of electric vehicles, lower drivers' operational costs, reduce maintenance, and ensure better performance, to all.

Cost Impact: The code change proposal will increase the cost of construction.
This proposal will slightly impact the cost of construction, but result in more equitable EV infrastructure, thus reducing public health costs associated with climate change and air pollution.

Attached Files

- **2022.10.20 Letter re. IECC 2024 code.pdf**
  https://energy.cdpaccess.com/proposal/910/1763/files/download/402/

Workgroup Recommendation

Proposal # 910

CEPC1-17-22

Proponents: Jenny Hernandez, representing Las Cruces Sustainability

2024 International Energy Conservation Code [CE Project]

Add new text as follows:

APPENDIX CG
ALL-ELECTRIC COMMERCIAL BUILDING PROVISIONS

SECTION CG 101 GENERAL . Intent. The intent of this Appendix is to amend the International Energy Conservation code to reduce greenhouse gas emissions from buildings and improve the safety and health for commercial building occupants by requiring new all-electric buildings and efficient electrification of existing buildings.

Reason: The City of Las Cruces Sustainability Office is writing this letter in support of New Building Institutes proposals to add an all-electric appendix and its proposal for electric ready requirement. The inclusion of such language is critical for meeting the nations climate goals in greenhouse gas emissions. The City of Las Cruces is making it’s own efforts to transition to clean energy however, cities across the nation including ourselves would have more success in passing such codes if it’s adopted into the standardized codes that states adopt. This means that on a local level we can begin transitioning our infrastructure to be resilient and ready to meet the needs of our constantly changing climate. These codes ensure that our buildings can seamlessly transition when appropriate in a cost-effective way and gives autonomy to our community to decided what kind of energy they prefer to use for the places they live, work, and play. We believe that these revisions support the direction that the nation is heading. There is also a unique once in a lifetime opportunity for the all-electric appendix to be incentivized by the federal governments IRA. Parallel efforts for both of these can have tremendous outcomes in our nations success towards fighting climate change.

Cost Impact: The code change proposal will decrease the cost of construction.
This is in support of New Buildings Institutes comments for inclusion of an all-electric appendix

Attached Files

- **City of Las Cruces Letter of Support NBI Codes.pdf**
  https://energy.cdpaccess.com/proposal/883/1662/files/download/388/

Workgroup Recommendation

Proposal # 883

CEPC1-18-22

Proponents: Diana Burk, representing New Buildings Institute (diana@newbuildings.org)

2024 International Energy Conservation Code [CE Project]

C403.4.6 Demand responsive controls. Buildings shall be provided with demand responsive controls capable of executing the following actions in response to a demand response signal:

1. Automatically increasing the zone operating cooling set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).
2. Automatically decreasing the zone operating heating set point by the following values: 1°F (0.5°C), 2°F (1°C), 3°F (1.5°C), and 4°F (2°C).

Where a demand response signal is not available the heating and cooling system controls shall be capable of performing all other functions. Where thermostats are controlled by direct digital control including, but not limited to, an energy management system, the system shall be capable of demand responsive control and capable of adjusting all thermal set-points to comply. The demand responsive controls shall comply with either Section C403.4.6.1 or Section C403.4.6.2

Exceptions:

1. Group I occupancies
2. Group H occupancies
3. Controls serving data center systems
4. Occupancies or applications requiring precision in indoor temperature control as approved by the code official
5. Controls that serve only fossil fuel equipment

Reason: Heating, ventilation, and air conditioning (HVAC) system control allows for dialing back heating and cooling, as well as accepting additional heating or cooling when renewable energy generation is high or energy prices are low. This is often done through thermostats, and has been at the center of demand response (DR) programs for decades. DR programs continue to rely deeply on thermostat control strategies, but the need for such controls is fast growing. As electricity systems transform to include more variable renewable energy, from 20% of electricity supply in 2020 to an estimated 67% by 2035 due to the passage of the Inflation Reduction Act, demand flexibility is increasingly critical to both grid operation and further transformation. [1] Building systems that can use energy when it is abundant, clean, and low-cost not only help decarbonize the entire energy system, they also insulate their owners from future increases in demand charges and peak hour energy rates – a current and accelerating trend. Requiring buildings to have grid integrated HVAC controls is therefore an important requirement in the 2024 IECC.
Attached is a letter stating support for this proposal from 40 organizations, 9 of which are from local or state governments and universities, 11 of which are from NGOs, and 20 of which are from design and construction industry.

Cost Impact: The code change proposal will neither increase nor decrease the cost of construction.
We are proposing no changes.

Bibliography: [1] Seiple, Chris. “US Inflation Reduction Act set to make climate history.” Wood Mackenzie. 19 Aug. 2022, https://www.woodmac.com/news/opinion/us-inflation-reduction-act-set-to-make-climate-history/

Attached Files

- **NBI Sign On Letter Commercial 2024 IECC.pdf**
  https://energy.cdpaccess.com/proposal/813/1675/files/download/362/

Workgroup Recommendation

Proposal # 813

CEPC1-19-22

Proponents: Scott Fenwick, representing Clean Fuels Alliance America (sfenwick@cleanfuels.org)

2024 International Energy Conservation Code [CE Project]

Add new definition as follows:

New Definition.

Reason: To harmonize with existing regulatory and legislative language, definitions and requirements.

Cost Impact: The code change proposal will decrease the cost of construction.
By allowing additional options, competition and currrent technologies will decrease costs.

Attached Files

- **Clean Fuels response to IECC.docx**
  https://energy.cdpaccess.com/proposal/837/1697/files/download/374/

Workgroup Recommendation

Proposal # 837
