ICC 2019 LAS VEGAS NEVADA

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2019 Annual Conference Educational Sessions

AHRI AIR-CONDITIONING, HEATING, & REFRIGERATION INSTITUTE

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Session: 2018 IgCC / ASHRAE

IgCC AND ASHRAE STANDARD 189.1 TECHNICAL PROVISIONS

Co-presented with ICC

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ASHRAE

College of Engineering
UNIVERSITY OF GEORGIA

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EDUCATION PARTNER

IgCC and ASHRAE Standard 189.1 Technical Provisions

By ASHRAE

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Course ID: 920019174

Approved for:

3

General CE hours

0

LEED-specific hours

- LEED GREEN ASSOCIATE ☐
- LEED AP BD+C ☐
- LEED AP HOMES ☐
- LEED AP ID+C ☐
- LEED AP ND ☐
- LEED AP O+M ☐

International Green Construction Code **and the ASHRAE Standard 189.1-2017**

ASHRAE, in conjunction with the U.S. Green Building Council and the Illuminating Engineers Society, developed a standard for high performance, green buildings (Standard 189.1) to providing a minimum set of requirements for a high-performance green building.

- Since the agreement with the International Code Council (ICC), this standard is now used as the technical basis for the *International Green Construction Code* (*IgCC*).
- This session provides a detailed look at the technical standard and its application to a building under the *IgCC*.

Learning Objectives

1. Recognize the importance of developing a code-intended standard for design of high-performance green buildings and how these standards can be applied in practice
2. Differentiate *Ig*CC and ASHRAE/ICC/USGBC/IES Standard 189.1 from green building certification systems (e.g., LEED, Green Globes)
3. Describe key requirements contained in the *Ig*CC and ASHRAE/ICC/USGBC/IES Standard 189.1 on the important topics of sites, water, energy, IEQ, and materials
4. Distinguish between the two compliance path options (Prescriptive and Performance), their associated provisions in the *Ig*CC, and how to apply them in a design
5. Describe the requirements for construction and plans for operating the building

Introduction

- Background(s) and introduction

- Questions are encouraged as we go…
  my job is to manage time

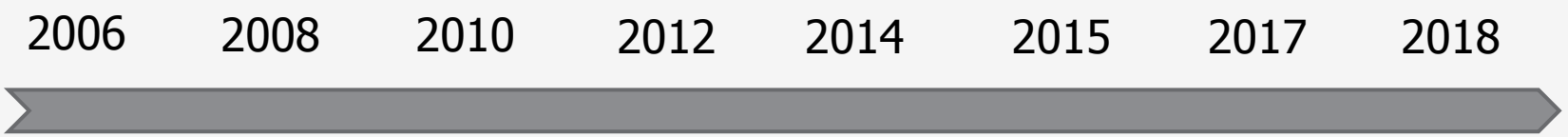
History and Convergence

Standard 189.1 for the Design of High-Performance Green Buildings

- 2006: work begun to create a standard that could be adopted into building codes.
- 2009: first edition released.
- 2011: edition released.
- 2014: ASHRAE and ICC reached agreement for joint development.
- 2017: edition released and submitted to ICC for technical content of the 2018 *Ig*CC.

International Green Construction Code (IgCC)

- 2009: work begun to create a green building code developed by and for local building officials.
- 2012: first edition released.
- 2014: ICC accepts 189.1 technical content for future edition.
- 2015: edition released.
- 2018 edition released with 189.1 technical content.

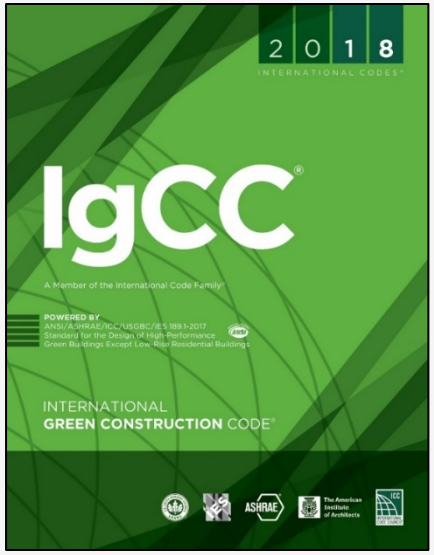


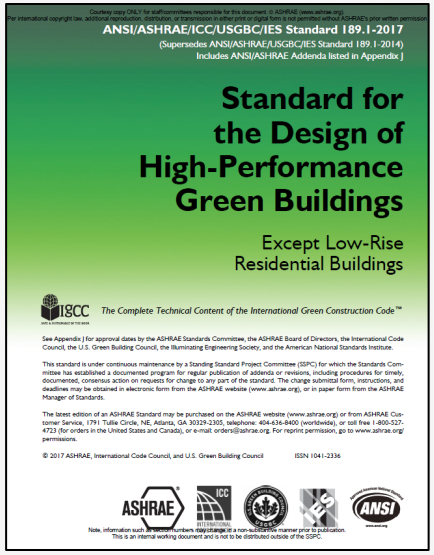
The New Arrangement

- According to the 2014 agreement between ICC and ASHRAE, the following is how the marketing of the code and standard will take place, effective 2018:
  - In the U.S. and Canada, ASHRAE will market the *IgCC* with ICC
  - Outside the U.S. and Canada, ASHRAE will still be allowed to publish and sell ASHRAE/ICC/USGBC/IES Standard 189.1. (Standard 189.1 is the technical basis of the *IgCC*)

*Ig*CC and Standard 189.1

- Optional compliance path ("Jurisdictional Compliance Option") to the 2015 *International Green Construction Code* (*Ig*CC)
- Standard 189.1 is the technical basis for the 2018 *Ig*CC (merged together)
- This talk focuses primarily on the technical basis of the *Ig*CC (Standard 189.1)





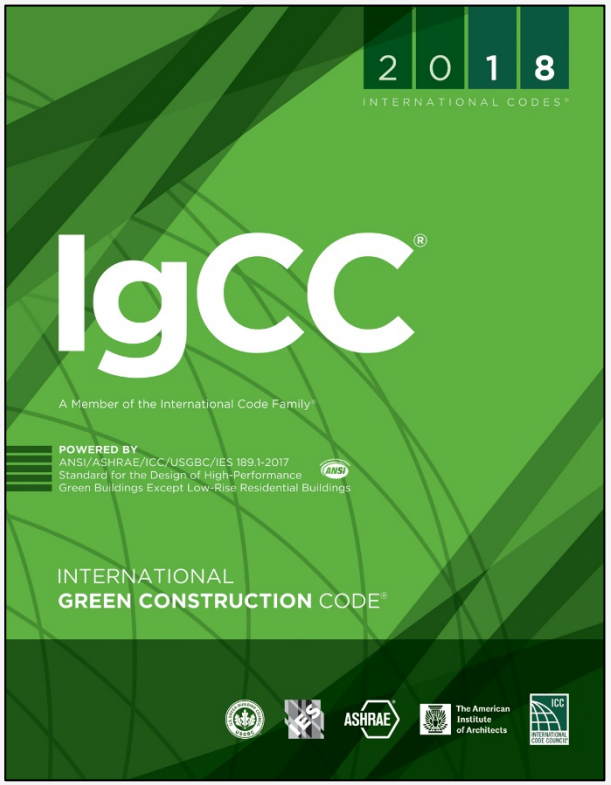
Sponsors and Project Committee

- Consensus process
- Sponsor and co-sponsors:
  - ASHRAE
  - ICC (International Code Council)
  - IES (Illuminating Engineering Society)
  - USGBC (U.S. Green Building Council)
- Project committee:
  35± voting members;
  variety of disciplines,
  industries, and organizations
- Industry and interested parties

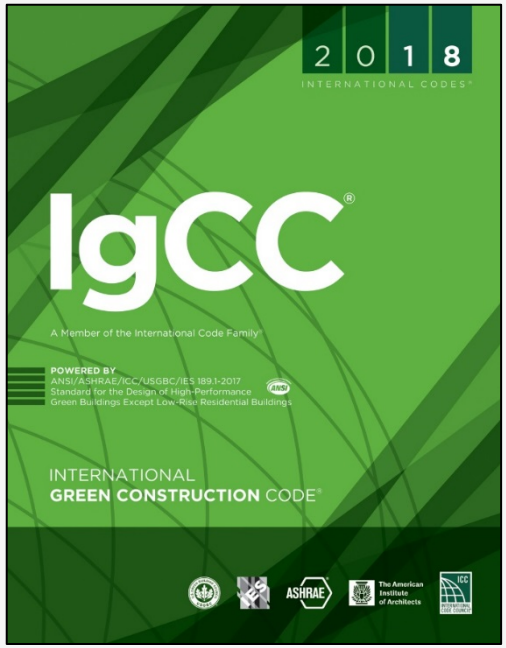
ADMINISTRATIVE PORTIONS OF THE *Ig*CC

The Administrative Portions of the *IgCC*

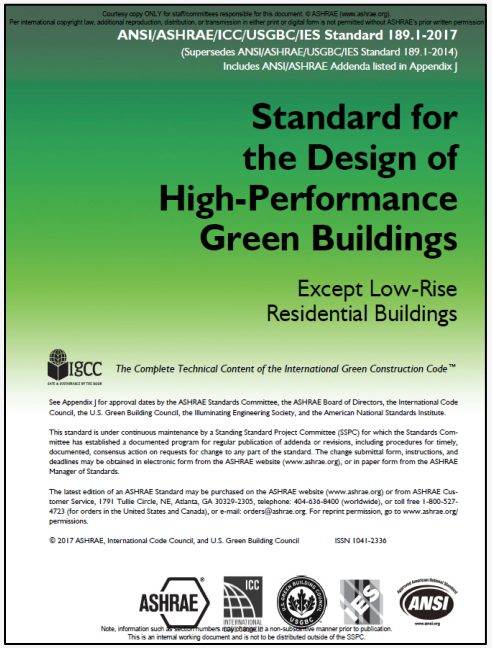
- The official 2018 version of the *IgCC* was released in late 2018.
- It contains the technical requirements described here, with the administrative features for a typical International Code (I-Code) (similar to the 2015 *IgCC*)



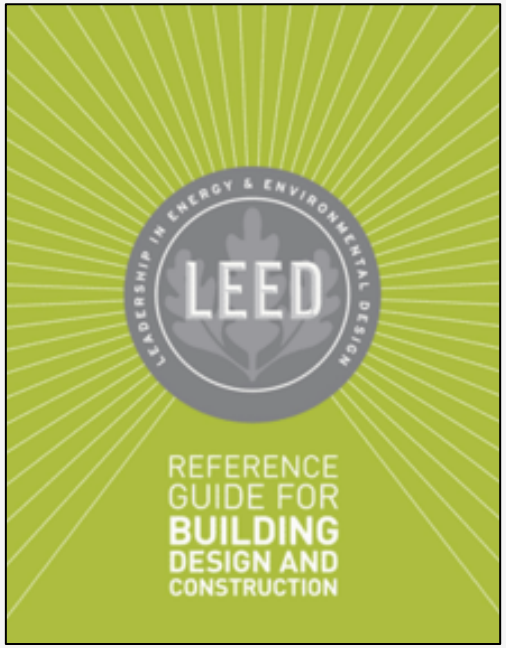
*Ig*CC/Standard 189.1 Versus LEED



Mandatory code intended for adoption in North American jurisdictions



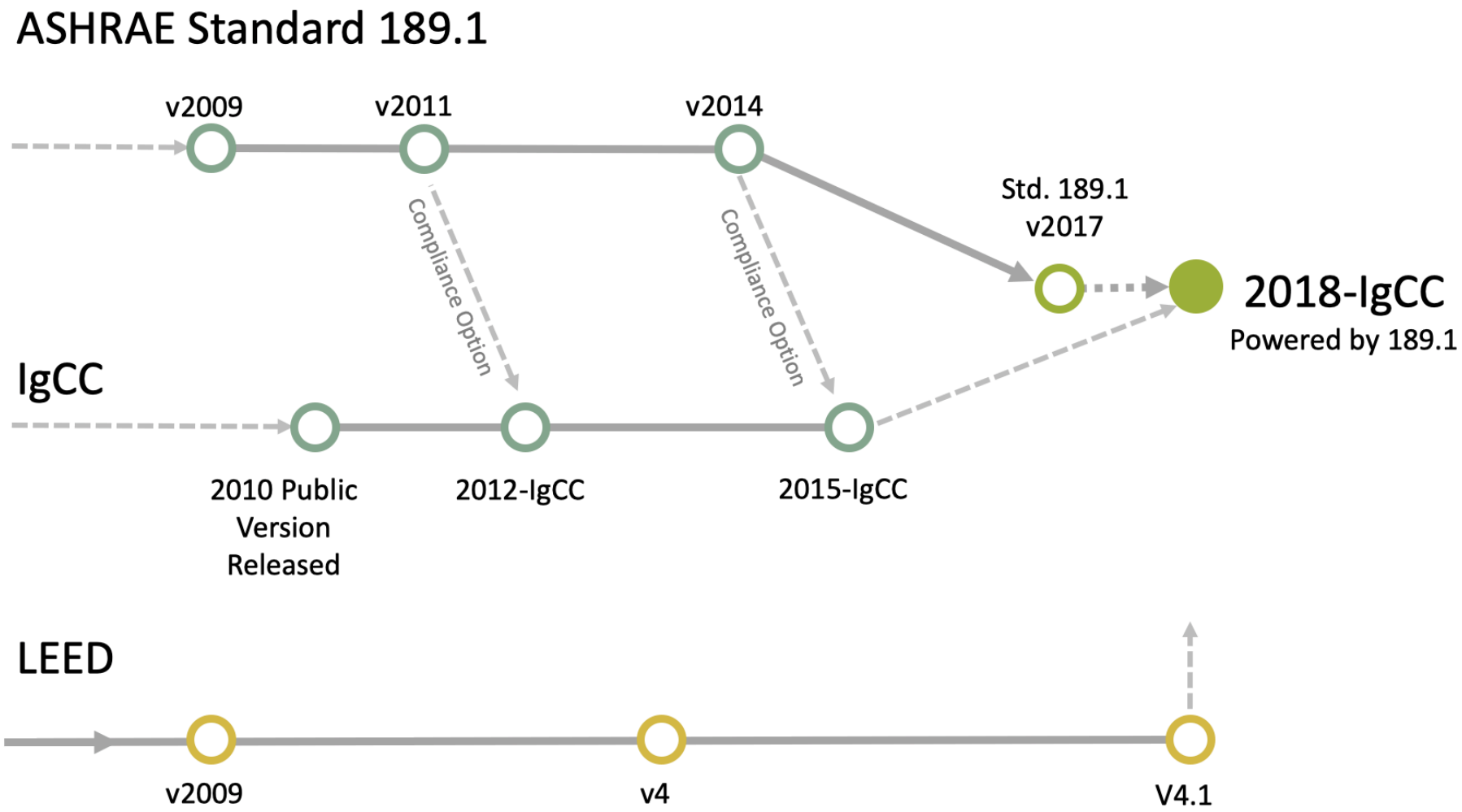
International standard

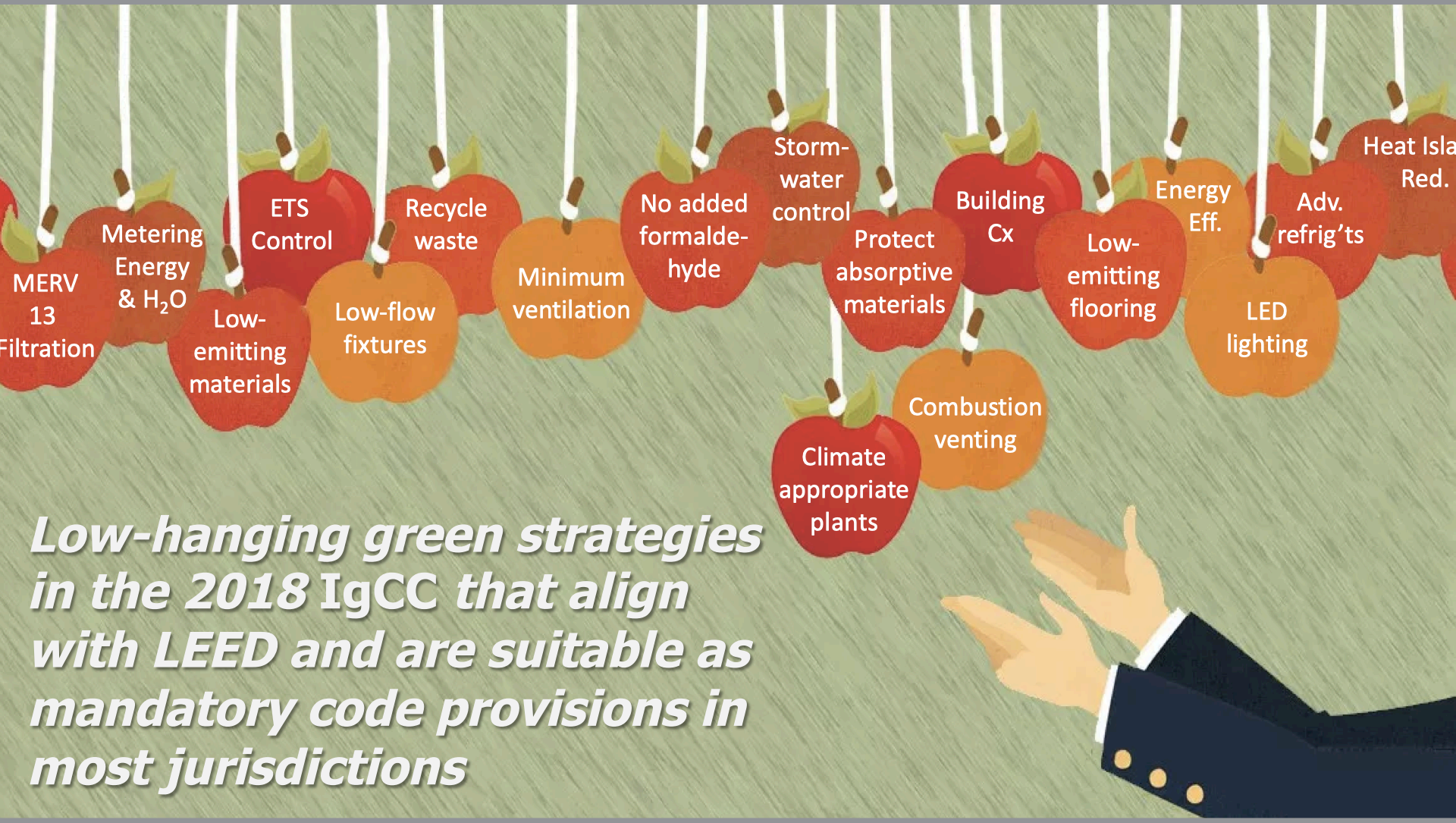


Voluntary rating system

2018 *IgCC* and LEED

2018 *IgCC*: A Coordinated Code with Connections to LEED




MERV 13 Filtration
Metering Energy & H_2O
Low-emitting materials
ETS Control
Low-flow fixtures
Recycle waste
Minimum ventilation
No added formalde-hyde
Storm-water control
Climate appropriate plants
Protect absorptive materials
Combustion venting
Building Cx
Low-emitting flooring
Energy Eff.
LED lighting
Adv. refrig'ts
Heat Isla
Red.
Low-hanging green strategies in the 2018 IgCC that align with LEED and are suitable as mandatory code provisions in most jurisdictions

USGBC recommends widespread adoption of a "**subset**" of the IgCC:

- **Measures** aligned with LEED
- **Measures suitable as** mandatory code provisions in most locations on most projects

These represent all LEED prerequisites and up to 20 points in LEED v4.

USGBC is working to formalize these connections so that LEED projects built in jurisdictions that have adopted these IgCC measures automatically satisfy the corresponding LEED measures.

Alignment of LEED and the 2018-IgCC

Green building strategies are increasingly being introduced into traditional building codes, addressing the cross-cutting categories of site selection, water conservation, energy efficiency, renewables, indoor environmental quality and resource conservation. USGBC believes a strong and successful green building code is vital to create the best communities for today without compromising the needs of future generations. That's why USGBC co-sponsored the 2018-International Green Construction Code powered by ASHRAE Standard 189.1 (2018-IgCC).

LEED and codes are not mutually exclusive. The following list of LEED Version 4 credits and prerequisites map closely to specific sections of the 2018-IgCC and have very high achievement rates for the 90,000+ LEED projects worldwide, making them ready for widespread adoption in code. USGBC is in the process of developing formal connections to the 2018-IgCC in LEED for jurisdictions that adopt the IgCC. Learn more at www.new.usgbc.org/green-codes.

LEED Credit Category	LEED BD+C v4 Prerequisite or Credit	Corresponding 2018-IgCC Measure	Potential LEED Points	Achievement Rates
Location & Transportation	Sensitive Land Protection	501.3.1.1 Allowable Sites	1 Point	70%
		501.3.1.2 Prohibited Development Activity		
Sustainable Sites	Construction Activity Pollution Prevention	1001.3.1.7 Construction Activity Pollution Prevention: Idling of Construction Vehicles	Prerequisite	100%
		1001.3.1.8 Construction Activity Pollution Prevention: Protection of Occupied Areas		
		1001.3.1.4 Erosion & Sedimentation Control		
	Rainwater Management (95th percentile)	501.3.4.1 Projects on Greenfield Sites (Stormwater Management)	2 Points	40%
		501.3.4.2 Projects on Greyfield Sites (Stormwater Management)		
	Heat Island Reduction	501.3.5 Mitigation of Heat Island Effect: 501.3.5.1 Site Hardscape	1 Point	70%
		501.3.5.3 Roofs, 501.3.5.4 SRI, 501.3.5.5 Vegetated Terrace and Roofing Systems		
	Light Pollution Reduction (Option 1 BUG rating method)	501.3.6 Reduction of Light Pollution	1 Point	60%
Water Efficiency	Outdoor Water Use Reduction (Option 2, 30%)	601.3.1.1 Landscape Design	Prerequisite	100%
		601.3.1.2 Irrigation		
		601.3.1.2.3 Irrigation of Rainfall-ETc Compatible Plants		
		601.3.2.4 Roofs		
		601.3.3 Special Water Features		
	Indoor Water Use Reduction (20%)	601.3.2.1 Plumbing Fixtures and Fittings	Prerequisite	100%
		601.3.2.2 Appliances		
		601.3.2.5 Commercial Food Service Operations		
		601.3.2.6 Medical and Laboratory Facilities		
		601.3.6 Reverse Osmosis Water Treatment Systems		
	Cooling Tower Water Use	601.3.2.3 HVAC Systems and Equipment	1 Point	25%
	Building-Level Water Metering	601.3.4 Water Consumption Measurement	Prerequisite	100%
	Outdoor Water Use Reduction (Option 2, 50%)	601.3.1.2 Irrigation	1 Point	90%
		601.3.1.2.3 Irrigation of Rainfall-ETc Compatible Plants		
		601.3.2.4 Roofs		

https://new.usgbc.org/green-codes

Sample of IgCC Measures that Align with LEED

LEED Credit Category	LEED BD+C v4 Prerequisite or Credit	Corresponding 2018-IgCC Measure	Potential LEED Points	Achievement Rates
Energy & Atmosphere	Fundamental Commissioning and Verification	1001.3.1 Construction/10.3.1.1 Building Systems FPT	Prerequisite	100%
	Enhanced Commissioning (Option 1)	1001.3.1.1.1 FPT Requirements	3 Points	80%
		1001.3.1.2 Building Project Commissioning (Cx) Process		
		1001.3.1.3 Project Cx Documents		
	Minimum Energy Performance (Option 1, 5%)	701.3.1 General	Prerequisite	100%
	Optimize Energy Performance (14%)	701.4 Prescriptive Option	5 Points	90%
		701.5 Performance Option		
	Fundamental Refrigerant Management	901.3.3 Refrigerants	Prerequisite	100%
	Building Level Energy Metering	701.3.3 Energy Consumption Management	Prerequisite	100%

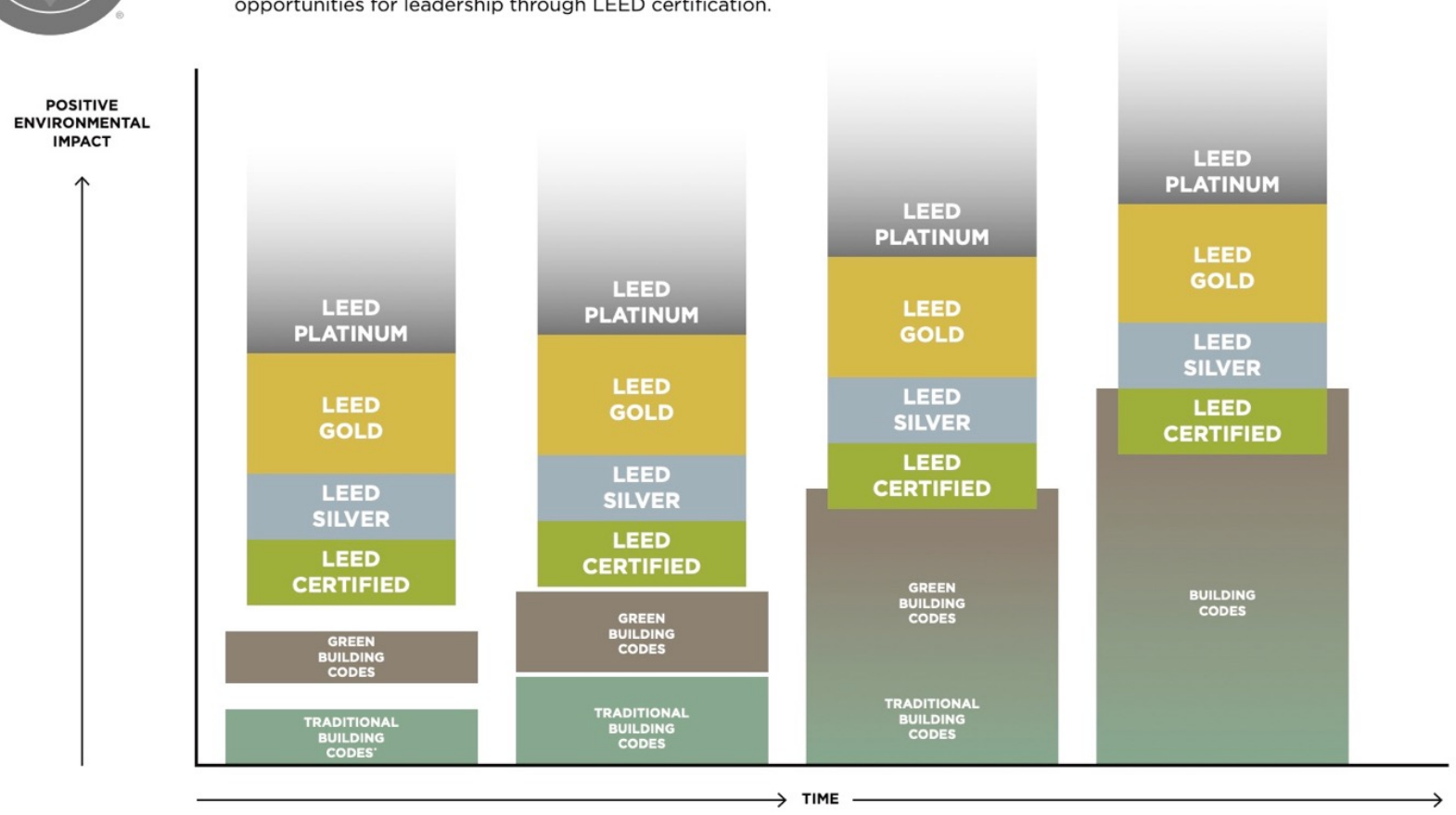
https://new.usgbc.org/green-codes

Proof of Concept: California's Green Code + LEED

- Statewide green code and energy code required on nearly all permitted projects
  - USGBC has created Alternative Compliance Pathways that allow CALGreen and Energy code provisions to satisfy all 12 prerequisites and up to 6 points automatically
  - Available for LEED v4 BD+C, ID+C and Homes
- California continues to require LEED on state-funded and state-operated buildings
  - **Local leadership policies continue to leverage LEED**

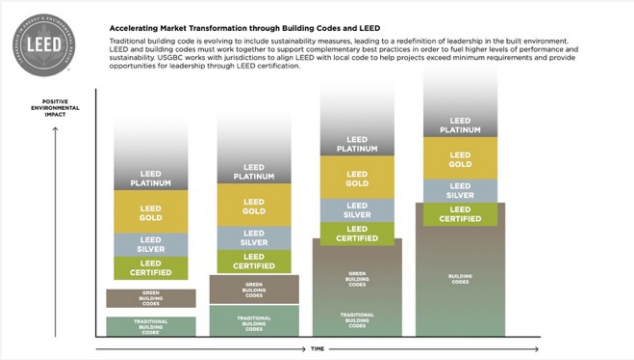
Accelerating Market Transformation through Building Codes and LEED

Traditional building code is evolving to include sustainability measures, leading to a redefinition of leadership in the built environment. LEED and building codes must work together to support complementary best practices in order to fuel higher levels of performance and sustainability. USGBC works with jurisdictions to align LEED with local code to help projects exceed minimum requirements and provide opportunities for leadership through LEED certification.



USGBC Resources

- Articles
- Policy briefs
- LEED/*Ig*CC recommended alignment list with high achievement rates
- Coordinated *Ig*CC trainings with ASHRAE and ICC (coming 2019)
- Sample *Ig*CC code compliance forms based on LEED forms (coming 2019)



https://new.usgbc.org/green-codes

Purpose of *IgCC*/189.1

- Provides technical basis of mandatory building codes for high-performance green buildings to:
  - Protect local diversity and ecosystems
  - Support regenerative material cycles
  - Reduce emissions from buildings
  - Enhance building occupant health and comfort
  - Conserve water resources
  - Enhance resilience to natural and human-caused hazards

Scope of *IgCC*/189.1

- Applies only to the following projects:
  - New buildings and their systems
  - New portions of buildings and their systems
  - New systems and equipment in existing buildings
  - Relocated existing buildings
- Does not apply to the following:
  - Single-family dwellings
  - Multifamily three stories or less
  - Buildings that use no electricity, fossil fuels, or water

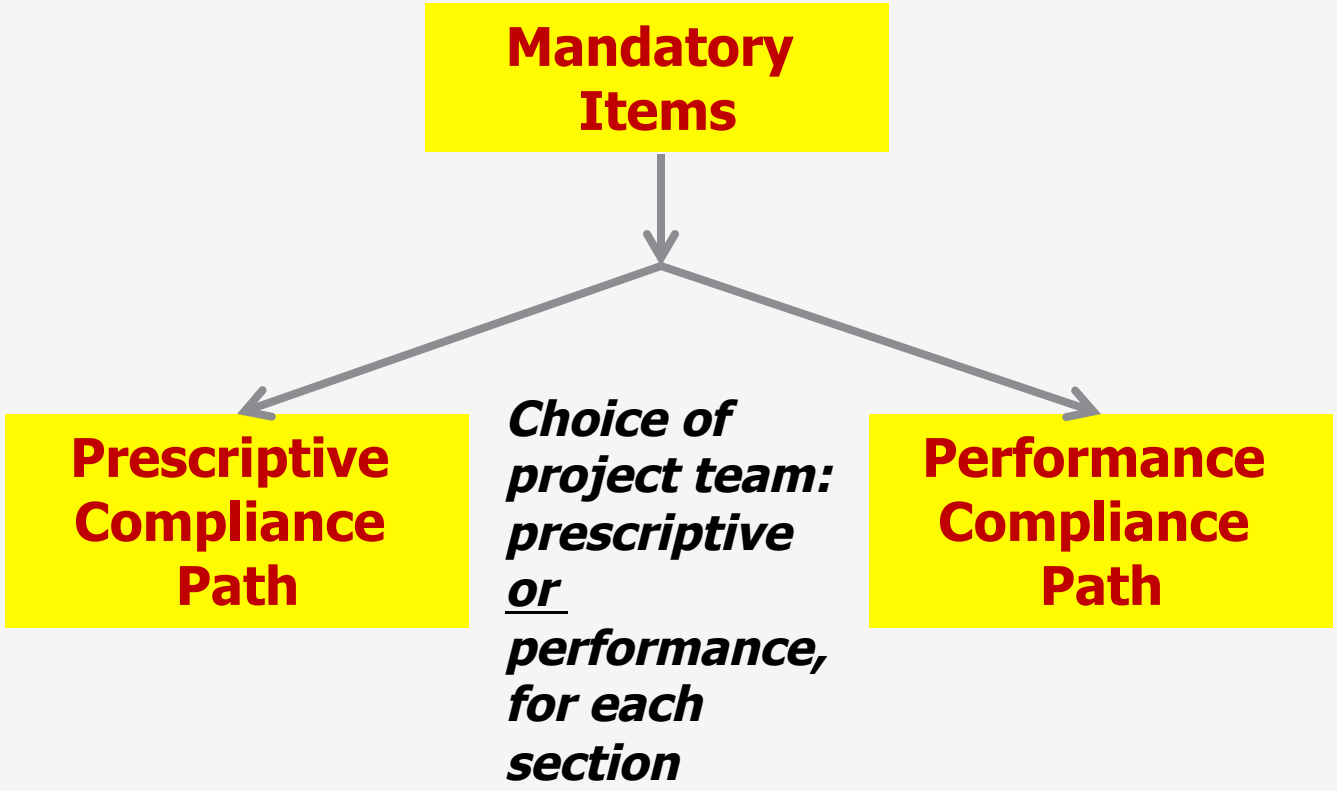
Photo credit: Michael Dollin

Application

- Building projects shall comply with Chapters/Sections 5 through 11
- Within each of these chapters/sections, building projects shall comply with all mandatory provisions and, where offered, either the
  - Prescriptive option or
  - Performance option

Even if not adopted by your local jurisdiction, this standard is an indication of future industry trends

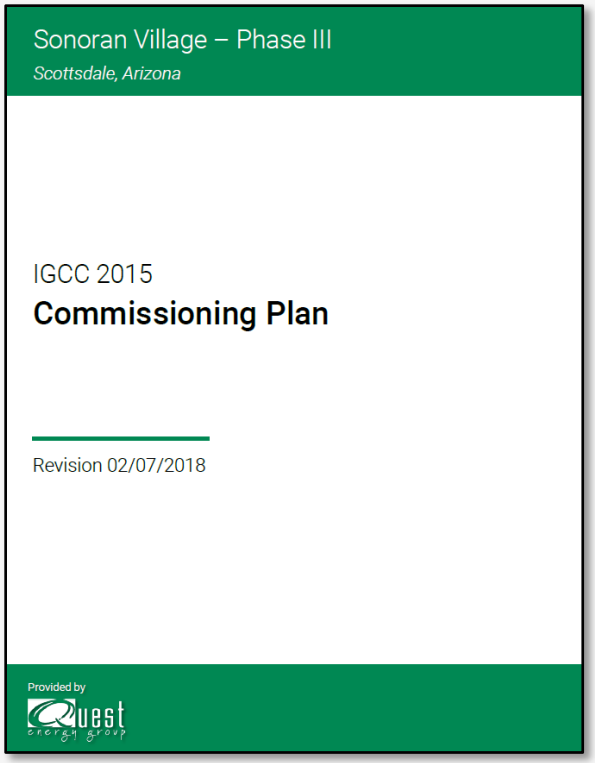
Compliance Paths



Note: Over time some sections have been simplified to make all provisions mandatory or to eliminate the performance option

Local Approval and Inspections

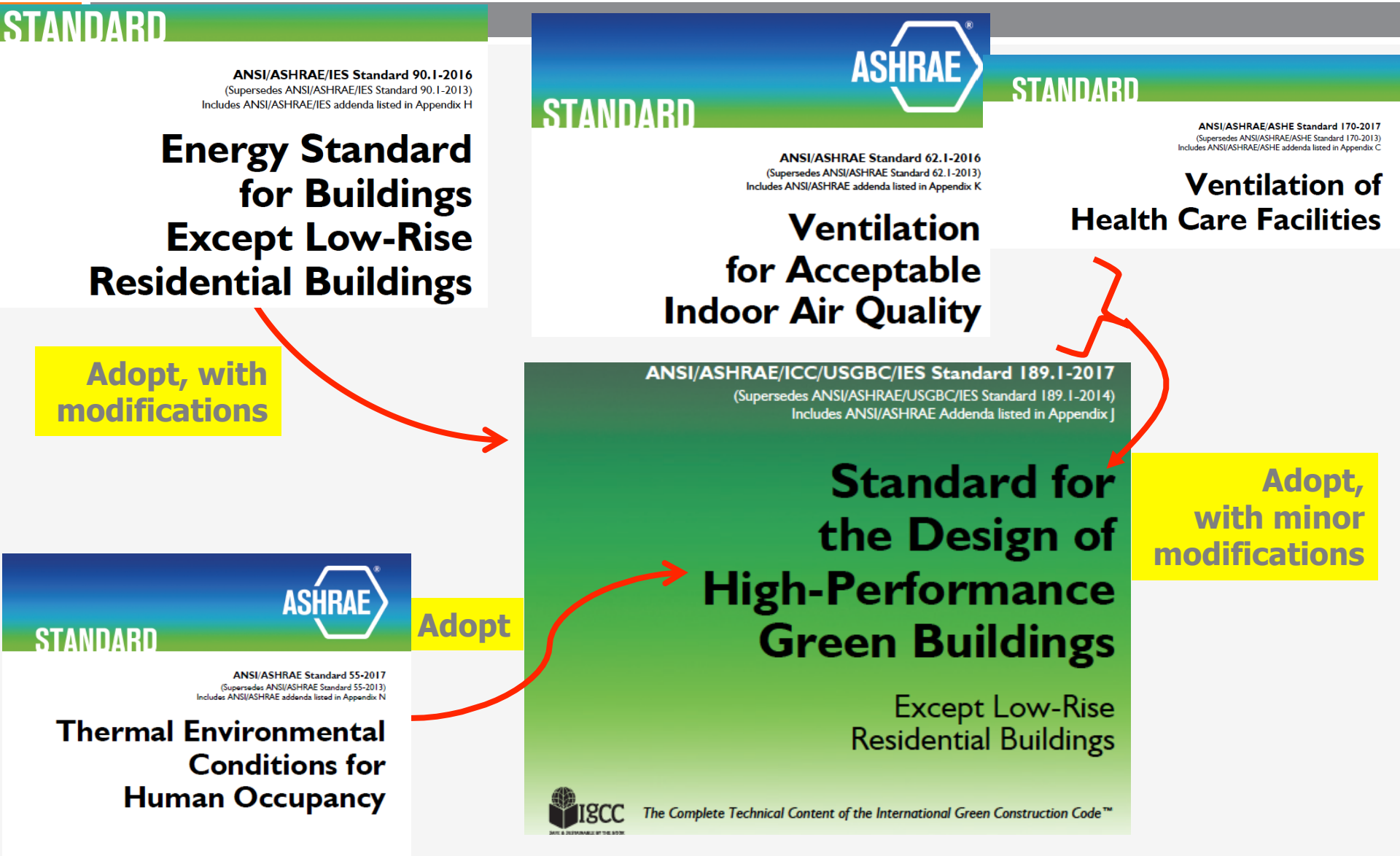
- Plan review submittals and approvals
  - Information on construction documents
  - Content and format in compliance with *International Building Code* (IBC)
  - Authority having jurisdiction (AHJ) shall have the authority to deem a national, state, or local program as meeting or exceeding this code
- Permits and inspections
  - Construction or work for which a permit is required shall be subject to inspection by the AHJ



Relation to ICC Family of Codes

Usually adopted with modifications

Relation to ASHRAE Standards



Organization and What it Covers

- **Chapter/Section 1**—Scope, Administration, and Enforcement
- **Chapter/Section 3**—Definitions
- **Chapter/Section 5**—Site Sustainability
- **Chapter/Section 6**—Water Efficiency
- **Chapter/Section 7**—Energy Efficiency
- **Chapter/Section 8**—Indoor Environmental Quality
- **Chapter/Section 9**—Materials and Resources
- **Chapter/Section 10**—Construction and Plans for Operation

Organization and What it Covers

- **Chapter/Section 11**—Normative References
- **Normative Appendix A**—Climate Zones and Prescriptive Building Envelope and Duct Insulation Tables
- **Normative Appendix B**—Prescriptive Equipment Efficiency Tables for the Alternative Reduced Renewables and Increased Equipment Efficiency Approach
- **Normative Appendix C**—Performance Option for Energy Efficiency
- **Normative Appendix D**—Building Concentrations

Organization and What it Covers

- **Informative Appendix E**—Building Envelope Tables
- **Informative Appendix F**—Integrated Design
- **Informative Appendix G**—Informative References
- **Informative Appendix H**—Option for Energy Efficiency Using the IECC Prescriptive Compliance Path
- **Informative Appendix I**—Additional Guidance for Functional and Performance Testing and Commissioning Process
- **Informative Appendix J**—Option for Residential Compliance using the National Green Building Standard

Organization

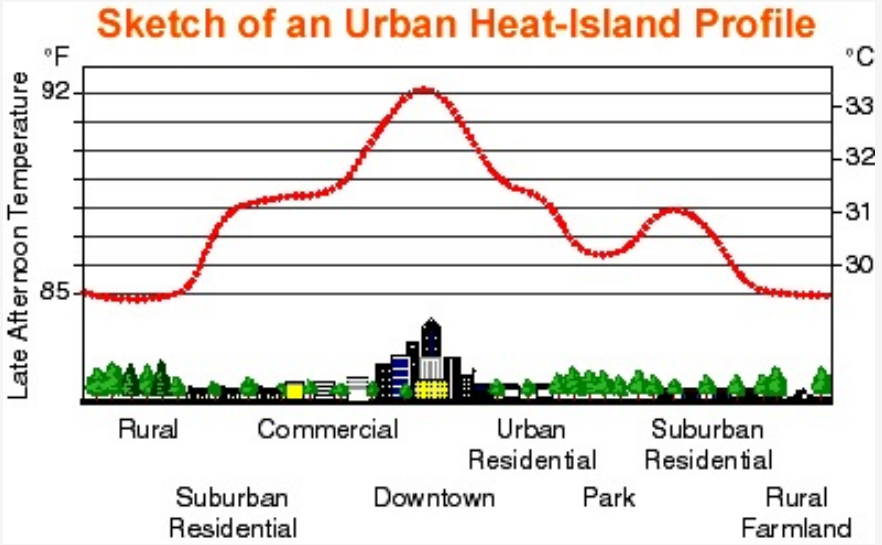
- Note: Section numbers listed in this course are based on the Standard 189.1 format. The *Ig*CC section numbers are similar, but organized in a I-Code format followed by the corresponding 189.1 section number in parentheses.
- For example:
  - 189.1format - **§6.3.1 Site Water Use Reduction**
  - *Ig*CC format - **§601.3.1 (6.3.1) Site Water Use Reduction**

CHAPTER/SECTION 5—SUSTAINABLE SITES

Sustainable Sites Highlights

All Requirements Are Now Mandatory

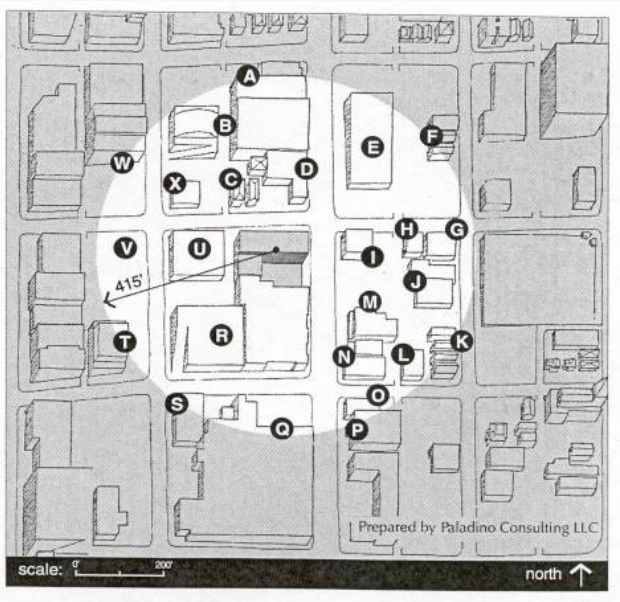
- **Allowable sites, where to build, or where not to allow**
- **Site assessments**
- **Key areas addressed:**
  - Urban heat island
  - Light "pollution" limitations
  - Stormwater management
  - Transportation impacts
  - Protection of natural areas and native site features
  - Electric vehicle charging stations
  - Building site construction waste management



Sustainable Sites

Site Selection (Mandatory)

- Allowable sites
  - Limit development on greenfield sites to areas that are in close proximity to existing development
  - Usually dictated by local planning and zoning laws
- Prohibited development activity
  - Prohibits development in flood zones, wetlands & conservation areas
- Predesign and site inventory
- Invasive plants
- Greenfield site development
  - Retention of native or adapted plants and biodiverse plantings



Sustainable Sites

Stormwater Management (Mandatory)

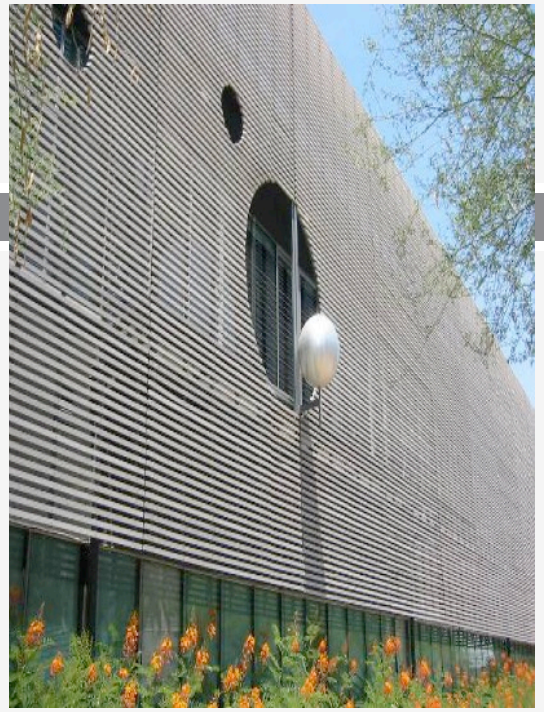
- Greenfield shall retain no less than 95th percentile precipitation event during a single 24 hour period
- Greyfield shall retain no less than 60th percentile precipitation event during 24 hour
- Brownfield shall not use use infiltration practices that will result in pollutant discharges to groundwater

Bioswale stormwater capture

Photo credit: Marion Brenner

Colwell Shelor, Landscape Architects

Sustainable Sites



Heat Island Mitigation (Mandatory)

- **Site hardscape:** **Except CZ 6, 7, and 8**
  50% to be either shaded, minimum SRI of 29, or water-permeable hardscape
- **Wall:** **CZ 1–4 east walls, 1–6 west walls**
  30% to be shaded up to 20 feet above grade (or minimum SRI 29 level)

What is SRI?

Solar Reflectance Index (SRI) for Standard Paving Materials

Material	Emissivity	Reflectance	SRI
Typical new gray concrete	0.9	0.35	35
Typical weathered* gray concrete	0.9	0.20	19
Typical new white concrete	0.9	0.7	86
Typical weathered* white concrete	0.9	0.4	45
New asphalt	0.9	.05	0
Weathered asphalt	0.9	.10	6

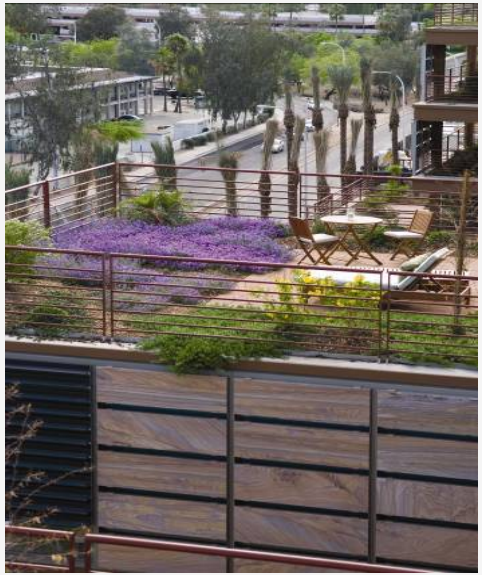
* Reflectance of surfaces can be maintained with cleaning. Typical pressure washing of cementitious materials can restore reflectance close to original value. Weathered values are based on no cleaning.

Source: USGBC. 2009. *LEED Reference Guide for Green Building Design and Construction*. Washington, DC: U.S. Green Building Council.

Sustainable Sites

Heat Island Mitigation (Mandatory)

- **Roofs:** **Applies CZ 0, 1, 2, and 3**
  minimum **three-year aged** SRI: minimum 64 (low-slope) or 29 (steep-slope)
- Applies to areas not covered by mechanical equipment, renewable energy, rooftop walkways or vegetated roofs



Heat Island Issue is a Separate Topic from Building Heat Gains

- **Two separate issues!**
  - Heat Island

heat island effect: the tendency of urban areas to be at a warmer temperature than surrounding rural areas.

  - Building Heat Gain
    - A "cool roof" is just one of the potential strategies for reducing heat gain to a building structure

The heat island effect is a *site* issue (Section 5); heat gain to a building (and how fast it enters the building) is primarily an *energy* issue (Section 7)

Sustainable Sites

Light Pollution (Mandatory)

- **Reduction of light pollution**
  - Modification of Standard 90.1 exterior lighting power allowances (see Table 7.4.6.1.2 and Section 7.4.6.1.2)
  - Maximum backlight, uplight, and glare (BUG) limit

TABLE 5.3.6.2B Maximum Allowable Backlight, Uplight, and Glare (BUG) Ratings[a,b,c,d]

	LZ0	*LZ1*	*LZ2*	*LZ3*	*LZ4*
Allowed Backlight Rating					
>2 mounting heights from property line	B1	B3	B4	B5	B5
1 to 2 mounting heights from property line	B1	B2	B3	B4	B4
0.5 to 1 mounting height to property line	B0	B1	B2	B3	B3
<0.5 mounting height to property line	B0	B0	B0	B1	B2
Allowed Uplight Rating	U0	U1	U2	U3	U4
Allowed Glare Rating	G0	G1	G2	G3	G4

Sustainable Sites

- **Transportation Impact Mitigation (Mandatory)**
  - Pedestrian walkways
  - Bicycle paths and parking
  - Preferred parking for low-emission vehicles or electric vehicle charging infrastructure

Image source: ChargePoint.com

Water reservoir in North Georgia. USA: Oct. 2007.

CHAPTER/SECTION 6— WATER USE EFFICIENCY

Section 6—Water Use Efficiency

(All water efficiency measures now mandatory)

Mandatory Provisions

- **Site water use:**

  Irrigation: No more than one-third of improved landscape area shall be irrigated with potable water

  Irrigation System Design: hydrozoning

  Controls: smart irrigation controllers

Section 6—Water Use Efficiency

Mandatory Provisions

- **Building water use (§6.3.2)**
  - Efficient plumbing fixtures per U.S. EPA WaterSense or ASME standards, with specific limit on flow amount or rate (*table next page*)
  - Appliances per U.S. EPA ENERGY STAR®, with water use factor for dwelling unit or public access

Plumbing Fixture Requirements

Table 6.3.2.1 Plumbing Fixtures and Fittings Requirements

Plumbing Fixture	Maximum
Water closets (toilets)—flushometer single-flush valve type	Single-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—flushometer dual-flush valve type	Full-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—single-flush tank-type	Single-flush volume of 1.28 gal (4.8 L)
Water closets (toilets)—dual-flush tank-type	Full-flush volume of 1.28 gal (4.8 L)
Urinals	Flush volume 0.5 gal (1.9 L)
Public lavatory faucets	Flow rate—0.5 gpm (1.9 L/min)
Public metering self-closing faucet	0.25 gal (1.0 L) per metering cycle
Residential bathroom lavatory sink faucets	Flow rate—1.5 gpm (5.7 L/min)
Residential kitchen faucets	Flow rate—1.8 gpm (6.8 L/min) [a]
Residential showerheads	Flow rate—2.0 gpm (7.6 L/min)
Residential shower compartment (stall) in *dwelling units* and guest rooms	Flow rate from all shower outlets total of 2.0 gpm (7.6 L/min)

a. With provision for a temporary override to 2.2 gpm (8.3 L/min) as specified in Section 6.3.2.1(g).

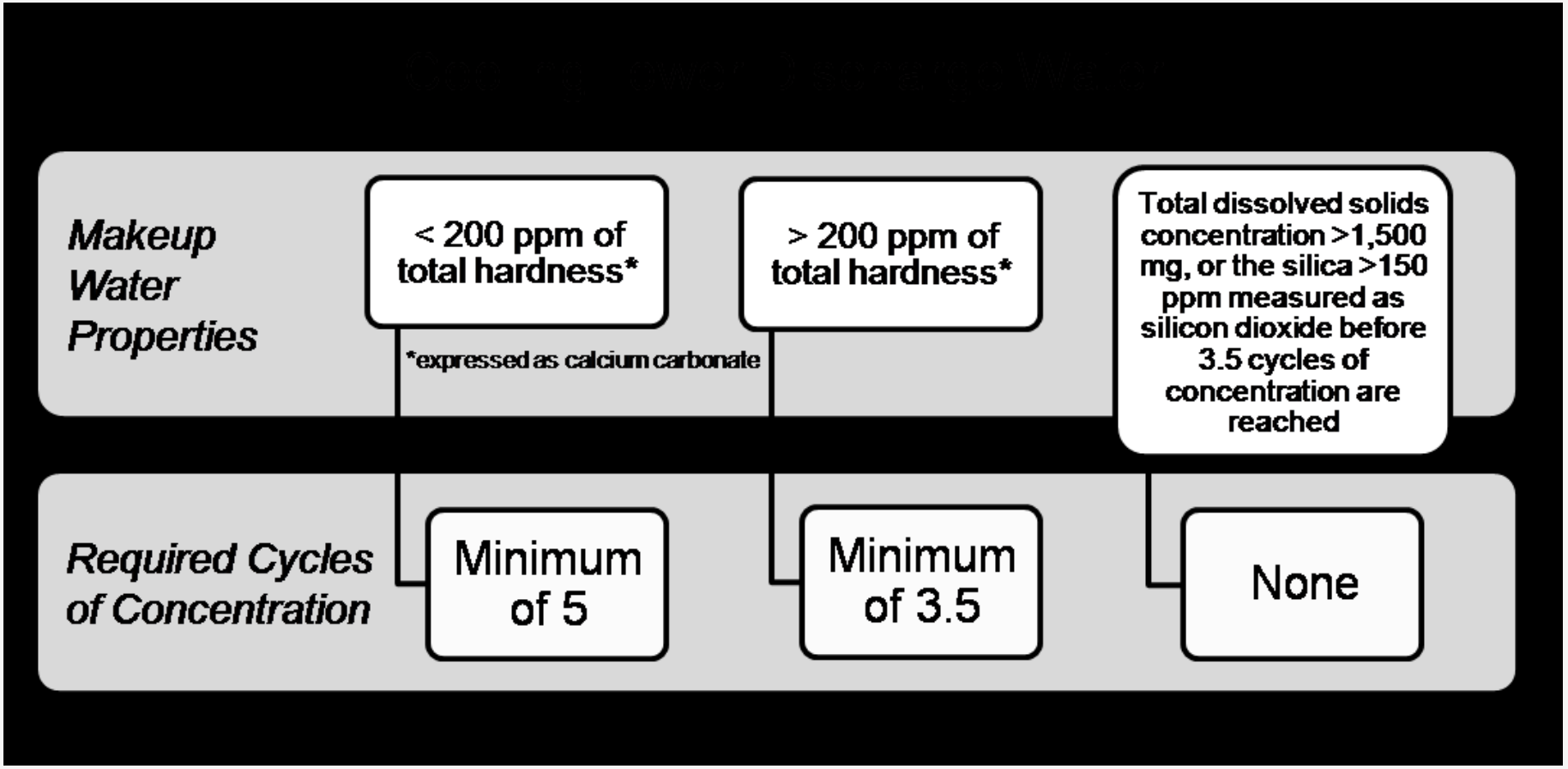
Section 6—Water Use Efficiency

Mandatory Provisions (*cont.*)

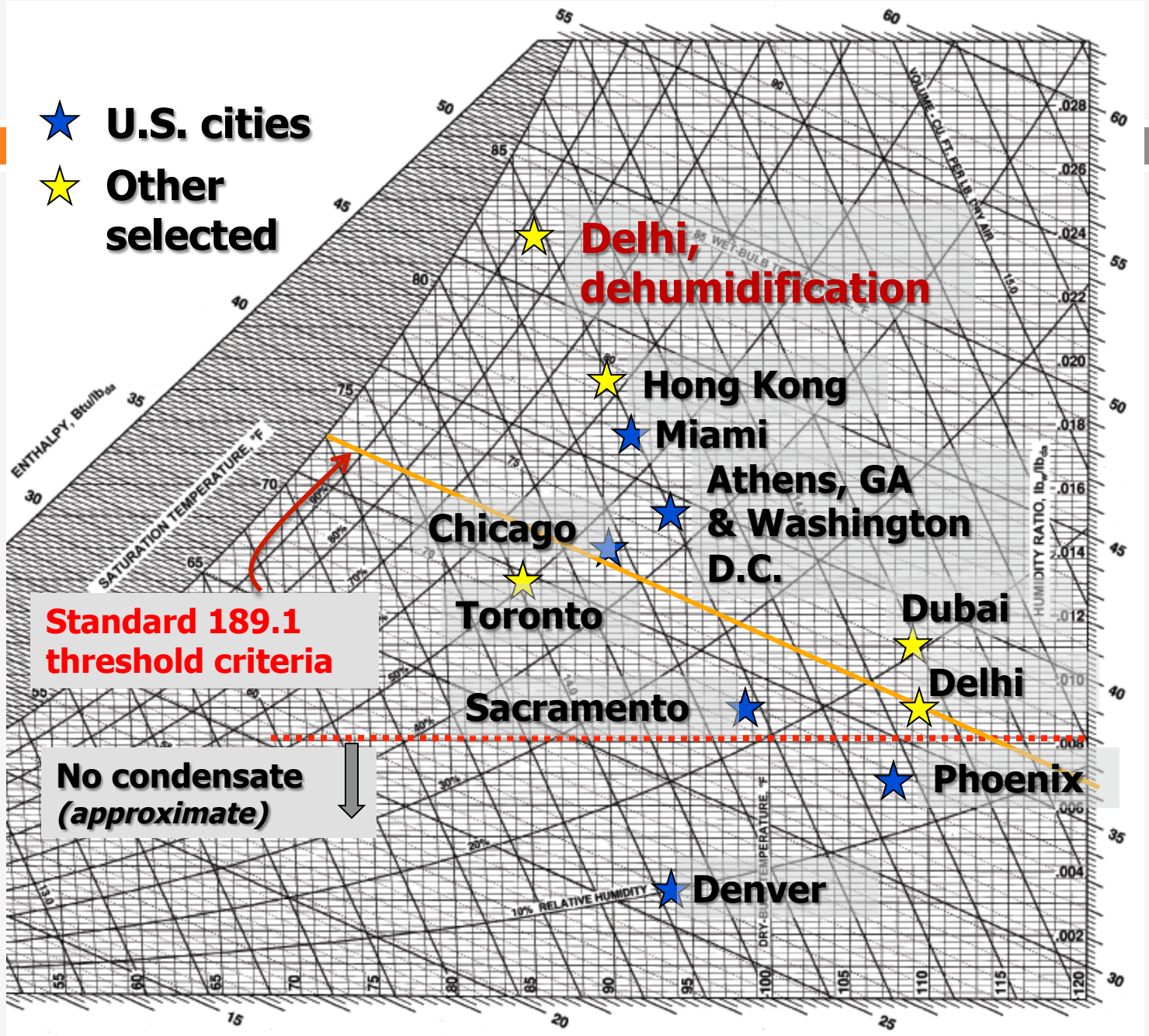
- **HVAC Systems, Equipment (§6.3.2.3):**
  - Once-through cooling with potable water is prohibited
  - Cooling towers and evaporative coolers shall be equipped with makeup and blowdown meters (threshold listings)
  - Cooling towers shall be equipped with efficient drift eliminators to achieve drift reduction
  - Condensate collection for reuse from AC units > 65,000 Btu/h in areas with ambient mean coincident wet bulb >72°F at 1% design cooling condition

Cooling Tower Water Use Reduction

Cooling Tower Cycles (§6.3.2.3):



Selected Cooling Design Conditions



Values are cooling load design conditions, *ASHRAE Handbook—Fundamentals*

Condensate Collection Discussion

- *How would you collect condensate water?*
- *How would you use the water?*
- *How would you estimate the amount of water collected?*
- *Issues associated with collection and reuse of condensate water.*

Section 6—Water Use Efficiency

Mandatory Provisions (*cont.*)

- Commercial food service (§6.3.2.5):
  - Use **ENERGY STAR** or equivalent rated equipment
    - for items such as spray valves, dishwashers
  - Medical and laboratory facilities
    - specific criteria (beyond scope of this talk)

Commercial Dishwashers

ENERGY STAR

Efficiency Requirements for Dishwashers				
Machine Type	**High Temp Requirements**		**Low Temp Requirements**	
	Idle Energy Rate	Water Consumption	Idle Energy Rate	Water Consumption
Under Counter	<= 0.9 kW	<= 1.00 gal/rack	<= 0.5 kW	<= 1.70 gal/rack
Stationary Single Tank Door	<= 1.0 kW	<= 0.95 gal/rack	<= 0.6 kW	<= 1.18 gal/rack
Single Tank Conveyor	<= 2.0 kW	<= 0.70 gal/rack	<= 1.6 kW	<= 0.79 gal/rack
Multiple Tank Conveyor	<= 2.6 kW	<= 0.54 gal/rack	<= 2.0 kW	<= 0.54 gal/rack

Specification effective 2007

ENERGY STAR qualified include: High and low undercounter temp, single tank door type, single tank conveyor, and multiple tank conveyor machines

NOT Eligible to QUALIFY include: flight type dishwashers; dishwashers that include an optional manual rinse after the final sanitizing rinse

EPA

Water Measurement Thresholds

TABLE 601.3.4.1A (TABLE 6.3.4.1A)
WATER SUPPLY SOURCE MEASUREMENT THRESHOLDS

WATER SOURCE	MAIN MEASUREMENT THRESHOLD
Potable water	1000 gal/day (3800 L/day)
Municipally *reclaimed water*	1000 gal/day (3800 L/day)
Alternate sources of water	500 gal/day (1900 L/day)

TABLE 601.3.4.1B (TABLE 6.3.4.1B)
SUBSYSTEM WATER MEASUREMENT THRESHOLDS

SUBSYSTEM	SUBMETERING THRESHOLD
Cooling towers (meter on makeup water and blowdown)	Cooling tower flow through tower > 500 gpm (30 L/s)
Evaporative coolers	Makeup water > 0.6 gpm (0.04 L/s)
Steam and hot-water boilers	> 500,000 Btu/h (150 kW) input
Total irrigated landscape area with controllers	> 25,000 ft^2 (2500 m^2)
Separate campus or project buildings	Consumption > 1000 gal/day (3800 L/day)
Separately leased or rental *space*	Consumption > 1000 gal/day (3800 L/day)
Any large water-using process	Consumption > 1000 gal/day (3800 L/day)

Case Study—Water Reuse

Biological Research Building

Condensate Water Collected
≈ 750,000 gallons per year
(2,850 m³ per year)
[not including rain, sumps]

Occupancy began 2006

"Inputs" to Storage

- Roof rainwater collection
- AHU condensate collection
- Building perimeter sump water collection

"Outputs" (Reuse)

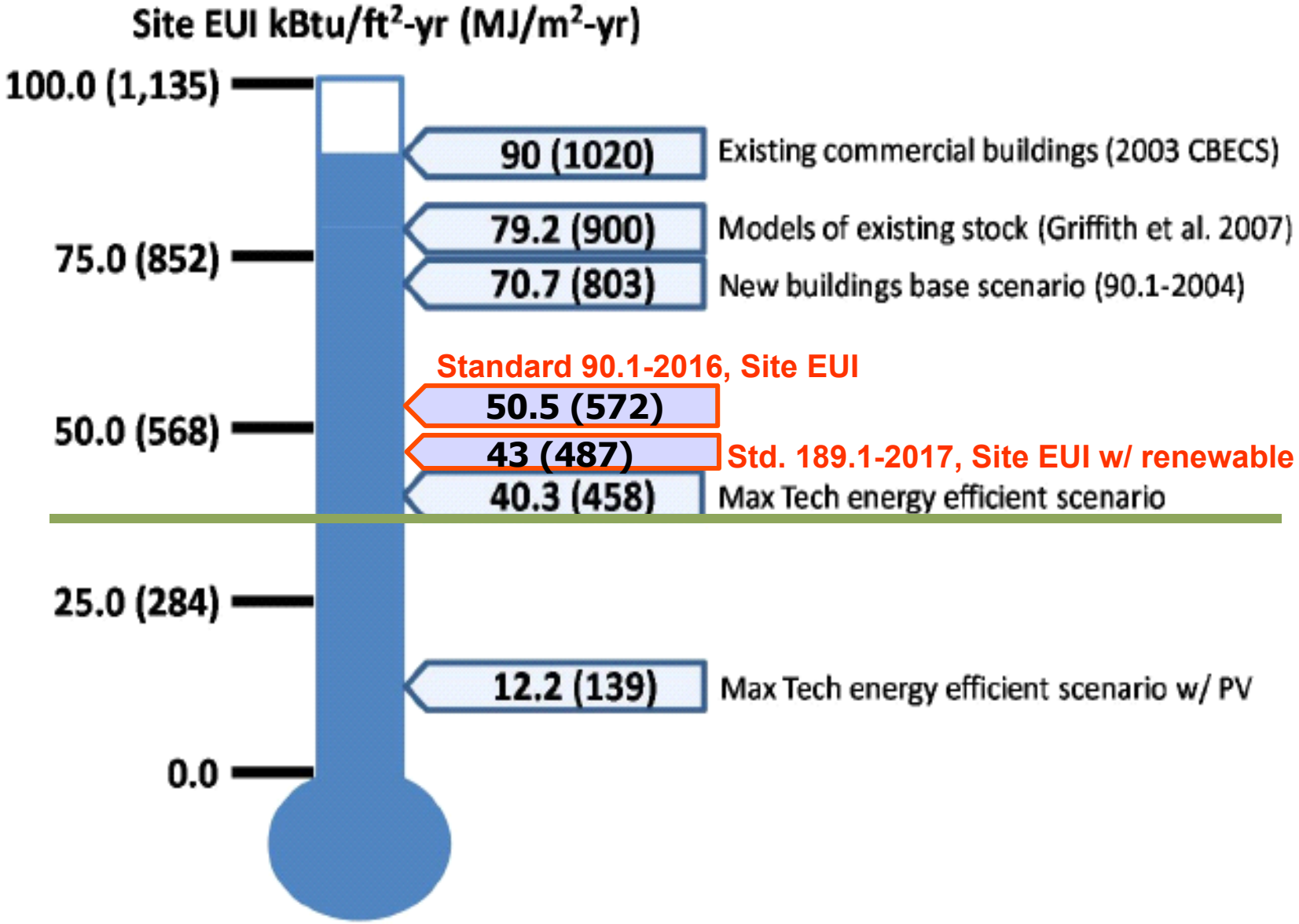
- Toilet flushing
- Cooling tower makeup

Case Study—
Water Reuse: Lessons Learned

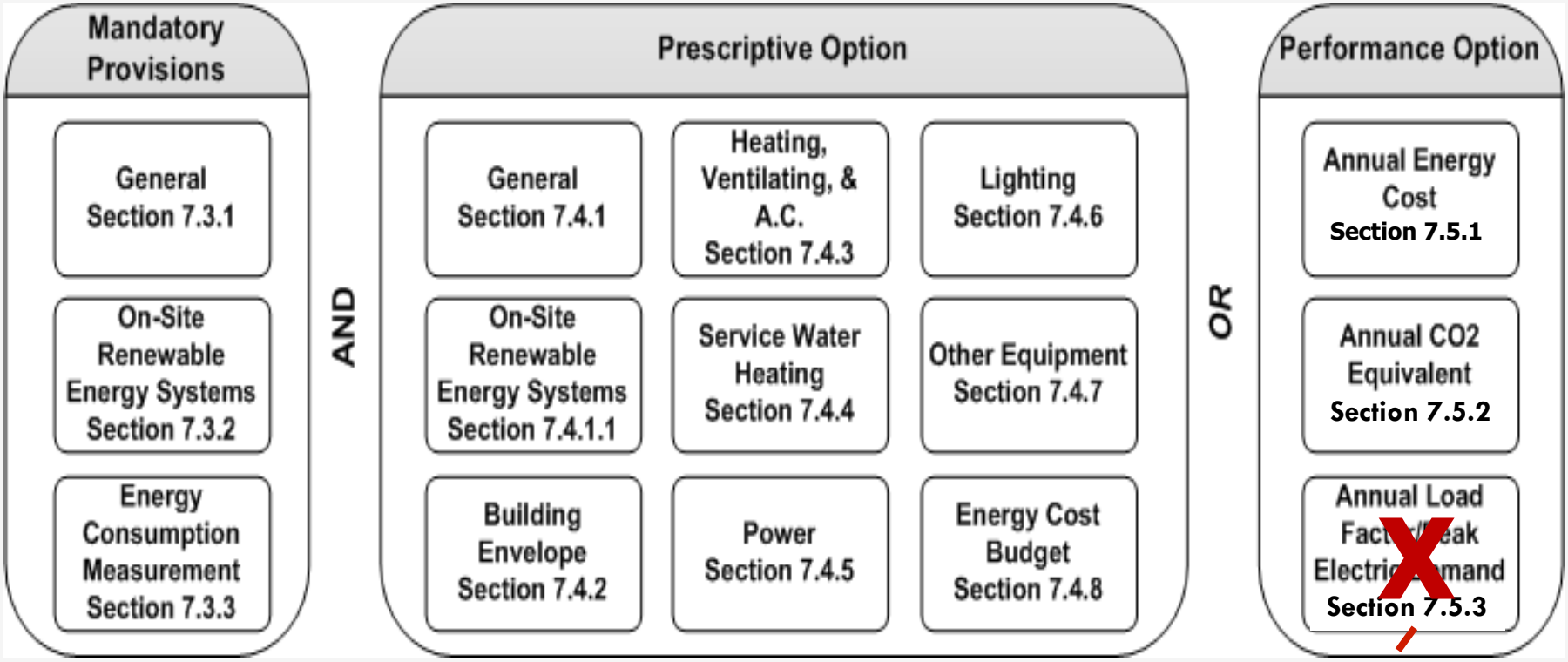
- Routing of collected (cold) condensate water
  - Beware of "son of condensate" (condensate forming on outside of pipe [insulation required per code])
- Consider location of cooling towers with respect to air handling units for condensate water collection and reuse
- Not possible to collect more condensate than cooling tower makeup needs
- Condensate water quality, monitoring

CHAPTER/SECTION 7—ENERGY

Progression of Overall Building Energy Efficiency (Using Site EUI as the Metric)



General Compliance Paths—Energy

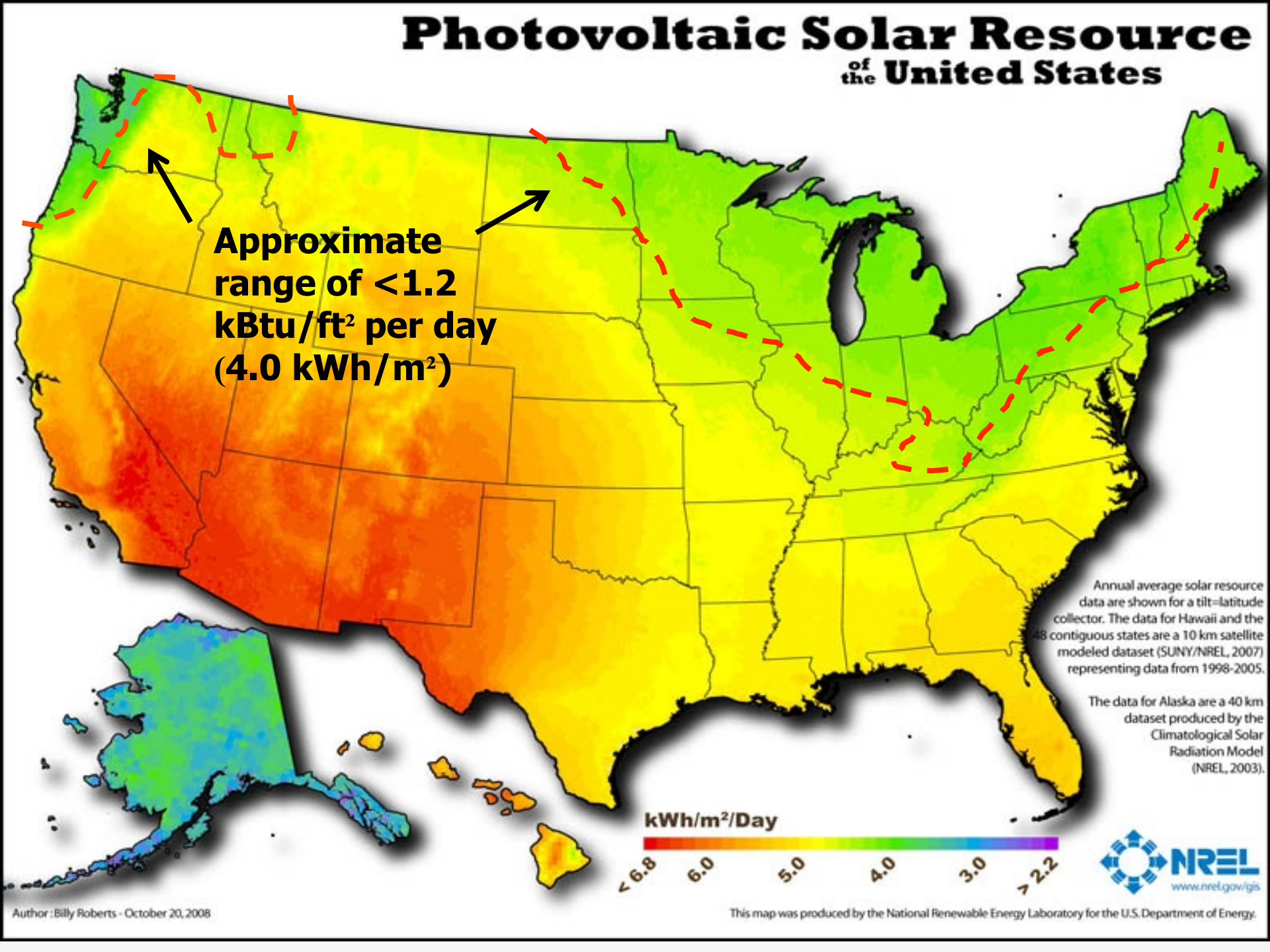


Energy: Mandatory On-Site Renewable

- **On-site renewable power (§7.3.2)**

  Provisions for future installation annual energy production ≥6 kBtu/ft² (20 kWh/m²) single story; ≥10 kBtu/ft² (32 kWh/m²) multistory

Photovoltaic Solar Resource of the United States



Annual average solar resource data are shown for a tilt=latitude collector. The data for Hawaii and the 48 contiguous states are a 10 km satellite modeled dataset (SUNY/NREL, 2007) representing data from 1998-2005.

The data for Alaska are a 40 km dataset produced by the Climatological Solar Radiation Model (NREL, 2003).

NREL
www.nrel.gov/gis

Author : Billy Roberts - October 20, 2008

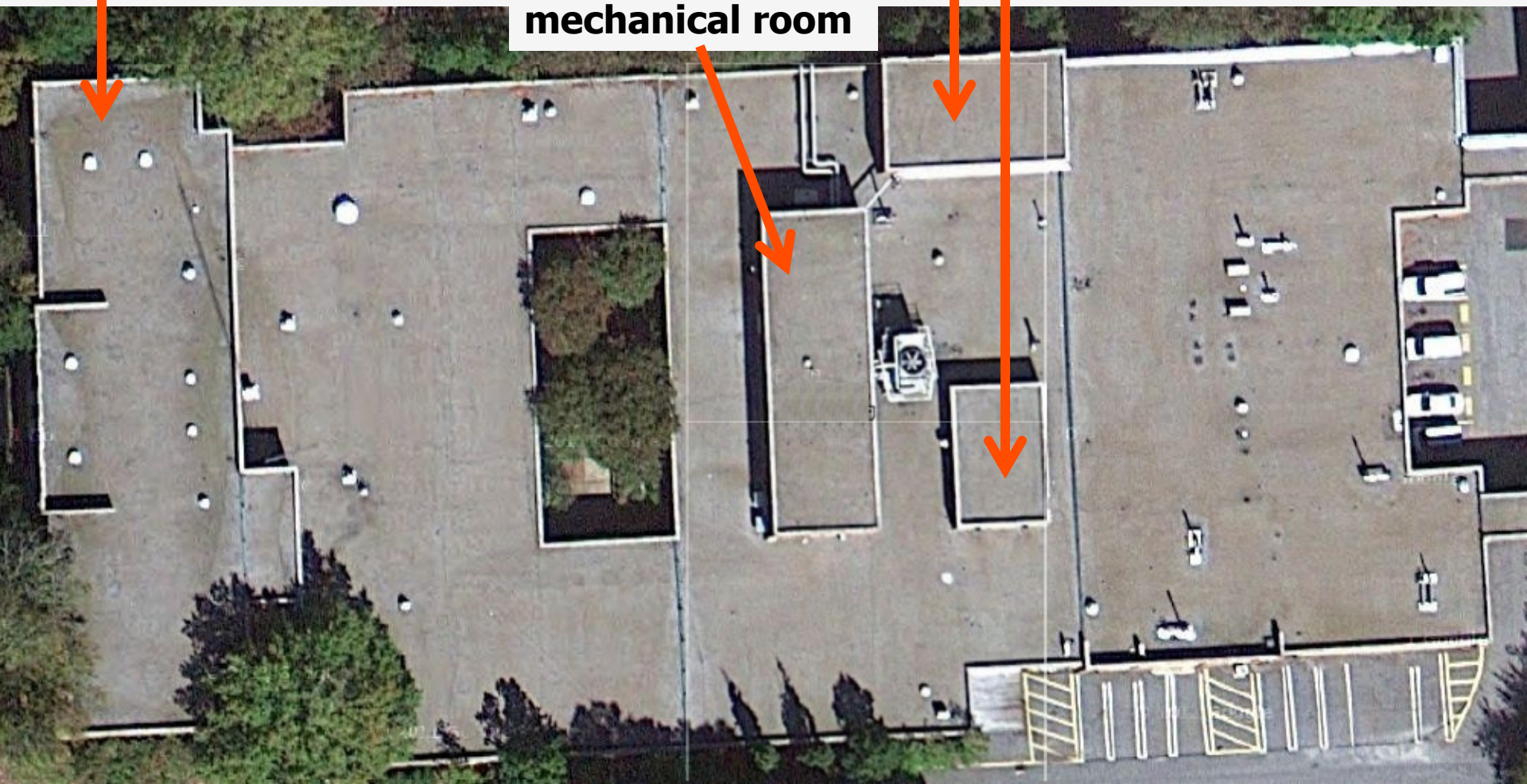
This map was produced by the National Renewable Energy Laboratory for the U.S. Department of Energy.

Points of Emphasis

- Why this requirement?
- How to meet this requirement?
- Does this change a mindset?
- Is thermal energy storage part of renewable plan (in general for society?)
- *Example follows*

Example: On-Site Renewable Energy

Mostly 1-story, except as indicated



Energy—Mandatory:

- **Remote or automatic energy monitoring (§7.3.3)** *criteria based on size*
  - Energy sources (Table 7.3.3-1)
  - Key systems (Table 7.3.3-2)
- Meters communicate to central recording system
- Data storage for minimum 36 months

Exception: Residential portions of buildings complying with this standard

Energy Metering Thresholds

TABLE 7.3.3.1A Energy Source Thresholds

Energy Source	Threshold
Electrical service	>200 kVA
On-site renewable electric power	All systems > 1 kVA (peak)
Gas and district services	>1,000,000 Btu/h (300 kW)
Geothermal energy	>1,000,000 Btu/h (300 kW) heating
On-site renewable thermal energy	>100,000 Btu/h (30 kW)

Table 7.3.3.1B System Energy Use Thresholds

Use (Total of All Loads)	Subsystem Threshold
HVAC system	Connected electric load > 100kVA
	Connected gas or district services load > 500,000 Btu/h (150 kW)
People moving	Sum of all feeders > 50 kVA
Lighting	Connected load > 50 kVA
Process and plug process	Connected load > 50 kVA
	Connected gas or district services load > 250,000 Btu/h (75 kW)

Automated Demand Response (§7.3.4)

- Automated demand response capability to allow communication with utility, to receive demand response signals, and to implement load adjustments to HVAC and lighting as appropriate
- During automated demand response (DR)
  - HVAC setpoints adjusted by minimum of 3°F (1.7 °C)
  - Ramp up and down logic to avoid rebound and large peak
  - VFD controllers to 90% of maximum
  - Lighting adjustments by 15% for those with centralized control systems

Energy: Prescriptive Option (§7.4)

Average net EUI = 43 kBtu/ft² (487 MJ/m²)

7.4.1 General Comprehensive Prescriptive Requirements. When a requirement is provided below, it supersedes the requirement in ASHRAE/IESNA Standard 90.1. For all other criteria, the *building project* shall comply with the requirements of ASHRAE/IESNA Standard 90.1.

Prescriptive Option: Renewable Energy

- Two options for demonstrating compliance:
  - **Standard Approach (Baseline Renewable):** Install the amount of on-site renewable energy equivalent to that specified in mandatory section.

    ≥6 kBtu/ft² (20 kWh/m²) single story;

    ≥10 kBtu/ft² (32 kWh/m²) multistory

    Exception (must demonstrate compliance with both of these):

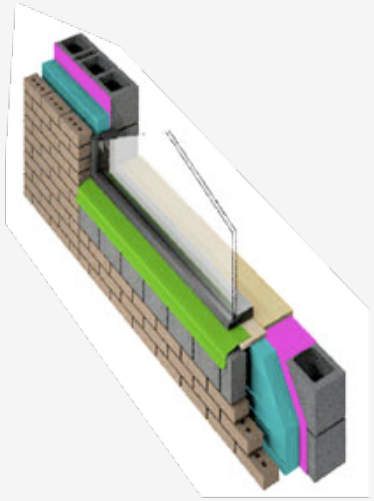
    - Low incident solar locations (<4.0 kWh/m²/day)
    - Purchase of green power in terms of 7 kWh/ft²•yr [75 kWh/m²•yr] annually until cumulative purchase of 70 kWh/ft²•yr [750 kWh/m²•yr]

Option 2: Alternate Renewables Approach

- **Reduced On-Site Renewable Energy and Higher-Efficiency Equipment**
  - If project complies with higher energy efficiency requirements in Appendix B, water heating, other efficiency measures (ENERGY STAR, etc.), on-site required lowers to **≥4 kBtu/ft²** (13 kWh/m^2) single story; **≥7 kBtu/ft²** (22 kWh/m^2) multistory

Prescriptive Option: Building Envelope

- Comply with Std 90.1, Section 5 as modified… **(§7.4.2)**
- Comply with Table 5.5-1 through 5.5-8 on building envelope in 90.1, as modified for Climate Zones 4–8:
  - U-, C- and F- factors reduced by **5%** (Tables 5.5-4 through 5.5-8)
  - Insulation minimum R-Value Column of Std. 90.1 shall not apply
  - Solar heat gain coefficient (SHGC) for east and west oriented fenestration reduced by **5%**



- If no requirement ("NR") listed, does not apply
- SHGC reduction not applicable for skylights in spaces meeting daylighting area requirements in §8.4.1

Prescriptive Option (Building Envelope)

- Vertical fenestration <40% gross wall area **(§7.4.2.5)**

Prescriptive Option (Building Envelope)

Permanent Projections

- Overhang: PF >0.5 **(§7.4.2.6)**
  Exceptions for
  "0 lot line," shaded surfaces,
  dynamic glazing,
  or automated controlled shading
  in response to daylight levels
  (with restrictions as listed)

  - West, east, and south orientations
  - Climate zones 0–3, plus 4B and 4C

Prescriptive Option (Building Envelope)

- Building envelope trade-off option of Standard 90.1 does not apply unless this incorporates all modifications in Standard 189.1 section **(§7.4.2)**
- Push toward "smarter" window placement and selection **(§7.4.2.9)**

Exceptions

Buildings adjacent to or shaded by other buildings, hills, etc.

7.4.2.9 Orientation. The *vertical fenestration* shall comply with either (a) or (b):

a. $A_W \le (A_N + A_S)/4$ and $A_E \le (A_N + A_S)/4$

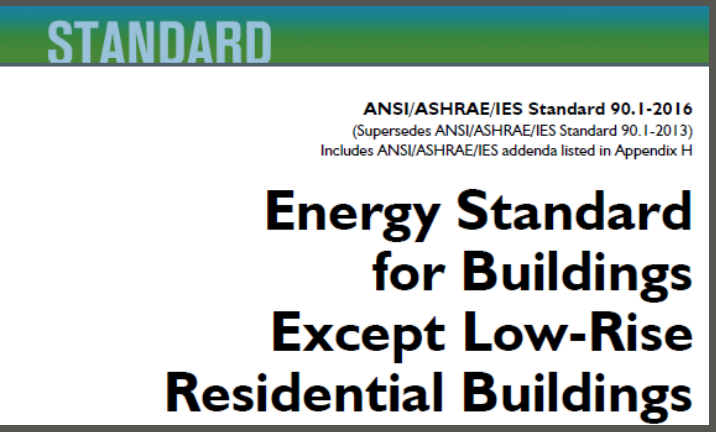
b. $A_W \times SHGC_W \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$ and $A_E \times SHGC_E \le (A_N \times SHGC_C + A_S \times SHGC_C)/6$

where

$SHGC_x$ = the *SHGC* for orientation *x* that complies with Section 7.4.2.7

$SHGC_C$ = the *SHGC* criteria for each *climate zone* from Section 7.4.2.1

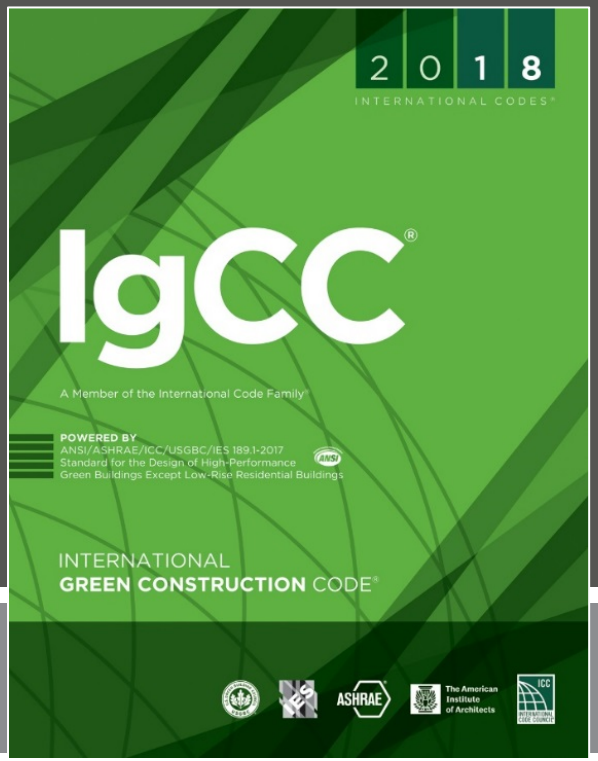
§7.4.3 HVAC



General Concept:

Based on Standard 90.1, but modifications to improved energy performance over code minimum standards

Adopt, with modifications



Renewables and Efficiency Summary

- Projects opting for **Alternate Renewables Approach**
  - §7.4.3.1 **Detailed descriptions for equipment efficiency incentives for higher efficient equipment (ENERGY STAR)**

Equipment Efficiency, Renewables Compliance Options

Standard Approach "Baseline Minimum" (Standard 90.1 Efficiency)

Use equipment with EPAct baseline efficiency levels, and:

- **Renewable energy system producing 6.0 kBtu/ft² roof area annually**
- **Peak electrical load reduction of 10%**

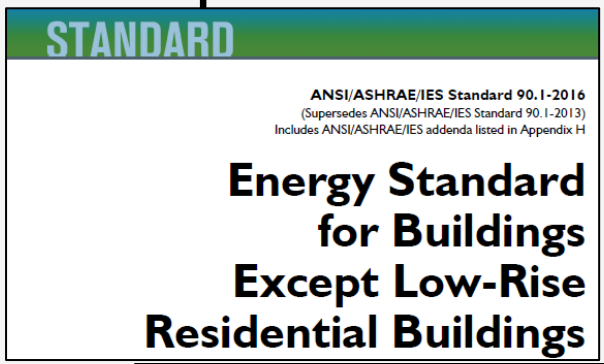
Alternate Renewables Approach → Higher Efficiency

Use higher efficiency of ENERGY STAR requirements, Appendix C, and:

- **Renewable energy system producing 4.0 kBtu/ft² roof area annually**
- **Peak electrical load reduction of 5%**

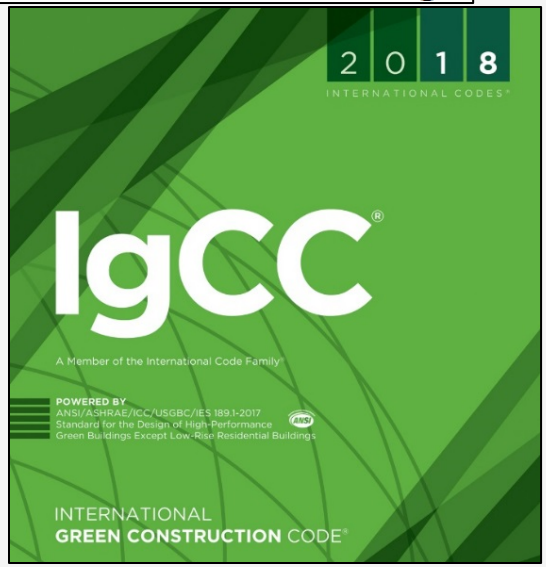
Ventilation for Densely Occupied Spaces: §7.4.3.2

- Requirements for DCV modifies that of Std. 90.1



DCV if one or more of these:

- **Air-side economizer**
- **Automated modulating OA dampers**
- **Design OA flow >1000 cfm**



Exceptions:

- design outdoor airflow <750 cfm
- Exhaust energy recovery
- ≥75% space outdoor airflow used as makeup for other spaces
- Prison cells, daycare sickrooms, science lab, barber, beauty salon, bowling alleys

Note: Type of DCV control is not specified

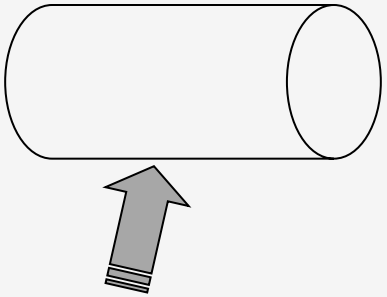
§7.4.3.3 Duct Leakage Test

Test for leakage if:

- Ductwork with design pressure > 2 in. water (500 kPa) or
- All ductwork located outdoors.

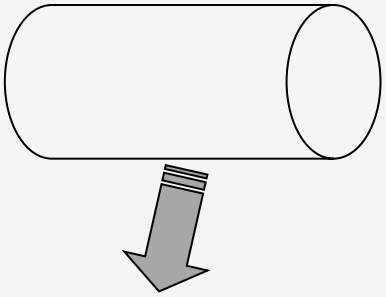
All duct systems will leak!

Duct P < P ambient



Leakage Into Duct

Duct P > P ambient



Leakage Out of Duct

§7.4.3.4 HVAC—Economizer

- **Minor requirement changes from Standard 90.1**

Table 7.4.3.4 Minimum System Size for which an Economizer is Required

Climate Zones	Cooling Capacity for which an Economizer is Required[a]
0A, 0B, 1A, 1B	No economizer requirement
2A, 2B, 3A, 3B, 3C, 4A, 4B, 4C, 5A, 5B, 5C, 6A, 6B, 7, 8	≥33,000 Btu/h (9.7 kW)[a]

a. Where economizers are required, the total capacity of all systems without economizers shall not exceed 480,000 Btu/h (140 kW) per building or 20% of the building's air economizer capacity, whichever is greater.

- Rooftop units <4.5 tons: two stage (first stage economizer, second stage adds mechanical)
- VAV with fixed supply temperature, capable for temperature reset by at least 5°F (3°C) during economizer operation

§7.4.3 HVAC—Fan Power

- §7.4.3.6 Fan power limits, below Standard 90.1

- 10%

From Standard 90.1-2016 (IP version, SI similar).
Parameter 'A' includes pressure drop adjustments based on system design

Table 6.5.3.1-1 Fan Power Limitation[a]

	Limit	Constant Volume	Variable Volume
Option 1: Fan *system* motor nameplate hp	Allowable *motor nameplate hp*	$hp \le cfm_S \times 0.0011$	$hp \le cfm_S \times 0.0015$
Option 2: Fan *system* bhp	Allowable fan *system* bhp	$bhp \le cfm_S \times 0.00094 + A$	$bhp \le cfm_S \times 0.0013 + A$

a. where
cfm_S = maximum design supply airflow rate to *conditioned spaces* served by the *system* in cubic feet per minute
hp = maximum combined motor *nameplate horsepower*
bhp = maximum combined fan-brake horsepower
A = sum of $(PD \times cfm_D/4131)$
where
PD = each applicable pressure drop adjustment from Table 6.5.3.1-2 in in. of water
cfm_D = the design airflow through each applicable device from Table 6.5.3.1-2 in cubic feet per minute

- Total fan efficiency at design operating point within 10% of the maximum efficiency of that fan.

§7.4.3.7 HVAC—Exhaust Energy Recovery

- Energy recovery effectiveness of 60% (instead of 50% in Standard 90.1)
- Standard 189.1/*IgCC* and 90.1 now use the same threshold size table (next slide)

Standard 90.1-2016 Energy Recovery

Table 6.5.6.1-1 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Less than 8000 Hours per Year

	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and <80%	≥80%
Climate Zone	Design Supply Fan Airflow Rate, cfm							
3B, 3C, 4B, 4C, 5B	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B,5C	NR	NR	NR	NR	≥26000	≥12000	≥5000	≥4000
6B	≥28,000	≥26,500	≥11000	≥5500	≥4500	≥3500	≥2500	≥1500
0A, 1A, 2A, 3A, 4A, 5A, 6A	≥26,000	≥16,000	≥5500	≥4500	≥3500	≥2000	≥1000	≥120
7,8	≥4500	≥4000	≥2500	≥1000	≥140	≥120	≥100	≥80

NR—Not required

Table 6.5.6.1-2 Exhaust Air *Energy* Recovery Requirements for *Ventilation Systems* Operating Greater than or Equal to 8000 Hours per Year

	% *Outdoor Air* at Full Design Airflow Rate							
	≥10% and <20%	≥20% and <30%	≥30% and <40%	≥40% and <50%	≥50% and <60%	≥60% and <70%	≥70% and < 80%	≥80%
Climate Zone	Design Supply Fan Airflow Rate, cfm							
3C	NR	NR	NR	NR	NR	NR	NR	NR
0B, 1B, 2B, 3B, 4C, 5C	NR	≥19,500	≥9000	≥5000	≥4000	≥3000	≥1500	≥120
0A, 1A, 2A, 3A, 4B, 5B	≥2500	≥2000	≥1000	≥500	≥140	≥120	≥100	≥80
4A, 5A, 6A, 6B, 7, 8	≥200	≥130	≥100	≥80	≥70	≥60	≥50	≥40

NR—Not required

HVAC: Kitchen Exhaust

- §7.4.3.8 Kitchen hoods > 2000 cfm (950 l/s)
  - 7.4.3.8.1—Comply with table (next slide)
  - 7.4.3.8.2—At least one of following:
    - At least 50% of replacement air is transfer air
    - At least 75% of exhaust air controlled by via demand controlled ventilation
    - At least 50% of exhaust with energy recovery (with at least 40% effectiveness)
    - Uncooled or not mechanically cooled makeup air in the "B" versions of climate zones 0–8 (limited to the capacity of any nonmechanical cooling system)

§7.4.3.8.1 Maximum Hood Exhaust

Table 7.4.3.8.1 Maximum Net Exhaust Flow Rate per Length of Hood

Type of Hood	Light-Duty Equipment		Medium-Duty Equipment		Heavy-Duty Equipment		Extra-Heavy-Duty Equipment	
	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre	cfm per linear foot	L/s per linear metre
Wall-mounted canopy	140	217	210	325	280	433	385	596
Single island [a]	280	433	350	541	420	650	490	758
Double island (per side)	175	271	210	325	280	433	385	596
Eyebrow	175	271	175	271	Not allowed	Not allowed	Not allowed	Not allowed
Backshelf/Passover	210	325	210	325	280	433	Not allowed	Not allowed

a. The total exhaust flow rate for all single-island hoods in a kitchen/dining facility shall be no more than 5000 cfm (2360 L/s).

Duct Insulation

- §7.4.3.9 Minimum duct insulation increased above ASHRAE/IES Standard 90.1 (Tables A-2 and A-3)

§7.4.3.10 Hotel/Motel Guest Rooms

- §7.4.3.10 Unoccupied hotel/motel (>50 guest rooms) occupancy control of HVAC (setback), ventilation and lighting, TV after 30-minute delay
- Reset thermostat for unrented or unoccupied rooms
- No captive keycard systems

§7.4.6 Lighting Power Allowance

- Interior and exterior lighting power allowance reduced from Tables 9.5.1(Building Area) or 9.6.1(Space-by-Space) in ASHRAE/IES Standard 90.1
  - New updated values

Building Area Method (Partial List)

Table 7.4.6.1A Lighting Power Densities Using the Building Area Method

Building Area Type[a]	LPD, W/ft^2	LPD, W/m^2
Automotive facility	0.64	6.9
Convention center	0.51	5.5
Courthouse	0.74	8.0
Dining: Bar lounge/leisure	0.69	7.4
Dining: Cafeteria/fast food	0.66	7.1
Dining: Family	0.61	6.6
Dormitory	0.52	5.6
Exercise center	0.61	6.6
Fire station	0.50	5.4
Gymnasium	0.67	7.2
Health care clinic	0.68	7.3
Hospital	0.86	9.3
Hotel/Motel	0.70	7.5
Library	0.72	7.8
Manufacturing facility	0.60	6.5
Motion picture theater	0.62	6.7
Multifamily	0.49	5.3
Museum	0.68	7.3
Office	0.69	7.4

Table 7.4.6.1B Lighting Power Density (LPD) Allowances and Room Cavity Ratio (RCR) Thresholds Using the Space-by-Space Method

Informative Note: This table is divided into two sections. The first section covers *space* types that can be commonly found in multiple-building types. The second part covers *space* types that are typically found in a single-building type.

Common Space Types [a]	LPD, W/ft^2	LPD, W/m^2	RCR Threshold
Atrium			(Room cavity ratio)
<20 ft (6.1 m) in height	0.023/ft total height	0.81/m total height	NA
≥20 ft (6.1m) and ≤40 ft (12.2 m) in height	0.023/ft total height	0.81/m total height	NA
>40 ft (12.2 m) in height	0.30 + 0.015/ft total height	3.2 + 0.53/m total height	NA
Audience Seating Area			
Auditorium	0.67	7.2	6
Convention center	0.65	7.0	4
Gymnasium	0.43	4.6	6
Motion picture theater	0.64	6.9	4
Penitentiary	0.44	4.7	4
Performing arts theater	1.34	14.4	8
Religious building	0.98	10.5	4
Sports arena	0.42	4.5	4
All other audience *seating* areas	0.40	4.3	4
Banking Activity Area	0.79	8.5	6
Breakroom (See Lounge/Breakroom)			
Classroom/Lecture Hall/Training Room			
Penitentiary	1.06	11.4	4
All other *classrooms*/lecture halls/training rooms	0.74	8.0	4

§7.4.6 Lighting Controls

- (§7.4.6.2) Occupancy sensor control to reduce power to <50% for commercial, industrial storage stack aisles

  Exception: HID lit areas < 0.8 W/ft² or 8 W/m²

- Egress lighting control (§7.4.6.3)
  < 0.1 W/ft² (1 W/m²)
  Additional allowed if with auto shut-off

- Also mentions exterior sign, parking, and outdoor sales lighting

§7.4.7 Other Equipment

- 7.4.7.1 **Alternate Renewable Approach** comply with applicable equipment efficiency requirements in Normative Appendix B (such as unitary A/C units, heat pumps, chillers)
- 7.4.7.2 Condenser heat recovery in larger supermarkets (>25,000 ft^2 or 2500 m^2)
  - 25% of full-load heat rejection
  - 80% of space or service HW heat, or dehumidification reheat
  - Limits of how system impacted (head pressure and condensing T)
- 7.4.7.3 ENERGY STAR equipment for **Alternate Renewables Approach**

Energy Performance-Based Options

§7.5 Performance-Based Option:

- Comply with a performance cost index (PCI) and CO_2 emissions equivalent

§7.5 Energy Performance

7.5.1 Annual Energy Cost. The *proposed building performance* cost index with consideration of renewables shall be calculated in accordance with ANSI/ASHRAE/IES Standard 90.1, Normative Appendix G, and be equal to or less than the Performance Cost Index (PCI) Target, as determined from the following equation:

$$PCI_{target} = \frac{BBUEC + (BBREC \times BPF) - REC}{BBUEC + BBREC}$$

where

PCI_{target} = target PCI required for achieving compliance with the standard, unitless

BBUEC = the component of *baseline building performance* that is due to *unregulated energy use*, $

BBREC = the component of *baseline building performance* that is due to *regulated energy use*, or *baseline building performance* minus BBUEC, $

BPF = building performance factor taken from Table 7.5.2A, unitless

REC = renewable energy production determined from Section 7.4.1.1.1 and converted to cost, $

Table 7.5.2A Energy Cost and CO_2e Building Performance Factors (BPF)

Building Type	Building Performance Factor (BPF)
Multifamily	0.71
Healthcare/hospital	0.56
Hotel/motel	0.58
Office	0.54
Restaurant	0.59
Retail	0.50
School	0.37
Semiheated warehouse[a]	0.44
All others	0.54

a. Conditioned warehouses shall use the "All others" category.

§7.5 Energy Performance Options

- ***CO_2 emissions factors*** based on the energy source

Table 7.5.2B CO_2e Emission Factors

Building Project Energy Source	CO_2e, lb/MWh	CO_2e, kg/MWh
Grid-delivered electricity and other fuels not specified in this table	1348	612
LPG or propane	601	273
Fuel oil (residual)	685	311
Fuel oil (distillate)	663	301
Coal	820	372
Gasoline	681	309
Natural gas	509	231
District chilled water	323	146
District steam	855	388
District hot water	807	366

The values in this table represent national averages for the United States and include both direct and indirect emissions.

National (U.S.) based numbers (modified recently and will be continuously updated)

CHAPTER/SECTION 8—
INDOOR ENVIRONMENTAL QUALITY

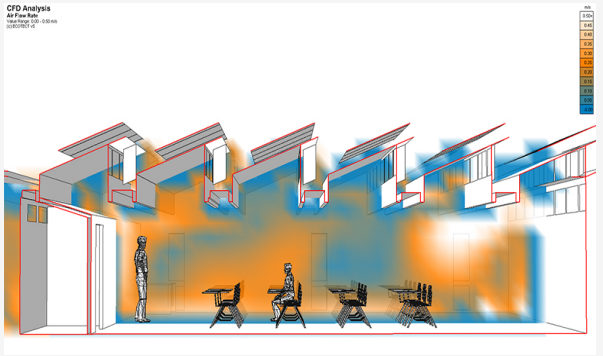
Areas of Concern with Indoor Environmental Quality

- Ventilation requirements
- Outdoor air delivery monitoring
- Contaminant source control
- Environmental tobacco smoke
- Building entry systems
- Thermal comfort
- Acoustics
- Lighting (daylighting, light quality, glare)
- Pressurization and humidity control
- Occupant IEQ surveys

IEQ—Mandatory: Ventilation Rate and Monitoring

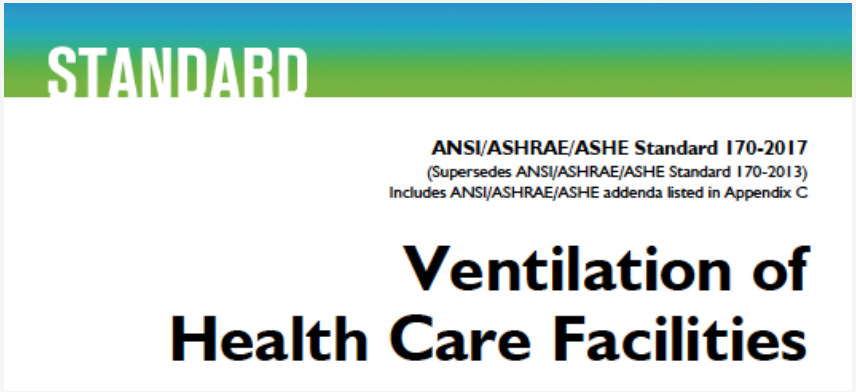
§8.3.1 IAQ

- Rate per Standard 62.1, using ventilation rate procedure (Healthcare use Std. 170)



§8.3.1.2 Outdoor Air Monitoring

- Permanently mounted, direct outdoor airflow measurement ±**10**% of ***minimum outdoor airflow***
  (Differs from LEED in that CO_2 monitoring for densely occupied spaces is not specified)



IEQ—Mandatory: Filtration and Air Cleaning

- **§8.3.1.3 Filtration, Air Cleaner**
  - (a) Particulates—minimum MERV 8 upstream of cooling coils, MERV 13 when project located in "non-attainment" area for $PM_{2.5}$ (for Healthcare Std. 170 applies). Equivalent to updated Std 62.1 values now.
  - (b) Ozone cleaners for outdoor air in building projects located in non-attainment areas for ozone. *(Ozone removal efficiency = 40%, per Std. 62.1 §6.2.1.2).*
  - (c) Filter frames, air cleaner racks, access doors sealed to eliminate bypass pathways.

Pressurization Control

§8.3.1.4 Building Pressure. The requirements in Section 801.3.1.4 (8.3.1.4) supersede the requirements in ASHRAE Standard 62.1, Section 5.9.2. *Building projects* shall be designed in accordance with the following subsections.

- **Mechanical Exhaust.** Mechanical systems shall include controls capable of disabling exhaust fans and closing exhaust dampers whenever mechanical intake airflow is discontinued.
- **Exfiltration.** Mechanical air-conditioning systems with dehumidification capability shall include system controls capable of maintaining static pressure inside the building, at the top floor, equal to or greater than the static pressure outside of the building during *mechanical cooling* operation.

Exceptions:

1. Where excess exhaust is required by process considerations, such as certain industrial or healthcare facilities.
2. Warehouse facilities.
3. Buildings in *Climate Zones* 0B, 1B, 2B, 3B, 3C, 4B, 4C, 5, 6, 7 and 8.

Exhaust of Combustion Products

- Criteria recently added for venting of combustion products of permanently mounted appliances, with exceptions:
  - Ovens in residential spaces
  - ANSI-certified heaters
- Ranges in residential spaces use range hood

Humidity Control §8.3.1.6

- Systems with dehumidification capacity in Climate Zones 0A, 1A, 2A, 3A, 4A, and 4C, comply with these→
- When direct evaporative cooling done, do not exceed 65% RH

a. Where recirculating systems do not include means for *HVAC zone* humidity sensing, such systems shall include controls capable of maintaining the average cooling-coil leaving air temperature at 53°F (12°C) or lower and shall include devices and controls capable of maintaining each *HVAC zone* sensible temperature set point using one of the following approaches:
   1. Variable *HVAC zone* supply airflow rate
   2. Variable return-air bypass flow around each cooling coil serving one or more *HVAC zones*
   3. Variable *HVAC zone* supply air reheat using *site*-recovered energy or *site* solar energy

b. Where a 100% *outdoor air* system provides preconditioned *outdoor air* for ventilation, and where such systems do not include means for *HVAC zone* humidity sensing, the 100% *outdoor air* system shall include devices and controls capable of maintaining the average cooling-coil leaving air temperature at 53°F (12°C) or lower.

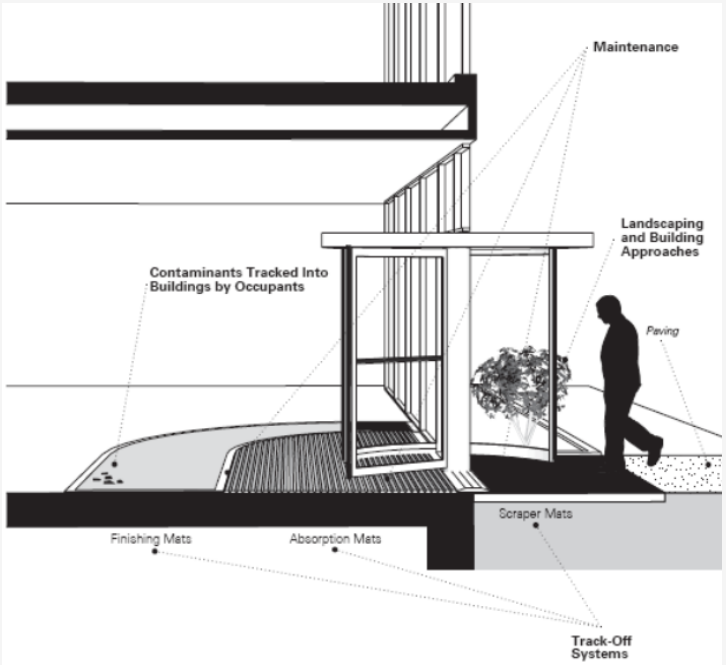
c. Where systems include means for *HVAC zone* relative humidity sensing, such systems shall include devices and controls capable of limiting *HVAC zone* relative humidity to not exceed 65% rh for more than 48 consecutive hours.

IEQ—Mandatory: Smoking and Building Entrances

- §8.3.1.7

  Environmental Tobacco Smoke Control

  - *No smoking inside, with signage*
  - *No smoking within 25 feet (7.5 m) of entrance, outdoor air intakes or operable windows*



- §8.3.1.8

  Building entrance mat system

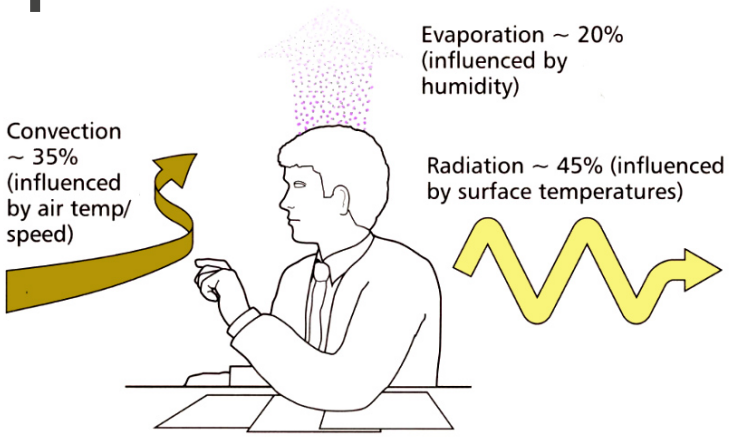
Pre-Occupancy Purge and Ventilation

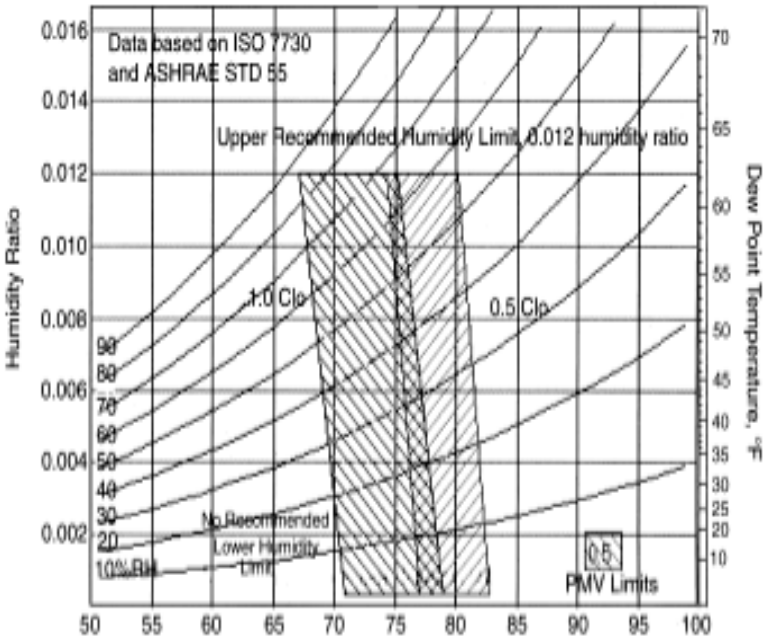
- New section 8.3.1.9, purge for 60 minutes before occupancy in guest rooms at rate of 1 ach
- Preoccupancy ventilation in Section 8.3.1.10 for one hour prior to occupancy start

IEQ—Thermal Comfort

§8.3.2

- Thermal Comfort
  - Comply with Std. 55 Sections 6.1 and 6.2 (Design and Documentation)
  - Exceptions for spaces with special thermal environments





IEQ—Mandatory: Acoustical Control

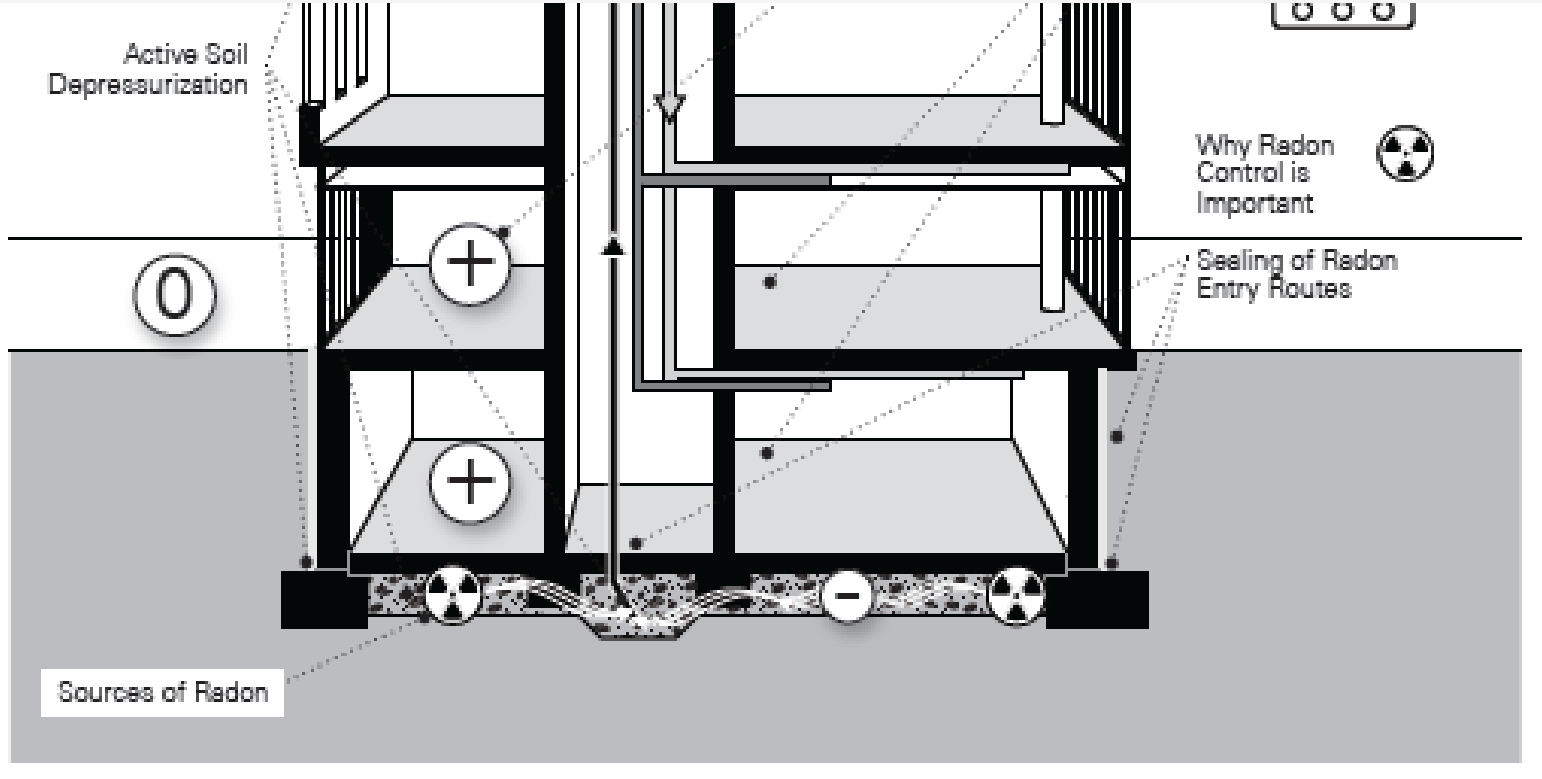
The quick summary:

§8.3.3

- School spaces comply with ANSI/ASA Standard 12.60
- Healthcare per Facility Guidelines Institute (FGI) specifications
- Other detailed requirements for exterior and internal noise management

IEQ—Mandatory: Isolation from Soil Pollutants

- Soil gas retarder for spaces immediately above crawlspaces, slab on grade, or basement slabs



IEQ—Mandatory: Lighting Quality

§8.3.5

- Enclosed offices: Provide at least one of the following for 90% of offices <250 ft² (23.3 m²)
  - Multilevel lighting control
  - Bi-level lighting control with separate task lighting
- Multioccupant spaces
  - Multilevel lighting control
  - Gyms, auditoriums, ballrooms, and cafeteria with at least two separate controlled groups of luminaires

IEQ—Mandatory: Moisture Control

§8.3.6

- Perform a moisture analysis per ASHRAE Standard 160 or vapor-transmission analysis as outlined in Section 8.3.6.1 and 8.3.6.2 for building envelope and humid spaces with potentially unique dew-point conditions (such as kitchens, pool enclosures, locker rooms, museum spaces, etc.)
- Provide flashing or sealants around fenestration, door assembles, penetrations for mechanical equipment

Prescriptive Option (§8.4)

Daylighting

Office space shading (glare)

Low-emitting materials

IEQ—Prescriptive: Daylighting

Daylighting in large spaces directly under roof and high ceilings

- Toplighting for spaces under three stories; larger open (>2,500 ft², 232 m²), ceilings >15 ft [4 m]
  - Minimum daylight area 50%, with adjustments for partitions, etc.
  - More flexibility but also more complete definitions added

With exceptions for Climate Zones 7 and 8, and certain building types (auditorium, etc)

IEQ—Prescriptive: Daylighting

Spaces directly under roof and high ceilings (cont'd)

- Combined skylight area at least 3% of daylight area
- Effective aperture of at least 1%
- Other requirements for vertical fenestration in monitors compared to skylights, side lighting
- Visible transmittance no less that 0.4, but haze value at least 90%

IEQ—Prescriptive: Daylighting for Offices and Classrooms

- Minimum sidelighting for spaces listed in Table 8.4.1.2A (next slide)
  - Side-lighted area at least 75% of wall
  - Interior surfaces visible light reflectance values
- Office space shading, with projections or other techniques (E, W, S) projection factor ≥0.5
  - Louvers, light shelves, etc.
  - Self-shading

<u>Exceptions to shading</u>:

- Translucent panels
- Direct solar <250 h/yr
- Automatically controlled shading devices
- Windows with dynamic glazing

TABLE 801.4.1.2B (TABLE 8.4.1.2B)
MINIMUM SIDELIGHTING EFFECTIVE APERTURE

CLIMATE ZONE	MINIMUM SIDELIGHTING EFFECTIVE APERTURE
0, 1, 2, 3A, 3B	0.10
3C, 4, 5, 6, 7, 8	0.15

Minimum Side Lighting Required

Table 8.4.1.2A Daylit Spaces

Classroom/training room
Conference /meeting/multipurpose room except in convention centers
Lounge/breakroom
Enclosed office and open plan office
Library reading area
Patient rooms and physical therapy rooms within a healthcare facility

Exceptions: Spaces not adjacent to an exterior wall.

IEQ—Materials (for IAQ)

§8.4.2

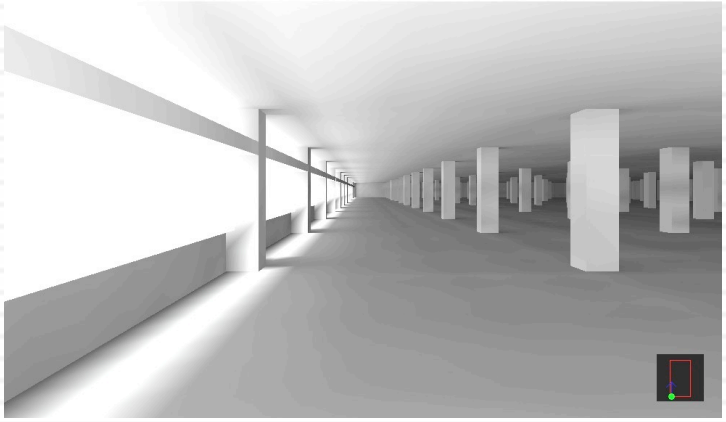
- Sets requirements for materials that may emit volatile organic compounds (VOCs) as a total VOC or individual compounds such as formaldehyde
  - Adhesives and sealants
  - Paints and coatings
  - Floor coverings
  - Composite wood, wood structural, and agrifibers

IEQ—Performance Option

Daylighting Simulation

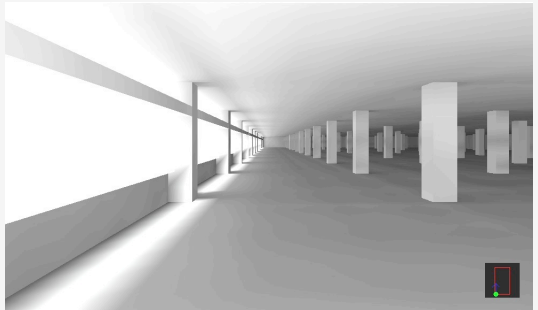
Materials Emissions

Lighting for Presentations



IEQ—Performance Option: Daylighting simulation

- Daylighting simulation for areas that have daylighting (top or side) requirements in 8.4.1
  - Sets minimum daylit levels
  - Minimize direct sun limitation on office worksurface
    - Direct sunlight on worksurface <20% of occupied hours on equinox day
      (worksurface = 2.5 feet [0.8 m] above floor)



IEQ—Performance Option: Materials

- Modeling for individual VOC concentrations for each material used, sum total to show compliance with CDPH/EHLB/Standard Method V1.1 (CA Section 1350)

Source: Scott Credit Union Home Office.

Questions?

CHAPTER/SECTION 9—BUILDINGS IMPACT ON ATMOSPHERE, MATERIALS, AND RESOURCES

Building's Impact on Atmosphere, Materials, and Resources (Section 9)

Mandatory:

- Construction waste management, materials extraction and harvesting, no CFC-based refrigerants, low-mercury lamps, storage for recyclable and discarded goods

Prescriptive Option:

- Reduced impact materials (recycled or salvaged, regional, bio-based)

Performance Option:

- Life-cycle assessment

Materials—Mandatory: Construction Waste

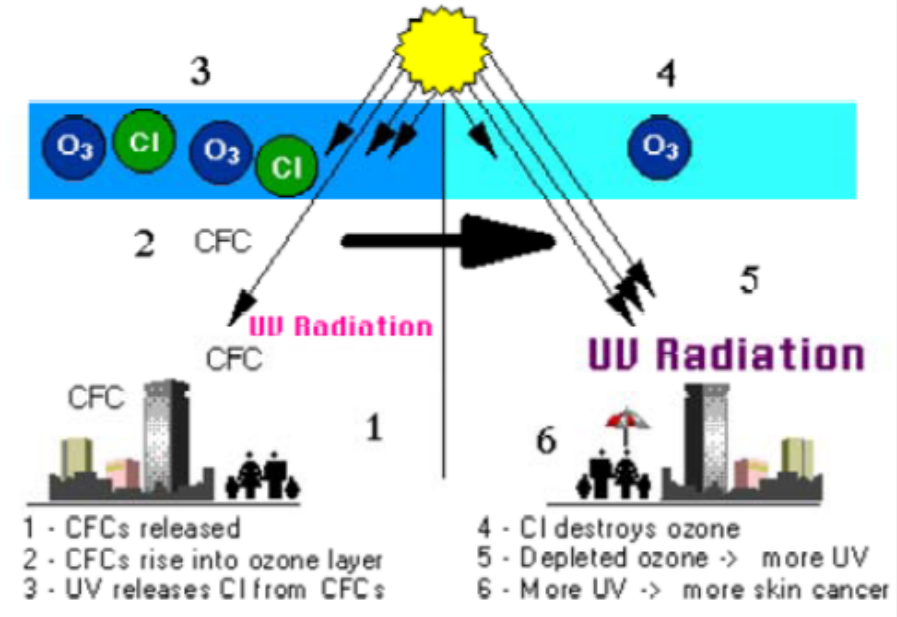
Mandatory Items Key to ASHRAE:

- **Construction waste management**
  - Divert 50% of non-hazardous waste, demolition debris (not counting soil, land clearing)
  - Total waste limit of 42 yd^3 or 12,000 lb per 10,000 ft^2 (35 m^3 or 6000 kg per 1000 m^2)
  - Construction waste management plan
  - Reuse includes donations to charitable organizations, salvage use, reclamation by manufacturers, return of packaging materials

Materials—Mandatory: Refrigerants, Recyclable/Reusable Materials

Mandatory Items Key to ASHRAE:

- No CFCs; fire suppression systems contain no ozone-depleting substances (CFCs, HCFCs , halons)



- Areas for storage and collection of recyclable materials, reusable materials, discarded fluorescent lamps and ballasts, electronics and batteries

Materials: Prescriptive Option (§9.4)

- *Reduced impact materials*
  Comply with two of the items listed:
  - Minimum 10% recycled, salvaged (cost)
  - Regionally extracted, processed, manufactured (15% by cost, 500 mile [800 km] radius)
  - Biobased products (wood, bamboo, wool, etc.) 5% by cost and wood building components—not less than 60% certified content
  - Multiple-attribute product declaration or certification
    - min. of 10 different products

Materials: Performance Option (§9.5)

- ***Life-cycle assessment (LCA)*** per ASTM E2921 & ISO 14044
- LCA shall demonstrate that the proposed building design achieves improvements over the reference building design
  - LCA to show 10% improvement in two impact categories, one of which must be global warming - or –
  - LCA to show 5% improvement in three impact categories, one of which must be global warming:

Impact categories include: land use, resource use, global warming, zone layer depletion, human health effects, ecotoxicity, smog, acidification, and eutrophication

CHAPTER/SECTION 10—CONSTRUCTION AND PLANS FOR OPERATION

§10.3.2 Plans for Operation

Construction and Plans for Operation

All Mandatory Provisions:

- §10.3.1 Construction
- §10.3.2 Plans for Operation

Source: Special Inspection Training

Construction and Operation Plans OVERVIEW

§10.3.1 Construction

- Building functional performance testing
- Commissioning
- Erosion and sediment control
- Indoor air quality during construction
- Moisture control during construction
- Construction vehicles

Point of Emphasis: Commissioning in High-Performance Buildings

- Not a luxury or budget line item that can be "value engineered" away
- ASHRAE/ICC/USGBC/IES Standard 189.1 includes a two-level approach, based on building size:

<10,000 ft² (1000 m²)

- Building functional performance testing of major systems
- Designated project *acceptance representative*

≥10,000 ft² (1000 m²)

- Full-scale commissioning
- Requirements essentially identical to ASHRAE's guidelines; comply with ASHRAE/IES Standard 202

Requirements Concerning Construction

§10.3.1.1 Building Functional Performance Testing

Activities prior to permit and prior to occupancy

- Designate representative to oversee
- Construction documents indicate who does what
- Verify proper installation, acceptance testing, and system manual preparation
- Mechanical systems, lighting, renewable energy, energy,- and water-measuring devices

Construction Requirements *(Cont'd)*

§10.3.1.2 and 3 Building Project Commissioning

- Full commissioning for >10,000 ft² (1000 m²)
  - HVAC, building envelope, lighting, irrigation, plumbing, domestic water, renewable energy
- Commissioning authority (CxA)
- Develop OPR and basis of design
- Design reviews and design review report

Construction Requirements *(Cont'd)*

Activities Prior to Occupancy

- Verify installation, verification of operation
- Verify system manual, including O&M documentation
- Verify training done per owner's requirements

Exception for seasonal-dependent system operations; required to be done when system can be fully demonstrated

Construction Requirements *(Cont'd)*

Commissioning

- Systems involved:
  - HVAC, IAQ, and refrigeration
  - Air curtain systems
  - Lighting and shading controls
  - Irrigation, plumbing, domestic hot water
  - Renewable energy systems
  - Energy, building management, and demand-control systems
- Building envelope airtightness

Construction Requirements *(Cont'd)*

§10.3.1.4 Erosion Control

- Develop and implement an erosion and sediment control plan for all construction activities

IAQ in Construction Process

- Simply summarized
  - Keep materials that will interact with indoor air clean and dry before and during construction
  - Confirm clean air before occupancy
  - Prevent contamination from nearby idling vehicles
- Two methods for confirming clean indoor air quality
  - Flush building with outdoor air for 14 days or
  - Verify “clean” by testing

Construction Requirements *(Cont'd)*

§10.3.1.4 IAQ Construction Management

- Develop and implement an IAQ construction management plan to include:
  - Air conveyance materials
  - Permanent HVAC not used during construction, except for start-up testing and commissioning
  - Flush-out or baseline IAQ monitoring (next 2 slides)

Construction Requirements *(Cont'd)*

IAQ Construction Management

- Post-construction, pre-occupancy
  1. Flush-out: Temp >60°F (15°C), RH ≤60%

Equation 10.3.1.4:

$$\text{TAC} = V_{ot} \times 1/A \times 1/H \times 60 \text{ min/h} \times 24 \text{ h/day} \times 14 \text{ days (I-P)}$$

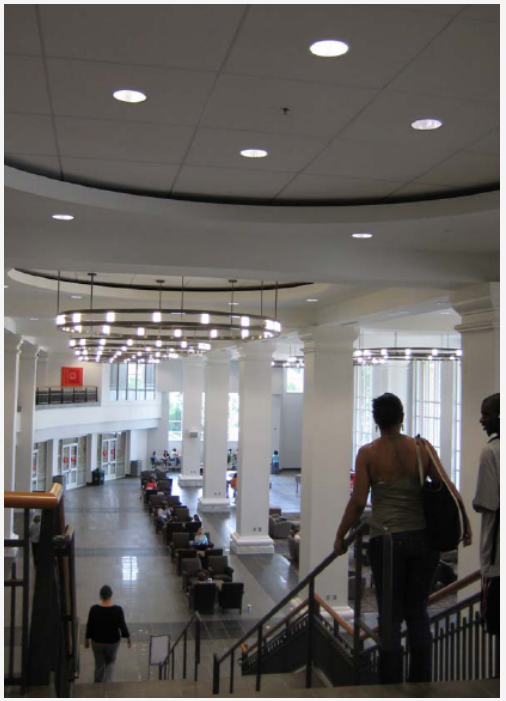
$$\text{TAC} = V_{ot} \times 1 \text{ m}^3/1000\ L \times 1/A \times 1/H \times 3600 \text{ s/h} \times 24 \text{ h/day} \times 14 \text{ days (SI)}$$

where:

V_{ot} = system design *outdoor air* intake flow cfm (L/s) (according to Equation 6-8 of ANSI/ASHRAE Standard 62.1)

A = floor area ft^2 (m^2)

H = ceiling height, ft (m)



- Filtration if air quality alert is forecast
- Occupancy at "½ flush" possible

Construction Requirements *(Cont'd)*

IAQ Construction Management

- Post-construction, pre-occupancy
  1. Flush-out or
  2. Baseline IAQ monitoring for 34 contaminants (next slide has sample list).
     Sample in return airstream or one sample point per 25,000 ft^2 (2500 m^2) or each contiguous floor area if can't separate from already occupied areas

TABLE 1001.3.1.5 (TABLE 10.3.1.5) MAXIMUM CONCENTRATION OF AIR POLLUTANTS RELEVANT TO IAQ

CONTAMINANT	MAXIMUM CONCENTRATION, µg/m³ (UNLESS OTHERWISE NOTED)
Nonvolatile Organic Compounds	
Carbon monoxide (CO)	9 ppm and no greater than 2 ppm above outdoor levels
Ozone	0.075 ppm (8-h)
Particulates (PM2.5)	35 (24 h)
Particulates (PM10)	150 (24 h)
Volatile Organic Compounds	
Acetaldehyde	140
Acrylonitrile	5
Benzene	60
1,3-butadiene	20
t-butyl methyl ether (methyl-t-butyl ether)	8000
Carbon disulfide	800
Caprolactam [a]	100
Carbon tetrachloride	40
Chlorobenzene	1000
Chloroform	300
1,4-dichlorobenzene	800

A portion of the list is shown here

Construction Requirements *(Cont'd)*

- Moisture control (§10.3.1.6)
  - Protect materials that might absorb water
  - No materials installed with visible bio growth

Construction Requirements *(Cont'd)*

- Construction vehicle idling (§10.3.1.7)
  - No more than 5 minutes in any 60-minute period, except as needed for construction-related function

- Protection of occupied areas (§10.3.1.8)
  - Identify potential entrance paths of contaminants into occupied portions of buildings within 35 ft (11 m) of construction activity
- Construction waste management (§10.3.1.10)
  - Plan to show areas designated for collection of recyclable and reusable materials

§10.3.2 Plans for Operation

1. High-Performance Building Operation
   - Site Sustainability
   - Water-Use Efficiency
   - Energy Efficiency
   - Indoor Environmental Quality
2. Maintenance
3. Service Life
4. Transportation Management

Plans for Operation: Site Sustainability

Site Sustainability

- Include maintenance procedures needed to maintain healthy vegetation growth for vegetation used for shading compliance

Plans for Operation: Water Use

1. Initial measurement and verification (M&V)
2. Procedures to track use
   - Benchmark use, ENERGY STAR Portfolio Manager
3. Assess water use efficiency, document

a. Usage Reports: Develop a Plan for collecting *building project* water use data for water sources and subsystems measured in Section 6.3.3.

b. Benchmark Water Performance: Develop a Plan to enter building operating characteristics and water use data into the ENERGY STAR Portfolio Manager. For building parameter inputs into Portfolio Manager (e.g., number of occupants, hours of operation, etc.), use actual average values.

c. Assess Water Use Performance: Develop a Plan to assess *building project* water use efficiency.

Plans for Operation: Energy Use

Energy Efficiency

1. Initial measurement and verification (M&V)
   - Using energy measurement devices specified in Section 7
2. Procedures to track and assess energy
   I. Hourly load profile
   II. Monthly average daily load profile
   III. Monthly and annual energy use
   IV. Monthly and annual peak demand

Plans for Operation: IEQ

Indoor Environmental Quality

- Outdoor airflow monitoring
  - Equipment verified using handheld devices or permanent stations on regular schedule
  - Procedure to react if lower than required *minimum outdoor airflow rate*
- Indoor air quality
  - Air cleaning equipment in non-attainment areas
  - Biennial monitoring through testing, occupant perception, or complaint/response programs
- Green cleaning

Plans for Operation: IEQ (Cont'd)

Indoor Environmental Quality

- Moisture management required where humidity sensors are used for compliance
  - Humidity sensors to monitor relative humidity levels
  - Cleaning or repairing sensors that exceed ±10% accuracy
- IEQ survey within 6–18 months of occupancy

Plans for Operation: Maintenance Plan

Maintenance Plan

- HVAC, electrical, plumbing—ACCA/ASHRAE Standard 180
- Outdoor air delivery monitoring equipment and systems
- Documentation of the plan via electronic storage and maintenance manuals

Plans for Operation: Service Life

Service Life Plan

- Maintenance and repair on structure, envelope, and hardscape

TABLE 10.3.2.3 Minimum Design Service Life for Buildings

Category	Minimum Service Life	Building Types
Temporary	Up to 10 years	Non-permanent construction buildings (sales offices, bunkhouses) Temporary exhibition buildings
Medium life	25 years	Industrial buildings Stand-alone parking structures
Long life	50 years	All buildings not temporary or medium life, including the parking structures below buildings designed for long life category

Plans for Operation: Transportation Management

Transportation Management Plan

1. All building projects have preferred parking for carpools, plan for bicycle transportation
2. Owner-occupied buildings or portions (exception for multifamily residential projects):
   - Incentives for transit or carpool, telework, ridesharing
   - Employees' access to emergency ride home
3. Building tenants
   - Copy of plan
   - Parking not in lease rate or identify value of the parking portion in lease

WRAP-UP

High-Performance Building Design: Related ASHRAE Learning Institute Courses

- *Basics of High-Performance Building Design*
- *Advanced High-Performance Building Design*
- *High-Performance Building Design: Applications and Future Trends*
- *Building Demand Response and the Coming Smart Grid*

Questions (for You)

- Describe how the *IgCC* and Standard 189.1 differ from the LEED program
- On an overall average, how much lower energy consumption (EUI) would a building built according to the *IgCC* be than the average values from the 2003 CBECS survey?
- How much lower fan energy is allowed by the *IgCC* compared to Standard 90.1, and how might that be achieved?
- In what climate zones are specific requirements set for humidity control in buildings, and what are the criteria?

Learning Objectives

1. Recognize the importance of developing a code-intended standard for design of high-performance green buildings and how these standards can be applied in practice
2. Differentiate *Ig*CC and ASHRAE/ICC/USGBC/IES Standard 189.1 from green building certification systems (e.g., LEED, Green Globes)
3. Describe key requirements contained in the *Ig*CC and ASHRAE/ICC/USGBC/IES Standard 189.1 on the important topics of sites, water, energy, IEQ, and materials
4. Distinguish between the two compliance path options (Prescriptive and Performance), their associated provisions in the *Ig*CC, and how to apply them in a design
5. Describe the requirements for construction and plans for operating the building

Thank you!

- Comments, questions, concerns, advice …

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Evaluation and Certificate

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