



Vermont Codes Update Webinar

October 4, 2018
2:00 – 4:00 p.m.

<http://publicservice.vermont.gov/content/building-energy-standards-update>



Presentation Overview

1. Code Overview (5 minutes)
2. Residential (35 minutes)
3. Commercial (60 minutes)
4. Q&A (20 minutes)

This presentation and the recording of it will be posted on the PSD website:

<http://publicservice.vermont.gov/content/building-energy-standards-update>

Please ask clarifying questions during the presentation by typing in your question. Please send other questions/comments via e-mail by October 18th and/or attend the October 11th, 2018 Stakeholder Meetings in Montpelier to review the redline in depth.

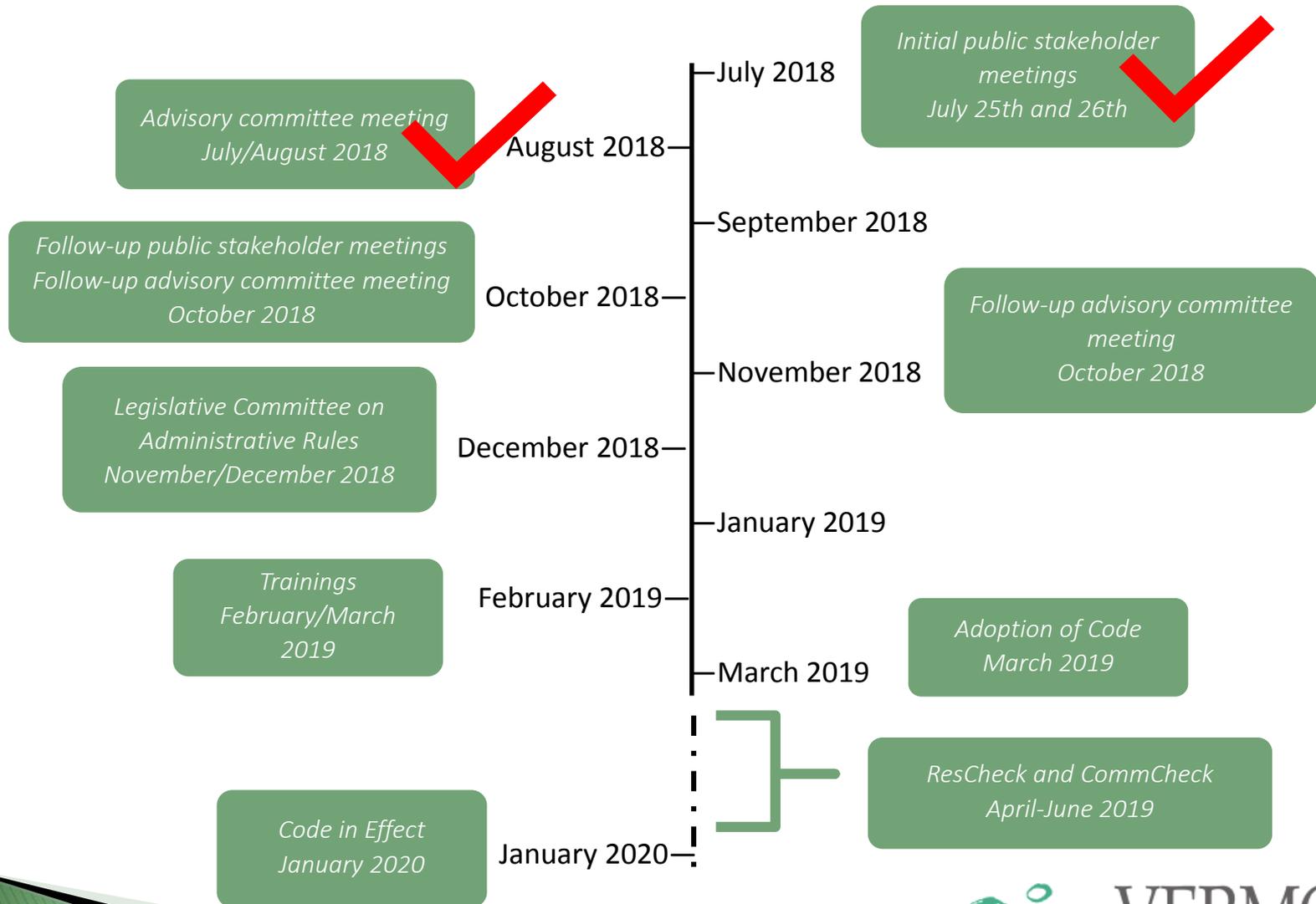
Code Overview: Who

- ▶ **Public Service Department**
 - Planning and Energy Resource Division
 - Kelly Launder: Assistant Director
 - Keith Levenson: Energy Program Specialist
 - Barry Murphy: Evaluation, Measurement and Verification Program Manager
- ▶ **Project Lead and Residential Code**
 - Energy Futures Group
- ▶ **Commercial Code**
 - Navigant Consulting
 - Cx Associates
- ▶ **Roadmap**
 - New Building Institute

Code Overview: Past Information

- ▶ **Please see the July presentations at <http://publicservice.vermont.gov/content/building-energy-standards-update> for more details regarding**
 - Statutory requirements and policy goals
 - What the code update process covers, and what it does not
 - Code framework (present code update through 2030)
 - Roadmap approach to new construction design to net zero by 2030
 - Strategic shift towards:
 - efficient electric heating
 - incorporating renewables (“solar ready”) and electric vehicle charging capabilities
 - Still recognize federal pre-emption requirements
- ▶ **Please attend the Stakeholder meetings on 10/11**
- ▶ **Please submit comments by 10/18 at the latest to:**
 - Residential focus: PSD.CodeUpdateRes@vermont.gov
 - Commercial focus: PSD.CodeUpdateComm@vermont.gov

Code Overview: Schedule



» Residential

Major Changes for 2019 vs 2015

- ▶ Some definitions and other language clarified
- ▶ Insulation and fenestration criteria (Base & Stretch)
 - Base Code
 - Prescriptive packages plus required points from list of options based on house size
 - Stretch Code
 - Same approach with more stringent prescriptive packages and more points
- ▶ Air Leakage Testing
 - Required blower door testing by certified testers in Base
- ▶ Electric resistance heating equipment
- ▶ Electric vehicle charging (Base & Stretch)
- ▶ HERS (ERI) rating values (Base & Stretch)
- ▶ Solar Ready (Stretch)

TABLE R402.1.2.1

INSULATION AND FENESTRATION REQUIREMENTS BY COMPONENT FOR BASE PACKAGES

Component ^a		Package 1	Package 2	Package 3	Package 4
		“Standard”	“SIPS”	“Thick Wall”	“Cavity Only”
Envelope	Ceiling R-Value	R-49 ^g	R-28 cont.	R-49 ^g	R-60 ^h attic / R-49 ^g slope
	Wood Frame Wall R-Value	R-20+5 ^f OR 13+10 ^f	R-21 cont.	R-20+12 ^f	R-20 cavity
	Floor R-Value	R-30 ^e	R-30 ^e	R-30 ^e	R-38 ^e
	Basement/Crawl Space Wall ^c R-Value	R-15 (continuous) OR 20 (cavity)	R-15 (continuous) OR 20 (cavity)	R-20 (continuous) OR R-13+10 ^f	R-20 (continuous) OR R-13+10 ^f
	Slab Edge ^d R-Value	R-15, 4ft	R-15, 4 ft	R-10, 4ft	R-15, 4 ft
	Heated Slab R-Value (Edge and Under)	R-15	R-15	R-15	R-15
	Fenestration ^b (Window and Door) max. U-Value	U-0.30	U-0.30	U-0.30	U-0.27
	Skylight ^b max. U-Value	U-0.55	U-0.55	U-0.55	U-0.55
Air Leakage and Ventilation	Air Leakage ⁱ	≤3.0 ACH50 tested	≤3.0 ACH50 tested	≤3.0 ACH50 tested	≤3.0 ACH50 tested
	Ventilation	EOV ^j 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)	EOV ^j 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)	EOV ^j 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)	EOV ^j 64 cfm; 24 hr/d; ≤50 w (ASHRAE 62.2-2013)
Mechanicals	Duct Leakage	Inside thermal boundary	Inside thermal boundary	4 CFM25 per 100 sq. ft. of CFA ^k	Inside thermal boundary
Lighting	Percent High Efficacy Lamps ^l	90% High Efficacy Lamps	90% High Efficacy Lamps	90% High Efficacy Lamps	100% High Efficacy Lamps

TABLE R402.1.2.2

REQUIRED POINTS BY BUILDING SIZE

Building Size	Required Points
Multifamily < 2000 square feet	4 points
<2000 square feet	5 points
2000 to 4000 square feet	7 points
>4000 square feet	10 points

TABLE R402.1.2.3

POINTS BY COMPONENT

Component		Description	Points
Envelope	Slab	R-10 below entire slab	1
	Walls - Upgraded	AG walls R-20+12 (or U-factor maximum 0.033 wall assembly) (Exception: not available for base package 3) OR ^b	2
	Walls - High-R	AG walls \geq R-40 (U-factor 0.025)	3
	Windows	Average U-factor \leq 0.27 OR ^b	1
		Average U-factor \leq 0.22	2
Air Leakage and Ventilation	Pre-Drywall	ACH50 is tested with blower door before drywall installed OR ^b	1
	Tight	ACH50 \leq 2.0 and balanced H/ERV ^c with \leq 70% SRE ^d and ECM ^e fans OR ^b	3
	Very Tight	ACH50 \leq 1.0 and balanced H/ERV ^c with \leq 80% SRE ^d and ECM ^e fans	4
Heating and Cooling ^a	Basic	ENERGY STAR basic: (1) Gas/propane furnace \geq 95 AFUE, Oil furnace \geq 85 AFUE, (2) Gas/Propane Boiler \geq 90 AFUE, Oil Boiler \geq 87 AFUE, (3) Heat pump HSPF \geq 9.0; PLUS any AC is SEER \geq 14.5 OR ^b	1
	Advanced	Advanced: Whole building heat/cool is (1) NEEP-listed heat pump combination, (2) GSHP, closed loop and COP \geq 3.3, (3) ATWHP ^f COP \geq 2.5 and 120F design temp, (4) Advanced wood heating system	3

TABLE R402.1.2.3 - POINTS CON'T

Component	Description	Points	
Water	Advanced	ENERGY STAR advanced: Electric [EF or UEF ≥ 2.00 for ≤ 55 gal; EF ≥ 2.20 for > 55 gal]	2
	Low Flow	All showerheads ≤ 1.75 gpm ^g , all lav. faucets ≤ 1.0 gpm ^g , and all toilets ≤ 1.28 gpf ^h (for new construction only) OR ^b	1
	Certified	Certified water efficient design per WERS, WaterSense, or RESNETH2O (for new construction only)	2
	Drain Heat Recovery	Drain water heat recovery system on primary showers and tubs	1
	On-Demand	Controlled on-demand hot water recirculation system for furthest bathroom	1
Solar	Solar Ready	Home is Solar Ready per R407.5	1
	Solar PV	Solar Photovoltaic (PV), 1 point per 1.5 kW per housing unit of renewable generation on site	1 per 1.5 kW, max. 4
	Solar Hot Water	Solar hot water system designed to meet at least 50% of annual hot water load	2
Other Measures	Monitoring	Install whole-building energy monitoring system, min. 5 circuits and homeowner access to data	1
	EV Ready	Level 2 electric vehicle charger-ready per 407.3	1
	Battery	Min. 6 kWh grid-connected dispatchable demand-response-enabled battery backup	1

Stretch Code

TABLE R407.2.1.1

Component ^a		Package 1	Package 2	Package 3
		“Standard”	“SIPS”	“Thick Wall”
Envelope	Ceiling R-Value	R-60 ^h attic / R-49 ^g slope	R-36 cont.	R-49 ^g
	Wood Frame Wall R-Value	R-20+5 ^f OR 13+10 ^f	R-21 cont.	R-20+12 ^f
	Floor R-Value	R-30 ^e	R-30 ^e	R-30 ^e
	Basement/Crawl Space Wall ^c R-Value	R-20 (continuous) OR R-13+10 ^f	R-20 (continuous) OR R-13+10 ^f	R-20 (continuous) OR R-13+10 ^f
	Slab Edge ^d R-Value	R-15, 4ft	R-15, 4 ft	R-15, 4ft
	Heated Slab R-Value (Edge and Under)	R-15	R-15	R-15
	Fenestration ^b (Window and Door) max. U-Value	U-0.27	U-0.27	U-0.30
	Skylight ^b max. U-Value	U-0.55	U-0.55	U-0.55
Air Leakage and Ventilation	Air Leakage ⁱ	≤3.0 ACH50 tested	≤3.0 ACH50 tested	≤3.0 ACH50 tested
	Ventilation	Balanced; min. SRE 70	Balanced; min. SRE 70	Balanced; min. SRE 70
Mechanicals	Duct Leakage	Inside thermal boundary	Inside thermal boundary	Inside thermal boundary
Lighting	Percent High Efficacy Lamps ^j	90% High Efficacy Lamps	90% High Efficacy Lamps	90% High Efficacy Lamps

Stretch Points

**TABLE R407.2.1.2
REQUIRED POINTS BY BUILDING SIZE**

Building Size	Required Points
Multifamily < 2000 square feet average unit size	6 points
<2000 square feet	7 points
2000 to 4000 square feet	9 points
>4000 square feet	12 points

Stretch Points

- ▶ Same table as for Base Code
- ▶ Table R402.1.2.3, Points by Component

Envelope Differences

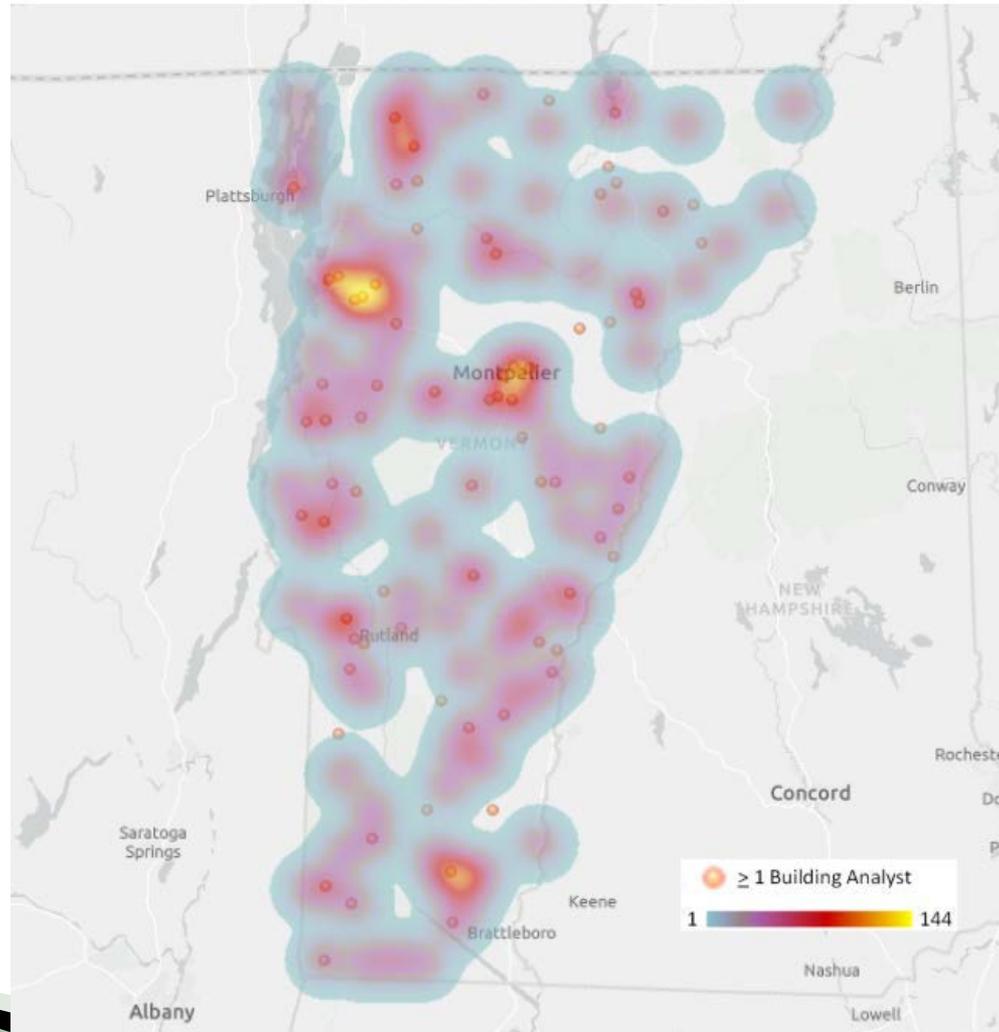
Approach		HERS	Savings vs. 2015
Base Code	Packages Only (excluding Points)	70	7%
	Packages + Points	61	19%
Stretch Code	Packages Only (excluding Points)	64	13%
	Packages + Points	54	23%

Air Leakage Testing for Base Code

- ▶ R402.4.1.2 Air Leakage Testing.
 - ...Testing and verification shall be conducted by an applicable Building Performance Institutes (BPI) Professional, a Home Energy Rating System (HERS) Energy Rater, HERS Field Inspector, or a Vermont Public Service Department approved air leakage tester
 - Optional reporting in Base, required in Stretch:
 - Report cubic feet per minute at 50 Pascals (CFM50) per square foot of building thermal shell area.
 - Building thermal shell area shall include all six (6) sides of the building.
 - For consistency with CBES and to prepare the market to move to this better metric

Building Permits & Building Analysts

Building Permits and Building Analysts per Town



Electric Resistance Heating

- ▶ **R404.2 Electric resistance heating equipment.**
 - The use of electric resistance heating equipment is prohibited.
 - Exceptions:
 1. In bathrooms and in multifamily stairwells;
 2. When at least 80% of the annual heating load of the building can be met with a heat pump(s) and any supplemental electric resistance heat is controlled to restrict it from coming on above 5 °F outdoor temperature.

HERS Rating

- ▶ R406.4 ERI-based compliance
 - Standards:
 - Base – HERS (“Energy Rating Index” or “ERI”) of 61
 - Stretch – HERS (ERI) of 54
 - Based on current HERS software
 - “Up to 5 ERI points can be earned with renewables.”

Electric Vehicle Charging

- ▶ R404.3 Electric vehicle charging.
- ▶ Language from 2015 Stretch is now in Base
 - For multifamily developments of 10 or more dwelling units, 4% of parking spaces (rounded up to the nearest whole number) shall have a socket capable of providing either a level 1 or level 2 charge (see below) within 5 feet of the centerline of the parking space (“EV Charging Parking Space”).
- ▶ R407.4 Stretch
 - For multifamily developments of 10 or more dwelling units, at least 10% of parking spaces (rounded up to the nearest whole number) shall have either Level 2 charging installed or be Level 2 “ready”...

Solar Ready for Stretch

- ▶ **R407.5 Solar Ready Zone for Stretch Code**
 - Construction documents need to show
 - Roof area or ground mount minimum areas
 - Roof load documentation
 - Interconnection pathway
 - Electrical service reserved space

Redlines & Comments

- ▶ Marked-up and clean versions for review
- ▶ Note that Stretch Code section was revised on 10/1 to replace the original section
- ▶ Please try to review and provide comments/corrections/recommendations by COB 10/9 to inform the 10/11 Stakeholder Agenda, otherwise please ensure your comments are submitted by 10/18.

» Commercial

Presentation Overview & Schedule

- ▶ Building Envelope (15 minutes)
- ▶ Mechanical and Service Water Heating (15 minutes)
- ▶ Electric Power and Lighting Systems (15 minutes)
- ▶ Additional Efficiency Package Options (10 minutes)
- ▶ Performance Cost Index (5 minutes)

Model Prototypes and Measures

Mid-rise Apartment building – 4 stories, 33,700sf

Mid-rise Office building – 4 stories, 53,600sf

Stand-alone Retail – 1 story, 30,000sf

Component	2015 CBES	2018 IECC	Proposed 2019 CBES
Wall Insulation (ci.)	R-13	R-18	R-21
Roof Insulation (ci.)	R-30	R-35	R-40
Under Slab Insulation	None	None	R-10
Infiltration	0.5CFM/sf	0.4CFM/sf	0.3CFM/sf
Window - Fixed	U-0.42	U-0.42	U-0.29
Window - Operable	U-0.43	U-0.43	U-0.37
ERV	>8,000 hrs/yr	>8,000 hrs/yr	>3,000 hrs/yr
VFDs fans and pumps	>5 hp and >7.5 hp	>5 hp and >7.5 hp	All fans and pumps
Dimming in Corridors	None	None	50% fixtures; 50% lumen
Fan efficiency	60%	60%	70%
Hot Water Heater efficiency	80%	82%	92% (condensing)

Modeling Outputs and Savings Targets

Table 1. Vermont Commercial Measure Modeling – Savings over 2015 CBES

Group	Measures	Stand Alone Retail	Mid-Rise Office	Mid-Rise Apartment
Net Zero Roadmap Savings Targets for 2019 CBES		21.2%	18.5%	18.7%
July Savings Summary		5%	9%	6%
A	R-21 wall insulation	16%	21%	9%
	R-40 roof insulation			
	R-10 under slab insulation			
	0.4CFM50/sf			
	Windows: U-0.29 Operable/ U-0.37 Fixed			
	ERV > 3,000 hours/year			
	VFDs on all fans and pumps			
	IECC 2018 LPD			
B	-25% LPD over 2018 IECC interior lighting	18%	26%	10%
	-25% LPD over 2018 IECC exterior lighting			
	50% dimming in corridors			
C	70% fan efficiency	19%	27%	12%
	92% efficient condensing hot water heater			
D	Decrease infiltration to 0.3CFM50/sf	19%	28%	17%
Cumulative Impact of Proposed Measures		19%	28%	17%

Code Changes C402 Building Envelope

Summary of Major Changes: Building Envelope

- ▶ **R-Values / U-factors Opaque Assemblies**
- ▶ Increased fenestration requirements
- ▶ **Air leakage compliance via testing**
- ▶ Construction documents must include air barrier information
- ▶ **Air leakage tests for dwelling units**
- ▶ Air barrier commissioning

Building Envelope – *Table C402.1*

Component	2015 CBES	Proposed July	Proposed Oct.
Roof – Above Deck	R-30ci	R-35ci	R-40ci
Roof – Metal Building	R-25 + R11 LS	R-30 + R11 LS	R-25 + R-11 + R11 LS
Roof – Attic and Other	R-49	R-49	R-49

Per stakeholder comment we now have requirements for semi-conditioned spaces. See redline for details.

Building Envelope – *Table C402.1 – Walls Above Grade*

Component	2015 CBES	Proposed July	Proposed Oct.
Mass	R-13.3 ci	R-15.2ci	R-19ci
Metal Building	R-13 + R-13ci or R19.5ci	R-13 + R-13ci or R19.5ci	R-13 + R-17ci or R22.1ci
Metal Framed	R-13 + R-7.5ci or R-13ci	R-13 + R12.5ci or R-18ci	R-13 + R-15ci or R-20ci
Wood Framed and others	R-13 + R-7.5ci or R-20 + R3.8ci or R-23 or R-15ci	R-13 + R-7.5ci or R-20 + R3.8ci or R-23 or R-15ci	R-13 + R-12ci or R-19 + R8ci or R-20ci

Per stakeholder comment we now have more U-factor reference tables available for more construction types.

Building Envelope – *Table C402.1 Floors*

Component	2015 CBES	Proposed July	Proposed Oct.
Mass	12.5ci	R-15ci	R-16.7ci
Joist/Framing – Metal	R-38	R-38	R-38
Joist/Framing – Wood and Other	R-30	R-30	R-30
Unheated Slabs	R-10 for 48”	R-10 for 48”	R-10 entire slab
Heated Slabs	R-10 entire slab	R-10 entire slab	R-20 entire slab

Air Leakage Compliance via Testing

Tested air leakage rate of the building thermal envelope is not greater than 0.50 0.40 0.30 cfm/per square foot of shell area (excluding area of slab and below grade walls) at 50 75 Pa, **six sided surface area**.

But there is an exemption if you fail to achieve 0.30 CFM/SF

Where the measured air leakage rate exceeds 0.30 cfm/ft² but does not exceed 0.60 0.40 cfm/ft², a diagnostic evaluation, such as a smoke tracer or infrared imaging shall be conducted while the building is pressurized, and any leaks noted shall be sealed if such sealing can be made without destruction of existing building components.



Air Leakage Tests for Dwelling Units

A sampling of dwelling units shall be tested and the air leakage rate of each tested dwelling unit's enclosure surface area shall not exceed ~~0.30~~ **0.35** cfm/ft² at ~~50~~ **75** Pa and six-sided surface area.

- **Tested units will be randomly selected**
- The sampling of dwelling units tested shall include at least ~~20~~ **10** percent of the dwelling units in each building
- Including ~~at least one of each unit type~~ **at least one corner unit.**
- Approximately an equal number of units on each floor level.
- **At least one unit on each floor level.**



Image Source: The Energy Conservatory

Stretch Guidelines: Definitions & Envelope

- ▶ Redefine residential buildings with 20+ dwellings or sleeping units as commercial buildings
- ▶ Increased building envelope requirements by 15%
- ▶ Energy efficient fireplaces
- ▶ **Enhanced air infiltration to 0.25 CFM/SF**

Code Changes C403 Building Mechanical Systems

Summary of Major Changes: Mechanical

- ▶ Supplemental electric resistance heat is allowed on cold-climate heat pump systems with proper control and enhanced envelope
- ▶ Proper equipment sizing
- ▶ **Minimum 70% HVAC fan efficiency**
- ▶ Increased equipment efficiencies
- ▶ VFDs required on smaller hydronic systems and motors
- ▶ Energy recovery requirements expanded
- ▶ Required hotel/motel guestroom HVAC occupancy control

Building Mechanical Systems

- ▶ Cold-climate heat pumps may have supplemental electric resistance heat with controls that:
 - Prevent supplementary heater operation when the heating load can be met by the heat pump alone; and
 - In which the cut-on temperature for compression heating is higher than the cut-on temperature for supplementary heating, and the cut-off temperature for compression heating is higher than the cut-off temperature for supplementary heating; and
 - In buildings with 0.25CFM/sf air barrier efficiency.

- ▶ Electric resistance prohibition has not changed
 - See list of exceptions, Section C403.1.2

Equipment sizing

C403.3

- ▶ The output capacity of heating and cooling equipment shall be not greater than the loads calculated in accordance with Section C403.2.1. A single piece of equipment providing both heating and cooling shall satisfy this provision for one function with the capacity for the other function as small as possible, within available equipment options.
- ▶ Heating and cooling equipment sizing is permitted to be up to ten percent greater than the calculated peak heating and cooling loads to allow for building pickup and cool down after temperature setback conditions. A single piece of equipment providing both heating and cooling greater than 10 tons shall have variable capacity control. Hot gas bypass variable capacity control is prohibited.

Mechanical Efficiencies: *Table 403.2.x*

TABLE C403.2.3(3)
 MINIMUM EFFICIENCY REQUIREMENTS:
 ELECTRICALLY OPERATED PACKAGED TERMINAL AIR CONDITIONERS,
 PACKAGED TERMINAL HEAT PUMPS, SINGLE-PACKAGE VERTICAL AIR CONDITIONERS,
 SINGLE VERTICAL HEAT PUMPS, ROOM AIR CONDITIONERS AND ROOM AIR-CONDITIONER HEAT PUMPS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY
Room air conditioners, with louvered sides	< 6,000 Btu/h	—	9.7 11 CEER
	³ 6,000 Btu/h and < 8,000 Btu/h	—	9.7 11 CEER
	³ 8,000 Btu/h and < 14,000 Btu/h	—	9.8 10.9 CEER
	³ 14,000 Btu/h and < 20,000 Btu/h	—	9.7 10.7 CEER
	³ 20,000 Btu/h and ≤ 25,000 Btu/h	—	8.5 9.4 CEER
	³ 25,000 Btu/h	—	9.0 CEER
Room air conditioners, without louvered sides	< 6,000 Btu/h	—	10.0 CEER
	³ 6,000 Btu/h and < 8,000 Btu/h	—	9.0 10.0 CEER
	³ 8,000 Btu/h and < 11,000 Btu/h	—	8.5 9.6 CEER
	³ 11,000 Btu/h and < 14,000 Btu/h	—	8.5 9.5 CEER
	³ 14,000 Btu/h and < 20,000 Btu/h	—	9.3 CEER
	³ 20,000 Btu/h	—	9.4 CEER
Room air-conditioner heat pumps with louvered sides	< 20,000 Btu/h	—	9.8 CEER
	³ 20,000 Btu/h	—	8.5 9.3 CEER
Room air-conditioner heat pumps without louvered sides	< 14,000 Btu/h	—	8.5 9.3 CEER
	³ 14,000 Btu/h	—	8.7 CEER

Mechanical Efficiencies: *Table 403.2.x*

TABLE 403.2.3(4)
 WARM-AIR FURNACES AND COMBINATION WARM-AIR FURNACES/AIR-CONDITIONING UNITS,
 WARM-AIR DUCT FURNACES AND UNIT HEATERS, MINIMUM EFFICIENCY REQUIREMENTS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY
Warm-air furnaces, gas fired	< 225,000 Btu/h	—	78% 80% AFUE or 80%Etc
	³ 225,000 Btu/h	Maximum capacity ^c	80%Etf
Warm-air furnaces, oil fired	< 225,000 Btu/h	—	78% 83% AFUE or 80%Etc
	³ 225,000 Btu/h	Maximum capacity ^b	81%Etg

Mechanical Efficiencies: *Table 403.2.x*

TABLE C403.2.3(5)
MINIMUM EFFICIENCY REQUIREMENTS: GAS- AND OIL-FIRED BOILERS

EQUIPMENT TYPE	SIZE CATEGORY (INPUT)	SUBCATEGORY OR RATING CONDITION	MINIMUM EFFICIENCY
Boilers, hot water	Gas-fired	< 300,000 Btu/h	80% 82% AFUE
		³ 300,000 Btu/h and £ 2,500,000 Btu/hb	80% Et
		> 2,500,000 Btu/ha	82% Ec
	Oil-fired ^c	< 300,000 Btu/h	80% 84% AFUE
		³ 300,000 Btu/h and £ 2,500,000 Btu/hb	82% Et
		> 2,500,000 Btu/ha	84% Ec
Boilers, steam	Gas-fired	< 300,000 Btu/h	75% 80% AFUE
	Gas-fired- all, except natural draft	³ 300,000 Btu/h and £ 2,500,000 Btu/hb	79% Et
		> 2,500,000 Btu/ha	79% Et
	Gas-fired-natural draft	³ 300,000 Btu/h and £ 2,500,000 Btu/hb	77% Et
		> 2,500,000 Btu/ha	77% Et
	Oil-fired ^c	< 300,000 Btu/h	80% 82% AFUE
³ 300,000 Btu/h and £ 2,500,000 Btu/hb		81% Et	
		> 2,500,000 Btu/ha	81% Et

Fan Efficiency: *Section C403.8.3*

- ▶ **C403.8.3 Fan efficiency (Mandatory).**

Fans shall be electronically commutated motors or shall have a fan efficiency grade (FEG) of not less than **70**, as determined in accordance with AMCA 205 by an *approved*, independent testing laboratory and labeled by the manufacturer. The total efficiency of the fan at the design point of operation shall be within 15 percentage points of the maximum total efficiency of the fan.

- ▶ **Exception:** The following fans are not required to have a fan efficiency grade:

- ▶ ~~1. Fans of 5 hp (3.7 kW) or less as follows:~~
 - ▶ ~~1.1. Individual fans with a motor nameplate horsepower of 5 hp (3.7 kW) or less, unless Exception 1.2 applies.~~
 - ▶ ~~1.2. Multiple fans in series or parallel that have a combined motor nameplate horsepower of 5 hp (3.7 kW) or less and are operated as the functional equivalent of a single fan .~~

VT change based on modeling for state goal

Pump Controls C403.4.2.4

- ▶ Automatically vary pump flow on heating–water systems, chilled–water systems and heat rejection loops serving water–cooled unitary air conditioners as follows:
 - 1 Where pumps operate continuously or operate based on a time schedule, pumps with nominal output motor power of 2 hp or more shall have a variable speed drive.
- ▶
 - Where pumps have automatic direct digital control configured to operate pumps only when zone heating or cooling is required, a variable speed drive shall be provided for pumps with motors having the same or greater nominal output power indicated in Table C403.4.4 based on the climate zone and system served.
- ▶ Where a variable speed drive is required, pump motor power input shall be not more than 30 percent of design wattage at 50 percent of the design water flow. Pump flow shall be controlled to maintain one control valve nearly wide open or to satisfy the minimum differential pressure.

Fan Speed Control

- ▶ **C403.4.3.1 Fan speed control.**

Each fan system powered by an individual motor or array of motors with connected power, including the motor service factor, totaling 2 hp or more shall have controls and devices configured to automatically modulate the fan speed to control the leaving fluid temperature or condensing temperature and pressure of the heat rejection device. Fan motor power input shall be not more than 30 percent of design wattage or 50 percent of the design airflow.

- ▶ **C403.4.4 Heat rejection equipment fan speed control.**

Each fan powered by a motor of 5 hp or larger shall have the capability to operate that fan at two-thirds of full speed or less, and shall have controls that automatically change the fan speed to control the leaving fluid temperature or condensing temperature/pressure of the heat rejection device.

- **Exception:** Factory-installed heat rejection devices within HVAC equipment tested and rated in accordance with Tables C403.2.3(6) and C403.2.3(7).

Economizer Fault Detection and Diagnostics: Section C403.2.4.7

- ▶ Air cooled unitary direct-expansion units and variable refrigerant flow (VRF) units (≥ 15 tons) equipped with economizer shall include fault detection and diagnostics (FDD) system complying with:
 - Temperature sensors permanently installed to monitor system operation
 - Outside air
 - Supply air
 - Return air

Unit size was ≥ 20 tons in CBES 2015

Energy Recovery Ventilation

TABLE C403.7.4(1)
ENERGY RECOVERY REQUIREMENT
(Ventilation systems operating less than 3,000 hours per year)

PERCENT (%) OUTDOOR AIR AT FULL DESIGN AIRFLOW RATE							
³ 10% and < 20%	³ 20% and < 30%	³ 30% and < 40%	³ 40% and < 50%	³ 50% and < 60%	³ 60% and < 70%	³ 70% and < 80%	³ 80%
DESIGN SUPPLY FAN AIRFLOW RATE (cfm)							
NR	³ 16,000	³ 5,500	³ 4,500	³ 3,500	³ 2,000	³ 1,000	> 120

Reduced from 8,000 hours per year to 3,000 hours per year

Automatic HVAC Controls in Hotels/Motels > 50 30 Guestrooms

Each guestroom shall be provided with card key controls which comply with these requirements:

- ▶ **Automatic temperature setpoint controls**
 - Controls shall be provided on each HVAC system that are capable of and configured to automatically raise the cooling setpoint and lower the heating setpoint from the occupant setpoint within 30 minutes after the occupants have left the guestroom.
- ▶ **Ventilation controls**
 - Controls shall be provided on each HVAC system that are capable of and configured to automatically turn off the ventilation and exhaust fans within 30 minutes of the occupants leaving the guestroom, or isolation devices shall be provided to each guestroom that are capable of automatically shutting off the supply of outdoor air to and exhaust air from the guestroom.

Exterior Pipe Insulation Protection

Section C403.11.3.1

Piping insulation shall comply with both of the following requirements:

- i. Insulation exposed to weather shall be suitable for outdoor service and shall be protected by aluminum, sheet metal, painted canvas, plastic cover, or other similar materials approved by the building official. Cellular foam insulation shall be protected as above or painted with a coating that is water-retardant and provides shielding from solar radiation; and
- ii. Unless the insulation is vapor-retardant, insulation covering chilled-water piping or refrigerant suction piping located outside the conditioned space shall include a vapor retardant located outside the insulation. All penetrations and joints shall be sealed

Heated Vestibules

- ▶ The heating system for heated vestibules and air curtains with integral heating shall be provided with controls configured to shut off the source of heating when the outdoor air temperature is greater than 45°F (7°C). Vestibule heating systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 60°F (16°C). Cooling for vestibules is prohibited.
- ▶ **Exception:** Control of heating provided by site-recovered energy or transfer air that would otherwise be exhausted.

Stretch Guidelines: Mechanical

- ▶ All HVAC equipment shall be 20% more efficient
- ▶ Dedicated outdoor air system required for 90% of the building area
- ▶ Condenser motors shall be ECM
- ▶ Walk-in cooler and freezer evaporator and condenser fan motors shall be ECM
- ~~▶ Automatic Demand Shed Control~~
- ~~▶ Refrigeration Heat Recovery~~

Code Changes

C404

Service Water Heating

Major Change – from July

- ▶ **C404.2.1 High input service water-heating systems.** Gas-fired water-heating equipment installed in new buildings shall be in compliance with this section. Where a singular piece of water-heating equipment serves the entire building, ~~and the input rating of the equipment is 1,000,000 Btu/h (293 kW) or greater,~~ such equipment shall have a thermal efficiency, E_t , of not less than **92** percent. Where multiple pieces of water-heating equipment serve the building and the combined input rating of the water-heating equipment is 1,000,000 Btu/h (293 kW) or greater, the combined input-capacity-weighted-average thermal efficiency, E_t , shall be not less than **92** percent.

Stretch Guidelines: Service Water Heating

- ▶ Heat recovery for service water heating
 - ▶ 1. In facilities operating >12 hours a day,
 - ▶ 2. The total installed heat capacity of water-cooled systems exceeds 3,000,000 Btu/hr of heat rejection, and
 - ▶ 3. The design service water heating load exceeds 500,000 Btu/h

Code Changes C405 Electrical Power and Lighting Systems

Summary of Major Changes: Electric & Lighting

- ▶ Open office area occupancy sensors
- ▶ **Egress lighting controls**
- ▶ Requirements added to daylight control functions
- ▶ **Reduced lighting power allowance**
- ▶ **Renewable energy systems**
- ▶ **Electric vehicle charging stations**

Egress Lighting Controls

Luminaires serving the exit access and providing means of egress illumination where the means of egress shall be illuminated at all times the room or space is occupied, including luminaires that function as both normal and emergency means of egress illumination shall be controlled by a combination of listed emergency relay and occupancy sensors, or signal from another building control system, that automatically reduces the lighting power by 50% when unoccupied for a period longer than 15 minutes.

Lighting Power Density – *Table C405.4.2(1)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Automotive facility	0.80	0.71	0.60
Convention center	1.01	0.76	0.70
Courthouse	1.01	0.90	0.76
Dining: bar lounge/leisure	1.01	0.90	0.76
Dining: cafeteria/fast food	0.90	0.79	0.67
Dining: family	0.95	0.78	0.69
Dormitory	0.57	0.57	0.47
Exercise center	0.84	0.65	0.59
Fire station	0.67	0.53	0.48
Gymnasium	0.94	0.68	0.64
Health care clinic	0.90	0.82	0.69

Lighting Power Density – *Table C405.4.2(1)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Hospital	1.05	1.05	0.84
Hotel/Motel	0.87	0.75	0.65
Library	1.19	0.78	0.78
Manufacturing facility	1.17	0.90	0.82
Motion picture theater	0.76	0.75	0.64
Multifamily	0.51	0.51	0.48
Museum	1.02	1.02	0.83
Office	0.82	0.79	0.64
Parking garage	0.21	0.15	0.14
Penitentiary	0.81	0.75	0.62
Performing arts theater	1.39	1.18	1.02

Lighting Power Density – *Table C405.4.2(1)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Police station	0.87	0.80	0.67
Post office	0.87	0.67	0.61
Religious building	1.00	0.94	0.77
Retail	1.26	1.06	0.92
School/university	0.87	0.81	0.67
Sports arena	0.91	0.87	0.71
Town hall	0.89	0.80	0.67
Transportation	0.70	0.61	0.52
Warehouse	0.60	0.48	0.43
Workshop	1.19	0.90	0.83

Lighting Power Density for Zone 3 – *Table C405.4.2(2)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Base Site Allowance	750 W	500 W	375 W
Parking Area and Drives	0.10 W/ft ²	0.06 W/ft ²	0.05 W/ft ²
Walkways less than 10 feet wide	0.8 W/linear foot	0.6 W/linear foot	0.40 W/linear foot
Walkways 10 feet wide or greater, plaza areas special feature areas	0.16 W/ft ²	0.11 W/ft ²	0.08 W/ft ²
Dining Areas	Not Specified	0.75 W/ft ²	0.60 W/ft ²
Stairways	1.0 W/ft ²	0.70 W/ft ²	0.50 W/ft ²
Pedestrian tunnels	0.2 W/ft ²	0.14 W/ft ²	0.10 W/ft ²
Landscaping	Not Specified	0.04 W/ft ²	0.03 W/ft ²

Lighting Power Density for Zone 3 – *Table C405.4.2(2)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Main entries	30 W/linear foot of door width	21 W/linear foot of door width	15 W/linear foot of door width
Other doors	20 W/linear foot of door width	14 W/linear foot of door width	15 W/linear foot of door width
Entry canopies	0.4 W/ft ²	0.4 W/ft ²	0.20 W/ft ²
Loading Docks	Not Specified	0.35 W/ft ²	0.25 W/ft ²
Free-standing and attached	0.8 W/ft ²	0.60 W/ft ²	0.40 W/ft ²
Open areas (including vehicle sales lots)	0.5 W/ft ²	0.35 W/ft ²	0.25 W/ft ²
Street frontage for vehicle sales lots in addition to “open area” allowance	10 W/linear foot	7 W/linear foot	5 W/linear foot

Lighting Power Density for Zone 3 – *Table C405.4.2(2)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Building facades	0.113 W/ft ² of gross above-grade wall area	0.113 W/ft ² of gross above-grade wall area	0.113 W/ft ² of gross above-grade wall area
Automated teller machines (ATM) and night depositories	270 W per location plus 90 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location	135 W per location plus 45 W per additional ATM per location
Entrances and gatehouse inspection stations at guarded facilities	0.75 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area	0.5 W/ft ² of covered and uncovered area

Lighting Power Density for Zone 3 – *Table C405.4.2(2)*

Area Type	2015 CBES	Proposed July	Proposed Oct.
Loading areas for law enforcement, fire, ambulance and other emergency service vehicles	0.5 W/ft ² of covered and uncovered area	0.35 W/ft ² of covered and uncovered area	0.35 W/ft ² of covered and uncovered area
Drive-up windows/doors	400 W per drive-through	200 W per drive-through	200 W per drive-through
Parking near 24-hour retail entrances	800 W per main entry	400 W per main entry	400 W per main entry

Renewable Energy Systems

Building projects with footprint greater than 20,000 square feet, shall install *on-site renewable energy* systems with a minimum rating of 3.7 W/ft² or 13 Btu/h·ft² (40 W/m²) multiplied by the horizontally-projected gross roof area. This system must meet a minimum of ~~6%~~ 10% of the projected energy use of the building for mechanical and service water heating and lighting or cover an area not to exceed 75% of gross roof area less the area covered by rooftop equipment, skylights, occupied roof decks and planted areas. This system can be ground mounted as long as all relevant permits are obtained.

If the building location, required orientation or design cannot accommodate the required on-site renewables then other options should be explored and proposed by the design team to the relevant authority.



Electric Vehicle Charging Stations

Parking spots shall have a socket capable of providing the required level 1 or level 2 charge (see Table C405.11) within 5 feet of the centerline.

50% of the parking spaces, rounded up to the nearest whole number, shall have Electric Vehicle Supply Equipment (EVSE). The remainder shall be pre-wire to allow for installations at such time as they are needed.

Facility Type	Minimum Number of Chargers (rounded up to nearest whole number)					
	<25		≥25 and <500		≥500	
	Level 1	Level 2	Level 1	Level 2	Level 1	Level 2
Retail Groups A&M	0%	0%	2% 0%	1% 4%	1% 0%	5 10
Hotel/Motel Group R-1	4% 0	0% 1	2% 0%	1% 2%	1%	5 10
Restaurant	4%	4%	2%	2%	1%	5
Hospital/ Healthcare Groups I-1, I-2, I-3 & R-4	4% 1	0% 1	2%	2% 4%	1%	5 10
Office Groups B, E, F & H	4% 1	0% 1	4% 3%	1% 3%	2%	5
School/University	0%	0%	4%	2%	2%	5
Group R-2	1	0	8%	0%	3%	5

Stretch Guidelines: Electric & Lighting

- ▶ Parking garage lighting controls
- ▶ Dwelling unit lighting requirements **reduced from 20 foot-candles to 10 foot-candles**
- ▶ Reduced interior **and exterior** lighting power allowance
- ▶ ~~Requirement for fractional HP motors~~
- ▶ ~~Control of electrical receptacles~~
- ▶ Solar rooftop readiness

Code Changes C406

Additional Efficiency Package Options

Summary of Additional Efficiency Package Options

- ▶ In the base code must achieve 6 points, 9 for stretch guidelines
- ▶ Choose from the following options
 - More efficient HVAC performance
 - Reduced lighting power density
 - Enhanced lighting controls
 - On-site renewable energy
 - Dedicated outdoor air system (DOAS)
 - High efficiency service water heating

Summary of Additional Efficiency Package Options

▶ Continued:

- Heat pump water heating
- Enhanced envelope performance
- Reduced air infiltration
- Efficient kitchen appliances
- Controlled receptacles

▶ Considering adding networked lighting as an additional option

Points for Efficiency Package Options

Efficiency Package Option	Group R-1	Group R-2	Group B	Group E	Group M	All other groups
	Additional Efficiency Credits					
HVAC Performance	<u>2</u>	<u>2</u>	<u>5</u>	<u>2</u>	<u>6</u>	<u>3</u>
Lighting Power 1	<u>1</u>	<u>1</u>	<u>3</u>	<u>3</u>	<u>3</u>	<u>2</u>
Lighting Power 2	<u>2</u>	<u>2</u>	<u>5</u>	<u>5</u>	<u>5</u>	<u>4</u>
Lighting Controls	<u>N/A</u>	<u>N/A</u>	<u>2</u>	<u>1</u>	<u>2</u>	<u>1</u>
Renewable Energy	<u>3</u>	<u>2</u>	<u>2</u>	<u>3</u>	<u>3</u>	<u>3</u>
DOAS	<u>3</u>	<u>1</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>3</u>
Water Heating 1	<u>5</u>	<u>6</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>3 (Group I only)</u>
Water Heating 2	<u>3</u>	<u>3</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>2 (Group I only)</u>
HP Water Heater	<u>5</u>	<u>5</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>2 (Group I only)</u>
Envelope	<u>3</u>	<u>4</u>	<u>2</u>	<u>2</u>	<u>2</u>	<u>3</u>
Air Infiltration	<u>3</u>	<u>5</u>	<u>2</u>	<u>3</u>	<u>4</u>	<u>3</u>
Kitchen Appliances	<u>5</u>	<u>N/A</u>	<u>N/A</u>	<u>N/A</u>	<u>5</u>	<u>5 (Group A-2 only)</u>
Controlled Receptacles	<u>N/A</u>	<u>N/A</u>	<u>6</u>	<u>2</u>	<u>N/A</u>	<u>N/A</u>

Code Changes C407

System Commissioning

System Commissioning: *Section C407*

- ▶ Requirements are described in more detail:
 - Cx Plan
 - Test and Balance
 - Functional HVAC Performance Testing
 - Functional Lighting Testing
 - Commissioning Report
 - Documentation (Construction drawings and O&M manual)

- ▶ Thresholds are reduced
 - New buildings \geq ~~50,000~~ ft²
 - Mechanical & service water heating systems > 480,000 Btu/h cooling capacity
 - Mechanical & service water heating systems heating/cooling combined > 600,000Btu/h

Code Changes C501

Existing Buildings

Adopting language from 2018 IECC
No Major Changes

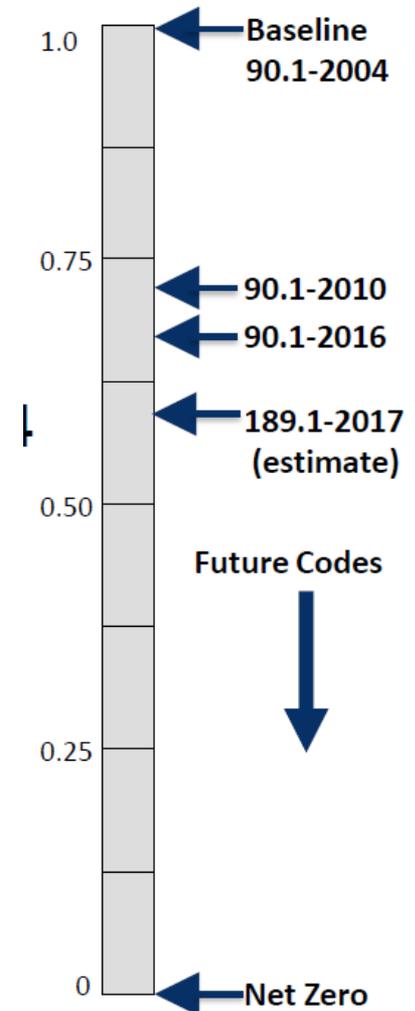
Code Changes ASHRAE 90.1 Appendix G Performance Cost Index

New Compliance Path

- ▶ 90.1–2016 Introduces a Third Path for Compliance
- ▶ Appendix G requires a Performance Cost Index (PCI) specific to building type and climate zone

$$\text{Performance Cost Index (PCI)} = \frac{\text{Proposed Building Performance}}{\text{Baseline Building Performance}}$$

- ▶ Stable and independent baseline set ~ 90.1–2004
- ▶ Intent is that the stringency of the baseline doesn't change (stable)
- ▶ Clear rules about what systems and other prescriptive choices are in baseline (independent)
- ▶ PCI target changes with each version of a code
- ▶ Each code edition has a required PCI for compliance
- ▶ Beyond code programs can choose a PCI to meet their needs
 - Vermont will base PCI on building modeling of the prescriptive CBES compliance path



Source: Pacific Northwest National Laboratory

Vermont Performance Cost Index found in CBES Section C401.2.1 Applicable provisions to 90.1

Building Area Type	Proposed Code BPF	Stretch BPF
Multifamily	0.62	0.71
Healthcare/hospital	0.46	0.49
Hotel/motel	0.48	0.55
Office	0.43	0.52
Restaurant	0.50	0.54
Retail	0.44	0.47
School	0.39	0.42
Warehouse	0.53	0.57
All Others	0.45	0.49

In closing...opportunities to weigh in

Please send comments by October 18th at the latest to:

- Residential focus: PSD.CodeUpdateRes@vermont.gov
- Commercial focus: PSD.CodeUpdateComm@vermont.gov

Stakeholder Meetings – October 11th, 2018

9:00 am – 12:00 pm – Residential focus

12:00 pm – 1:00 pm – Lunch hour (lunch not provided)

1:00 pm – 4:00 pm – Commercial focus

Note:

There will be no “overview” of changes at the Stakeholder meetings. Instead, we will develop an Agenda based on the areas/measures that received the most comments and will use the meetings to discuss in-depth the areas/measures most critical to the stakeholders.

Next steps in process:

- ▶ Late October – Advisory Group Meetings
- ▶ Begin ICAR/LCAR process in November/December 2018
- ▶ Adoption of code – March 2019 (estimated)
- ▶ Code in effect – December 2019 / January 2020 (estimated)



- Materials will be posted at <http://publicservice.vermont.gov/content/building-energy-standards-update>

» Q&A

- Send questions/comments by October 18th:
 - Residential focus: PSD.CodeUpdateRes@vermont.gov
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