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Vermont Energy Code Collaborative
CBES Committee Meeting #1

May 11, 2021
11:00 – 1:00

ENERGY FUTURES GROUP

Cxassociates LLC

Guidehouse

nbi new buildings institute

Meeting Agenda

1. Overview
2. Background and Goals of the Collaborative
   a. Introductions
   b. CBES topics
   c. Meeting schedule
   d. Ground rules, logistics, and use of chat
3. Results of survey and discussion
   1. General survey questions' results
   2. Lighting Power Density (LPD)
   3. Mechanical Controls
   4. Additional Efficiency Package C406
   5. Maintenance Information and Systems Commissioning C407
4. Wrap up/ next steps

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Background & Goals

- Not enough time to go into depth during the three-year energy code update cycle
- This is your opportunity to dive into critical topics in more depth
- Listening and gathering information to inform decisions
  - Hoping for diverse set of perspectives and opinions
- PSD is the ultimate decision-maker, but feedback and input are essential
- Discuss and provide multiple points of view, don't need to reach consensus

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Code Team: Who

- Lead State Agency
  - Public Service Department
    - Kelly Launder: Assistant Director
    - Keith Levenson: Energy Program Specialist
    - Barry Murphy: EM&V Program Manager
- Code Update Lead and Residential Code
  - Energy Futures Group
    - Richard Faesy, Gabrielle Stebbins & Liz Bourguet
- Commercial Code Update
  - Guidehouse Consulting
    - Keith Downes & Stu Slote
  - Cx Associates
    - Eveline Killian
- National Insights
  - New Building Institute
    - Jim Edelson & Mark Lyles

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Introductions in Chat

- Name
- Business
- Town
- Area of expertise

https://pointroadgroup.com/introduce-yourself-virtually-make-strong-impressions/

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Ground Rules

- Respectful listening
- Limit comments to less than 2 or 3 minutes
- Give everyone a turn to say something before speaking up again – may use hand raise feature
- State your name when you make a comment for the notes
- Notes
  - Attributed to speakers for future reference
  - Out for review before posting
- Use the chat to ask questions/ clarifications –not for having separate discussions.

CBES Topics

- First meeting: **Survey Results**
  - CBES Compliance
  - Mechanical Controls
  - Additional Efficiency Package C406
  - Maintenance Information and Systems Commissioning C407
- Second meeting: **June 2nd 2:00-4:00**
  - Topic open to input from committee members
- Third meeting: **June 15th 9:00-11:00**
  - Topic open to input from committee members

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Meeting Schedule

- Cross Cutting
  - #1 – May 4, 11:00 – 1:00
  - #2 – June 8, 11:00– 1:00
- C&I
  - #1 – May 11, 11:00 – 1:00
  - #2 – June 2, 2:00 – 4:00
  - #3 – June 15, 9:00–11:00
- Residential
  - #1 – May 13, 3:00 – 5:00
  - #2 – Week of June 14
- Multifamily
  - #1 – Week of June 1

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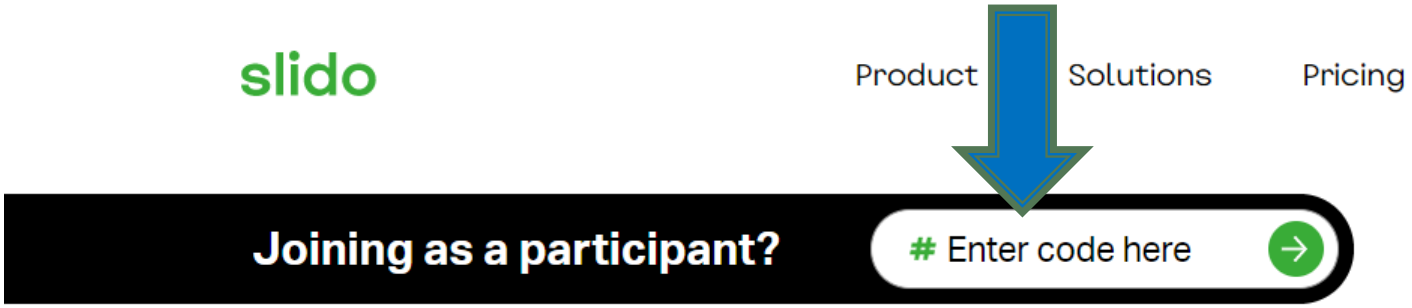
Polling

- Throughout our discussion, we will be asking you to respond to poll questions
- Before we get started, please go to https://www.sli.do/
- Enter **717491** into the field at the top of the website



- Leave this webpage open throughout our discussion
- We will let you know when it is time to answer a question

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General Survey Results

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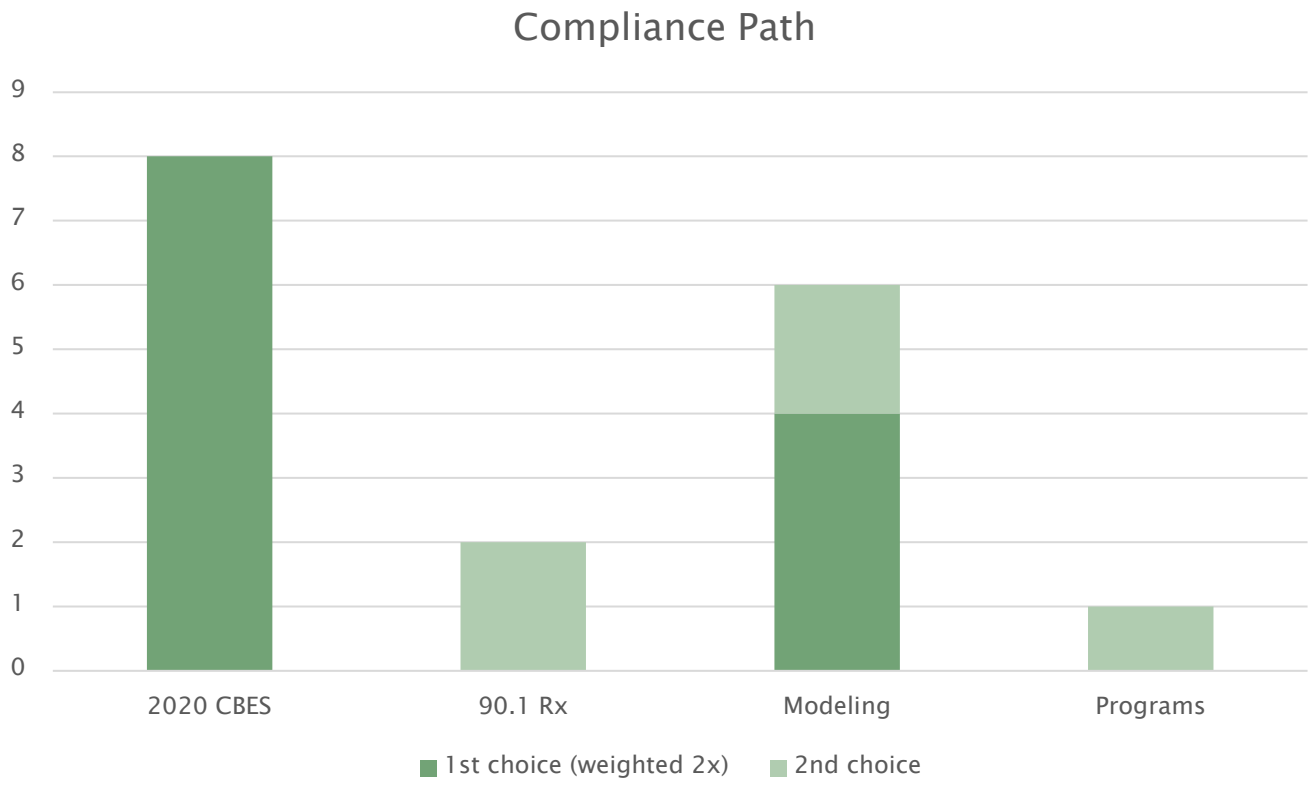
Compliance Path

- Which compliance paths do you use, rank in order of most common



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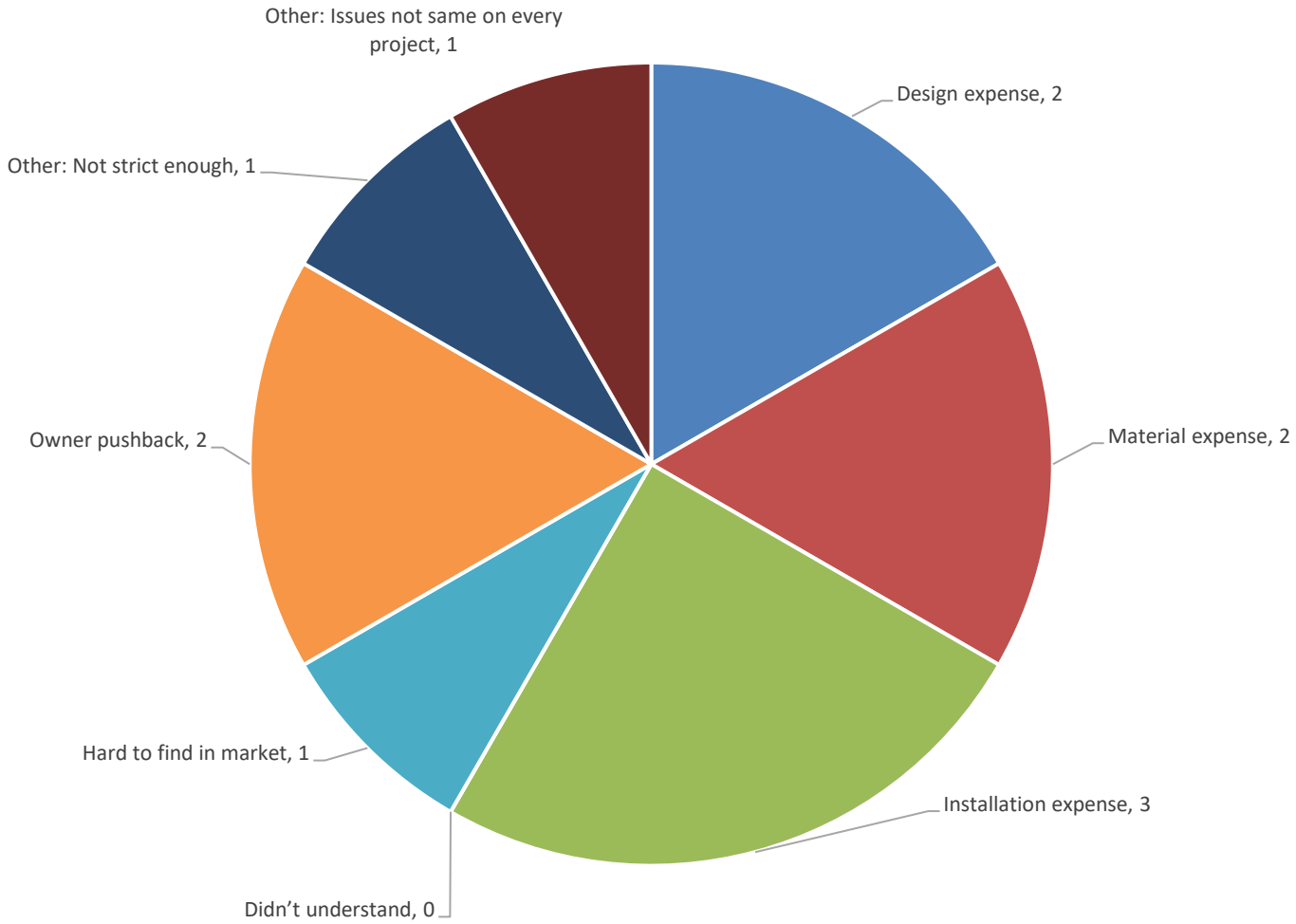
What 2020 CBES changes did you find most challenging to address? (top three ranked 1-3)				
Lighting Power Density	1			
Mechanical controls		1		
Additional Efficiency Package C406			1	
Maintenance Information and Systems Commissioning C407	2		3	3
Building shell insulation			2	
Mechanical equipment		2		
EV charging stations				2
Window and doors		3		

Reasons for Challenges



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Code Errors

- Are there any errors in the code that need to be addressed?

1. Mechanical sequences are archaic.
2. Renewable integration can be other than solar.
3. The F-factors and related values for under slab insulation are not consistent. Intent isn't 100% clear.
4. Not that I have noticed.

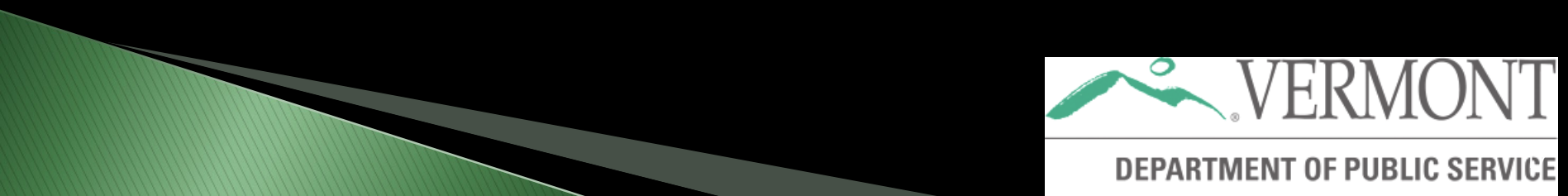
Other Survey Comments

- How do we simplify application of the code to partial renovations and avoid making complexity a reason to just not touch old buildings?
- EV charging during the day is an issue.
- Auxiliary electric heat on cold climate equipment in Vermont should not be installed.

Specific Survey Questions

- Additional Efficiency Package section C406 – discussed today
- Topics for Subsequent Meetings:
  - To further the state's energy and carbon savings goals, where would you recommend efficiency improvements in the next CBES update come from?
  - Would you support stricter code compliance? If yes, where would you suggest getting more code compliance (on-site inspections/code officials, certification/licensing requirements, etc)?
  - Would you support requiring on-site renewables or solar-ready roof requirements, provided sufficient exceptions were provided for particularly challenging sites?

Lighting Power Density



Lighting Power Density

Someone rated LPD the most challenging to address while others have had comments that LPD should be stricter?

- What are specific suggestions for changes?

- Topics for Discussion:
  - **Interior lighting**
  - **Exterior lighting**
  - **Sales area lighting**
  - **Areas that need exceptions**
  - **Sleeping units and dwelling units**

Mechanical Controls

Mechanical Controls

One survey comment was that controls are archaic

- What are specific suggestions for changes?
- Should sequences like Guideline 36 be referenced?
- Do existing sequences need to be in more detail?
- Are there currently any errors/issues?

- Topics for Discussion:
  - **Heat pumps**
  - **Boilers**
  - **Chillers/Cooling Towers**
  - **Pumps**
  - **Fans/AHUs**
  - **ERVs/HRVs**
  - **Economizers**

Additional Efficiency Package C406

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Summary of Additional Efficiency Package Options

- Must achieve 6 points
- 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
  - Heat pump water heating
  - Enhanced envelope performance
  - Reduced air infiltration
  - Efficient kitchen appliances
  - Controlled receptacles

Summary of Additional Efficiency Package Options

- Must achieve ~~6~~ 8 points
- 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
  - Heat pump water heating
  - Enhanced envelope performance
  - Reduced air infiltration
  - Efficient kitchen appliances
  - ~~Controlled receptacles~~

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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	2	2	5	2	6	3
Lighting Power 1	1	1	3	3	3	2
Lighting Power 2	2	2	5	5	5	4
Lighting Controls	N/A	N/A	2	1	2	1
Renewable Energy	3	2	2	3	3	3
DOAS	3	1	2	3	4	3
Water Heating 1	5	6	N/A	N/A	N/A	3 (Group I only)
Water Heating 2	3	3	N/A	N/A	N/A	2 (Group I only)
HP Water Heater	5	5	N/A	N/A	N/A	2 (Group I only)
Envelope	3	4	2	2	2	3
Air Infiltration	3	5	2	3	4	3
Kitchen Appliances	5	N/A	N/A	N/A	5	5 (Group A-2 only)
Controlled Receptacles	N/A	N/A	6	2	N/A	N/A

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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	24	2	56	26	67	36
Lighting Power 1	12	1	36	37	313	27
Lighting Power 2	24	2	513	515	527	415
Lighting Controls	N/A	N/A	21	12	2N/A	12
Renewable Energy	31	2	2	31	31	31
DOAS	310	1	27	3N/A	4	37
Water Heating 1	529	6	N/A	N/A3	N/A	3 (Group I only)16
Water Heating 2	310	3	N/A	N/A3	N/A	2 (Group I only)8
HP Water Heater	5	5	N/A	N/A1	N/A	2 (Group I only)7
Envelope	35	4	211	210	25	38
Air Infiltration	313	5	25	34	46	310
Kitchen Appliances	5A	N/AA	N/AA	N/AA	5A	5 (Group A-2 only)A
Controlled Receptacles	N/A	N/A	610	218	N/A	N/A14

A = 20 * AreaK / AreaB

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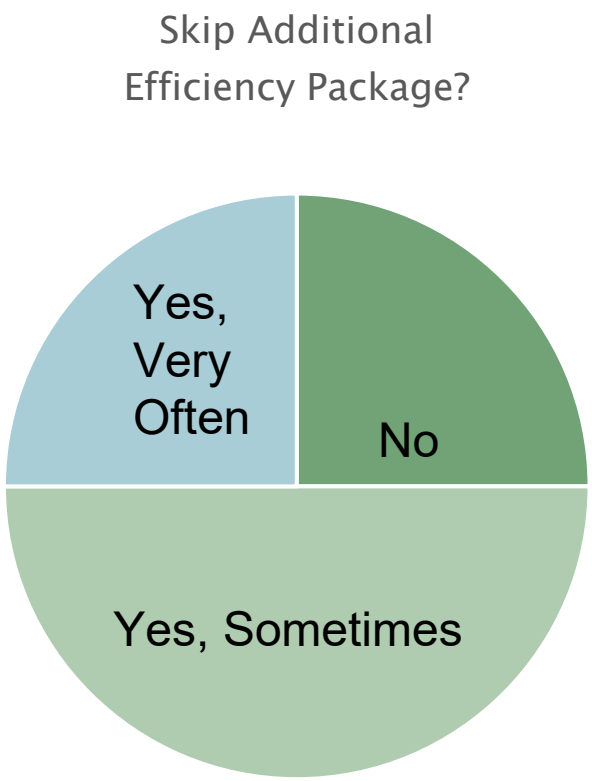
Survey Response



- Regarding the Additional Efficiency Package section C406, are you aware of and adhere to the requirements of this section of the code?
  - All responded yes, except one other
  - The other replied, “As a lighting consultant, I do not control all efficiency measures.”
- Do you ever “skip” the Additional Efficiency Package section C406 when working on a building? If so, how often?

Survey Response

- In general, are you in favor of Additional Efficiency Package section C406 which adds flexibility in reaching the CBES energy goals or would you rather everything be prescriptive without options?
  - Equal responses in favor or against having a menu of options.
  - Other responses:
    - Would rather everything be prescriptive with options directly in the section.
    - Frustrated that it is difficult to specified efficiencies from contractors and then find out at the end that there were not enough points.
- Do you find Additional Efficiency Package section C406 confusing and if so, how would you simplify without reducing the associated energy savings?
  - Need for options is obvious
  - Yes confusing, especially on non-category buildings, money could be better spent
  - Yes confusion, gives examples where energy savings could be better invested

Survey Response

- Would you agree that as energy goals get tighter, most of the energy savings will have to come from C406 Additional Efficiency Package section or do you believe it will be possible to reach savings targets outside of this section?
  - Reach targets outside of this section
  - Electrification needs to count toward energy goals, not just efficiency
  - C406 should be removed. To achieve net zero will require enforcement and incentives to energy modeling. Primary way to net zero is through PV from here.
  - Get to energy goals through better insulation, limit window area, reduce fresh air, exterior lighting run on PV

Survey Response

- The point system of Additional Efficiency Package section C406 is based off energy modeling and achieving a percentage of energy savings. Are there areas where you feel the points don't accurately reflect percentage of energy savings?
  - Not sure.
  - Yes, particularly in mixed use, industrial, assembly and "unusual" buildings.
  - Yes, and investment could be better spent on LPD, insulation levels, and high-efficiency mechanicals.

- Any other general comment regarding section C406?
  - It is confusing, not clear in how the values are established, easy to miss, and cumbersome. Few projects where it meaningfully changed the design, but usually lighting and roof insulation gets us most of the way there.
  - These measures don't work in the real world.

Additional Efficiency Package

Survey indicates low compliance with C406 and lots of strong opinions about it.

- What are specific suggestions for changes?

- Topics for Discussion:
  - **Compliance with C406**
  - **Simplified approach vs. more options**
  - **The point system by building type**
  - **Areas where the points are off**
  - **Points for electrification**
  - **Exceptions to C406 for certain situations?**
  - **Code vs. real world**
  - **Should we remove C406 all together?**

Maintenance Information and Systems Commissioning C407

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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)

- Exceptions: The following systems are exempt:
- 1. Mechanical systems and service water heater systems in buildings where the total mechanical equipment capacity is less than 480,000 Btu/h (140.7 kW) cooling capacity and 600,000 Btu/h (175.8 kW) combined service water-heating and space-heating capacity.
- 2. Systems included in Section C403.5 that serve individual dwelling units and sleeping units.

Survey Responses

- What are the issues:
  - **Commissioning**
    - Building size?
    - Calculation of heating/cooling/DHW loads?
    - Cost?
    - Contractor availability?
    - Code verbiage and description?
    - Owner pushback?
    - System balancing?
    - Lighting controls?
    - Documentation?
    - Other _____
  - **O&M**

Next Steps

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Possible Topics to be Discussed in Subsequent Meetings

- Definition of Multifamily
- Compliance
- Support requiring on-site renewables or solar-ready roof requirements
- Future CBES to further the state's energy and carbon savings goals

Next Steps

- Are there topic areas other than the ones listed above that you would like to see discussed?

- Focus of following (2) C&I meetings:
  - Building Shell Insulation
  - Windows and Doors
  - Air leakage including blower door tests
  - Mechanical Equipment
  - Service Water Heating
  - Lighting Controls
  - EV Charging Stations
  - Existing Buildings (additions, alterations, repairs)
  - Solar Ready Zone
  - Electrification
  - Compliance
  - Multifamily
  - Future CBES efficiency improvements
  - Other (Specify)

Thank You for Participating!

Next Meetings:

May 13 – Residential Committee Meeting 3-5pm

June 2 – Commercial & Industrial Committee Meeting 2-4pm

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Appendix

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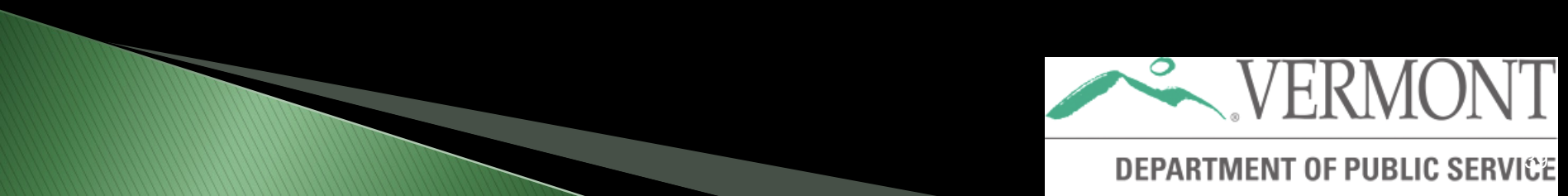
Lighting Power Density



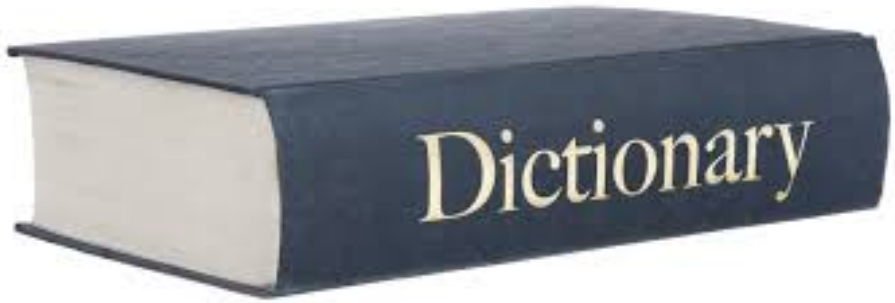
Summary of Major Changes: Electric & Lighting

- New definitions for lighting
- Dwelling and Sleeping unit requirements
- Reduced interior lighting power allowance
- Reduction in allowance for additional interior lighting power
- Reduced exterior lighting power allowance

New Definitions for Lighting Systems

HIGH-EFFICACY LAMPS/LIGHTING. Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy of not less than 65 lumens per watt; or light fixtures of not less than 55 lumens per watt.

LUMINAIRE-LEVEL LIGHTING CONTROLS. A lighting system consisting of one or more luminaires with embedded lighting control logic, occupancy and ambient light sensors, wireless networking capabilities and local override switching capability, where required.



Dwelling and Sleeping Units

Dwelling units and *Sleeping Units* within Group R-2 buildings shall install lamps or fixtures where not less than 90 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 90 percent of the permanently installed lighting fixtures shall be high-efficacy fixtures or contain only high-efficacy lamps.

- Changed from just multifamily to R-2 with also includes dormitories, fraternities, and sororities.
- *Dwelling units* within buildings other than Group R-2 with high-efficacy lighting are exempt from lighting controls.
- *Dwelling units* and *sleeping units* within buildings other than Group R-2 with high efficacy lighting are exempt for Lighting Power Density requirements.

HIGH-EFFICACY LAMPS/LIGHTING. Compact fluorescent lamps, light-emitting diode (LED) lamps, T-8 or smaller diameter linear fluorescent lamps, or other lamps with an efficacy of not less than 65 lumens per watt; or light fixtures of not less than 55 lumens per watt.

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

Area Type	2015 CBES	2018 IECC	2019 CBES
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	0.61	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

In a facility for the elderly or visually impaired there are higher LPD allowances in the space-by-space method.

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

Area Type	2015 CBES	2018 IECC	2019 CBES
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	0.83	0.64
Multifamily	0.51	0.68	0.48
Museum	1.02	1.06	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	IECC 2018	2019 CBES
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

Additional Interior Lighting Power

For lighting equipment to be installed in sales areas specifically to highlight merchandise, the additional lighting power shall be determined in accordance with Equation 4-10

Additional interior lighting power allowance	=	~~500~~ 250 W + (Retail Area 1 × ~~0.60~~ 0.20 W/ft2) + (Retail Area 2 × ~~0.60~~ 0.20 W/ft2) + (Retail Area 3 × ~~1.4~~ 0.50 W/ft2) + (Retail Area 4 × ~~2.5~~ 0.90 W/ft2)

Retail Area 1	=	The floor area for all products not listed in Retail Area 2, 3 or 4.
Retail Area 2	=	The floor area used for the sale of vehicles, sporting goods and small electronics.
Retail Area 3	=	The floor area used for the sale of furniture, clothing, cosmetics and artwork.
Retail Area 4	=	The floor area used for the sale of jewelry, crystal and china.

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

Area Type	2015 CBES	2018 IECC	2019 CBES
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

Zone 4 is removed from 2019 CBES

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

Area Type	2015 CBES	2018 IECC	2019 CBES
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	21 W/linear foot of door width	15 W/linear foot of door width
Entry canopies	0.40 W/ft^2	0.40 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	2018 IECC	2019 CBES
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 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 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

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Additional Efficiency Package C406

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Building Group Definitions

- R-1 = Occupancies containing sleeping units where the occupants are primarily transient in nature, e.g. hotels/motels
- R-2 = Occupancies containing sleeping units or more than two dwelling units where the occupants are primarily permanent in nature, e.g. apartment houses, dormitories, fraternities/sororities, vacation timeshare
- B = The use of a building for office, professional or service-type transactions, including storage of records and accounts, e.g. banks, civic administration, clinic (outpatient), dry cleaning, electronic data processing
- E = The use of a building by six or more persons at any one time for educational purposes through the 12th grade
- M = The use of a building for the display and sale of merchandise, and involves stocks of goods, wares or merchandise incidental to such purposed and accessible to the public, e.g. department stores, drug stores, markets, retail or wholesale stores, sales rooms

More Efficient HVAC Equipment and Fan Performance

2015 CBES required 10% improvement, 2019 CBES requires 15%.

Efficiency credits require all three of the following:

C406.2.1 HVAC system selection. No less than 90 percent of the total HVAC capacity serving the building shall be provided by equipment that is listed in Tables C403.3.2(1) through C403.3.2(12).

C406.2.2 Minimum equipment efficiency. Equipment shall exceed the minimum efficiency requirements listed in Tables C403.3.2(1) through C403.3.2(12) by 15 percent, in addition to the requirements of Section C403. Where multiple performance requirements are provided, the equipment shall exceed all requirements by 15 percent.

C406.2.3 Minimum fan efficiency. Stand-alone supply, return and exhaust fans designed for operating with motors over 750 watts (1 hp) shall have a fan efficiency grade of not less than FEG 71 as defined in AMCA 205. The total efficiency of the fan at the design point of operation shall be within 10 percentage points of either the maximum total efficiency of the fan or the static efficiency of the fan.

Reduced Lighting Power

2015 CBED required 10% improvement, 2019 CBES requires 10% for Option 1 and 20% for Option 2.

Buildings shall comply with Sections C406.3.1 or C406.3.2. Dwelling units and sleeping units within the building shall comply with C406.3.3.

C406.3.1 Reduced lighting power option 1. The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be 90 percent or less of the total interior lighting power value calculated in accordance with Section C405.3.2.1, or by using 90 percent of the total interior lighting power allowance calculated in accordance with Section C405.3.2.2.

C406.3.2 Reduced lighting power option 2. The total connected interior lighting power calculated in accordance with Section C405.3.1 shall be 80 percent or less of the total interior lighting power value calculated in accordance with Section C405.3.2.1, or by using 80 percent of the total interior lighting power allowance calculated in accordance with Section C405.3.2.2.

C406.3.3 Lamp fraction. Not less than 95 percent of the lamps in permanently installed lighting fixtures shall be high-efficacy lamps or not less than 95 percent of the permanently installed lighting fixtures shall be high-efficacy fixtures or contain only high-efficacy lamps.

Enhanced Digital Lighting Controls

Besides some minor editing, this is largely unchanged from 2015 CBES

Interior lighting shall be located, scheduled and operated in accordance with Section C405.2 and no less than 90 percent of the total installed interior lighting power shall be configured with the following enhanced control functions.

1. Luminaires shall be configured for continuous dimming.
2. Luminaires shall be addressed individually.
3. Not more than eight luminaires within a *daylight zone* are permitted to be controlled by a *daylight* responsive control.
4. Luminaires shall be controlled through a digital control system configured with the following capabilities:
    1. Scheduling and illumination levels of individual luminaires and groups of luminaires are capable of being reconfigured through the system.
    2. Load shedding.
    3. In open and enclosed offices, the illumination level of overhead general illumination luminaires are configured to be individually adjusted by occupants.
    4. Occupancy sensors and daylight responsive controls are capable of being reconfigured through the system.
5. Construction documents shall include submittal of a Sequence of Operations, including a specification outlining each of the functions required by this section.

On-Site Renewable Energy

2015 CBES did not distinguish between building type.

Buildings shall be provided with on-site renewable energy systems with a total system rating per square foot of conditioned floor area of the building of not less than the value specified in Table C406.5.

TABLE C406.5
ON-SITE RENEWABLE ENERGY SYSTEM RATING

(PER SQUARE FOOT) Building Area Type	kBTU per year	kWh per year
Assembly	1.8	0.53
Dining	10.7	3.14
Hospital	3.6	1.06
Hotel/Motel	2.0	0.59
Multi-family residential	0.50	0.15
Office	0.82	0.24
Other	2.02	0.59
Retail	1.31	0.38
School/University	1.17	0.34
Supermarket	5.0	1.47
Warehouse	0.43	0.13

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Dedicated Outdoor Air System

2019 CBES added not less than 90% of conditioned space to qualify.

Not less than 90% of the building conditioned floor area, excluding floor area of unoccupied spaces that do not require ventilation per ASHRAE Standard 62.1, shall be served by DOAS. Buildings containing equipment or systems regulated by Section C403.3.4, C403.4.3, C403.4.4, C403.4.5, C403.6, C403.8.4, C403.8.5, C403.8.5.1, C403.9.1, C403.9.2, C403.9.3 or C403.9.4 shall be equipped with an independent ventilation system designed to provide not less than the minimum 100-percent outdoor air to each individual occupied space, as specified by ASHRAE Standard 62.1. The ventilation system shall be capable of total energy recovery. The HVAC system shall include supply-air temperature controls that automatically reset the supply-air temperature in response to representative building loads, or to outdoor air temperatures. The controls shall reset the supply-air temperature not less than 25 percent of the difference between the design supply-air temperature and the design room-air temperature.

Reduced Energy Use in Service Water Heating

2015 CBES only had Load Fraction option. For 2019 CBES choose one of the three options for achieving energy credits.

To qualify for this credit, not less than 90 percent of the building conditioned floor area shall be of the following types: R-1, I-2, A-2, F, R-2, A-3

C406.7.2 Load fraction. Not less than 60 percent of the annual building service hot water energy use, or not less than 100 percent of the annual building service hot water heating energy use in buildings subject to the requirements of Section C403.9.5, shall be provided by waste heat recovery or on-site renewable energy water-heating systems.

C406.7.3 High Performance Water Heating Equipment. The combined input-capacity-weighted-average equipment rating of all water heating equipment in the building shall be not less than 95% Et or 0.95 EF.

C406.7.4 Heat pump water heater. All Service hot water system ~~delivering~~ heating requirements shall be met using heat pump technology with a minimum COP of 3.0. Air-source heat pump water heaters shall not draw conditioned air from within the building, except exhaust air that would otherwise be exhausted to the exterior.

Enhanced Envelope Performance

This is a new option in 2019 CBES that was not provided in 2015 CBES

The total UA of the building thermal envelope as designed shall be not less than 15 percent below the total UA of the building thermal envelope for a building of identical configuration and fenestration area in accordance with Section C402.1.3.

If using Section C402.1.4 Building above-grade performance alternative for compliance, UA-Total / Area ≤ 0.030 needs to be met as well as total UA of below-grade walls shall be not less than 15 percent below the total UA of the below-grade thermal envelope in accordance with Section C402.1.3.

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Reduced Air Infiltration

This is a new option in 2019 CBES that was not provided in 2015 CBES

Air infiltration shall be verified by whole-building pressurization testing conducted in accordance with ASTM E779 or ASTM E1827 by an independent third party. The measured air-leakage rate of the building envelope shall not exceed 0.25 cfm/ft2 (2.0 L/s × m2) under a pressure differential of 0.3 inches water column (75 Pa), with the calculated surface area being the sum of the above- and below-grade building envelope. A report that includes the tested surface area, floor area, air by volume, stories above grade, and leakage rates shall be submitted to the code official and the building owner.

Exception: For buildings having over 250,000 square feet (25 000 m2) of conditioned floor area, air leakage testing need not be conducted on the whole building where testing is conducted on representative above-grade sections of the building. Tested areas shall total not less than 25 percent of the conditioned floor area and shall be tested in accordance with this section.

Efficient Kitchen Appliances

This is a new option in 2019 CBES that was not provided in 2015 CBES

The following pieces of equipment that fall within the scope of the applicable Energy Star program shall comply with the equivalent criteria required to achieve the Energy Star label if installed prior to the issuance of the Certificate of Occupancy:

- Commercial Fryers
- Commercial Hot Food Holding Cabinets
- Commercial Steam Cookers
- Commercial Dishwashers
- Commercial Griddles
- Commercial Ovens

ENERGY STAR

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Controlled Receptacles

This is a new option in 2019 CBES that was not provided in 2015 CBES

At least 50 percent of receptacles installed in private offices, open offices, conference rooms, rooms used primarily for printing and/or copying functions, break rooms, individual workstations and classrooms, including those installed in modular partitions and modular office workstation systems, shall be controlled as required by this section. Either split receptacles shall be provided, with the top receptacle(s) controlled, or a controlled receptacle shall be located within 12 inches (0.30 m) of each uncontrolled receptacle. Controlled receptacles shall be visibly differentiated from standard receptacles and shall be controlled by one of the following automatic control devices:

An occupant sensor that turns receptacle power off when no occupants have been detected for a maximum of 20 minutes.

A time-of-day operated control device that turns receptacle power off at specific programmed times and can be programmed separately for each day of the week. The control device shall be configured to provide an independent schedule for each portion of the building not to exceed 5,000 square feet (465 m2) and not to exceed one full floor. The device shall be capable of being overridden for periods of up to two hours by a timer accessible to occupants.

Are there topic areas other than the ones listed above that you would like to see discussed?

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Mechanical

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Summary of Major Changes: Mechanical

- New definition for cold-climate heat pump
- New allowances for heat pump systems
- Equipment sizing – to reduce oversizing
- Air conditioner, furnace, boiler, cooling tower, VRF minimum efficiency increase
- ERV required for > 3,000 hours and lower CFMs
- Part-load control required on >2HP pumps and fans
- Economizers required in more locations
- Fan efficiency increased
- Fractional HP fan motors require ECM or NEMA premium

Definition: COLD-CLIMATE HEAT PUMP

- An air source heat pump with an inverter-driven, variable capacity compressor that is designed to **provide full heating heat pump capacity and having a minimum COP of 1.75 or greater at maximum operating capacity at an outside air temperatures of 5°F.** The indoor and outdoor units must be part of an AHRI matched system.

C403.2.3 Electric resistance space heating

Building heating with electrical resistance units, including baseboard radiation, heat pump reheat coils, duct coils, boilers, ~~domestic hot water heaters~~, outdoor air intake grids, and coils in terminal units and air systems, is prohibited.

Exceptions:

~~2. Replacement of existing electrical resistance unit –~~ Moved to Existing Buildings – not deleted

4. Multifamily buildings with heating loads ≤ 6.0 Btu/hour/square foot at design temperature.

5. Cold-Climate Heat Pump where:

a. the full heating demand can be met with the heat pump at an outside air temperature of 5°F; and

b. the building thermal envelope shall be tested in accordance with ASTM E 779 at a pressure differential of 0.3 inch water gauge (75 Pa) and deemed to comply with the provisions of Section C402.4.1 when the tested air leakage rate of the building thermal envelope is not greater than 0.20 cfm/ft2 (including the areas of the slab and below grade walls).

C403.4.1.1 Heat pump supplementary heat (Mandatory)

Heat pumps having supplementary electric resistance heat shall be certified *cold-climate heat pumps* meeting the requirements of section C403.2.3.

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C403.2.4.2.1 Thermostatic setback capabilities.(Mandatory)

Thermostatic setback controls shall ~~have the capability~~ be configured to set back or temporarily operate the system to maintain zone temperatures down to 60~~55~~°F (13°C) or up to 80~~85~~°F (29°C).

- Exemption:
- 1. Zones served exclusively by cold-climate heat pumps.

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C403.2.4.3.3.3 Two-position valve

Each hydronic heat pump on the hydronic system ~~having a total pump system power exceeding 10 hp (7.5 kW)~~ shall have a two-position valve.

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C403.3 Heating and cooling equipment efficiencies (Mandatory)

- Heating and cooling equipment installed in mechanical systems shall be sized in accordance with Section C403.3.1 and shall be not less efficient in the use of energy than as specified in Section C403.3.2.
-
- C403.3.1 Equipment sizing **(Mandatory).**
  The output capacity of heating and cooling equipment shall be not greater than that of the smallest available equipment size that exceeds the loads calculated in accordance with Section C403.1.1. 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 (to the next nearest available size) than the calculated peak heating and cooling loads to allow for building pickup and cool down after temperature setback conditions.

C403.4.1.4 Heated vestibules (Mandatory)

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 55°F (16°C). Vestibule heating systems shall be controlled by a thermostat located in the vestibule configured to limit heating to a temperature not greater than 55°F (16°C). Cooling of the vestibule is prohibited.

Exception: Control of heating or cooling provided by site-recovered energy or transfer air that would otherwise be exhausted.

C403.4.2.3 Automatic start (Mandatory)

Automatic start controls shall be provided for each HVAC system. The controls shall be configured to automatically adjust the daily start time of the HVAC system in order to bring each space to the desired occupied temperature immediately prior to scheduled occupancy.

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C403.4.3.3.2 Heat rejection

The following shall apply to hydronic water loop heat pump systems:

- 1. Where a closed-circuit cooling tower is used directly in the heat pump loop, either an automatic valve shall be installed to bypass the flow of water around the closed-circuit cooling tower, except for any flow necessary for freeze protection, or low-leakage positive-closure dampers shall be provided.

- 2. Where an open-circuit cooling tower is used directly in the heat pump loop, an automatic valve shall be installed to bypass all heat pump water flow around the open-circuit cooling tower.

- 3. Where an open-circuit cooling tower is used in conjunction with a separate heat exchanger to isolate the open-circuit cooling tower from the heat pump loop, heat loss shall be controlled by shutting down the circulation pump on the cooling tower loop.

C403.4.4 Part-load controls

Hydronic systems greater than or equal to 300,000 Btu/h (146.5 kW) in design output capacity supplying heated or chilled water to comfort conditioning systems shall include controls that are configured to do all of the following:

1. Automatically reset the supply-water temperatures in response to varying building heating and cooling demand using coil valve position, zone-return water temperature, building-return water temperature or outside air temperature. The temperature shall be reset by not less than 25 percent of the design supply-to-return water temperature difference.

2. Automatically vary fluid flow for hydronic systems with a combined pump motor capacity of 2 hp (1.5 kW) or larger with three or more control valves or other devices by reducing the system design flow rate by not less than 50 percent or the maximum reduction allowed by the equipment manufacturer for proper operation of equipment by valves that modulate or step open and close, or pumps that modulate or turn on and off as a function of load.

C403.4.4 Part-load controls

3. Automatically vary pump flow on heating-water systems, chilled-water systems and heat rejection loops serving water-cooled unitary air conditioners as follows:

- 3.1. Where pumps operate continuously or operate based on a time schedule, pumps with nominal output motor power of 1 hp or more shall have a variable speed drive.
- 3.2. 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 nominal output motor power of 2 hp or more.

4. Where a variable speed drive is required by Item 3 of this Section, 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. In systems where pump speed is controlled by a differential pressure setpoint, that setpoint shall be incrementally indexed down to maintain at least one valve nearly wide open. There shall be no lower limit to the differential pressure except to remain within the tolerances and accuracy of the controlling sensor.

C403.4.4 Part-load controls

Exceptions:

- 1. Supply-water temperature reset is not required for chilled-water systems supplied by off-site district chilled water or chilled water from ice storage systems.

- 2. Variable pump flow is not required on dedicated coil circulation pumps where needed for freeze protection.

- 3. Variable pump flow is not required on dedicated equipment circulation pumps where configured in primary/secondary design to provide the minimum flow requirements of the equipment manufacturer for proper operation of equipment.

- 4. For renovations, variable speed drives are not required on heating water pumps where more than 50 percent of annual heat is generated by a pre-existing electric boiler.

C403.5 Economizers (Prescriptive)

Requirements remained the same except for the following deletion in Exceptions:

~~5. Where the use of outdoor air for cooling will affect supermarket open refrigerated casework systems.~~

~~6. Where the cooling efficiency meets or exceeds a 50% efficiency improvement in cooling equipment performance (EER or IPLV).~~

~~7. Chilled-water cooling systems that are passive (without a fan) or use induction where the total chilled water system capacity less the capacity of fan units with air economizers is less than the minimum specified in Table C403.3(1).~~

~~8. Systems that include a heat recovery system in accordance with Section C403.4.5.~~

~~9. Systems serving primarily computer rooms~~

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C403.5.5 Economizer fault detection and diagnostics (Mandatory)

Air-cooled unitary direct-expansion units listed in Tables C403.3.2(1) through C403.3.2(3) and Tables C403.3.2(10) through C403.3.2(11) that are 15 tons (180,000 Btu/h) or greater and equipped with an economizer in accordance with Section C403.5 shall include a fault detection and diagnostics system complying with the following:

C403.6.1 Variable air volume and multiple-zone systems

Supply air systems serving multiple zones shall be variable air volume (VAV) systems that have zone controls configured to reduce the volume of air that is reheated, recooled or mixed in each zone to one of the following:

- 1. Twenty percent of the zone design peak supply for systems with DDC and 30 percent for other systems.
- 2. Systems with DDC where all of the following apply:
- 2.1. The airflow rate in the deadband between heating and cooling does not exceed 20 percent of the zone design peak supply rate or higher allowed rates under Items 3, 4 and 5 of this section.
- 2.2. The first stage of heating modulates the zone supply air temperature setpoint up to a maximum setpoint while the airflow is maintained at the deadband flow rate.
- 2.3. The second stage of heating modulates the airflow rate from the deadband flow rate up to the heating maximum flow rate that is less than 50 percent of the zone design peak supply rate.

C403.6.7 Parallel-flow fan-powered VAV air terminal control

Parallel-flow fan-powered VAV air terminals shall have automatic controls configured to:

1. Turn off the terminal fan except when space heating is required or where required for ventilation.

2. Turn on the terminal fan as the first stage of heating before the heating coil is activated.

3. During heating for warmup or setback temperature control, either:

3.1. Operate the terminal fan and heating coil without primary air.

3.2. Reverse the terminal damper logic and provide heating from the central air handler by primary air.

C403.7.3 Ventilation air heating control (Mandatory)

Units that provide ventilation air to multiple zones and operate in conjunction with zone heating and cooling systems shall not use heating to warm supply air to a temperature greater than 60°F (16°C) when representative building loads or outdoor air temperatures indicate that the majority of zones require cooling.

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C403.7.6 Automatic control of HVAC systems serving guestrooms (Mandatory)

In Group R-1 buildings containing more than 50 guestrooms, each guestroom shall be provided with controls complying with the provisions of Sections C403.7.6.1 and C403.7.6.2. Card key controls comply with these requirements.

C403.7.6.1 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 by not less than 4°F (2°C) from the occupant setpoint within 30 minutes after the occupants have left the guestroom. The controls shall be capable of and configured to automatically raise the cooling setpoint to not lower than 80°F (27°C) and lower the heating setpoint to not higher than 60°F (16°C) when the guestroom is unrented or has not been continuously occupied for more than 16 hours or a networked guestroom control system indicates that the guestroom is unrented and the guestroom is unoccupied for more than 30 minutes. A networked guestroom control system that is capable of returning the thermostat setpoints to default occupied setpoints 60 minutes prior to the time a guestroom is scheduled to be occupied is not precluded by this section. Cooling that is capable of limiting relative humidity with a setpoint not lower than 65-percent relative humidity during unoccupied periods is not precluded by this section.

C403.7.6 Automatic control of HVAC systems serving guestrooms (Mandatory)

C403.7.6.2 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.

Exception: Guestroom ventilation systems are not precluded from having an automatic daily pre-occupancy purge cycle that provides daily outdoor air ventilation during unrented periods at the design ventilation rate for 60 minutes, or at a rate and duration equivalent to one air change.

C403.9.1 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 ~~7.5~~ hp (1.5 kW) 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.

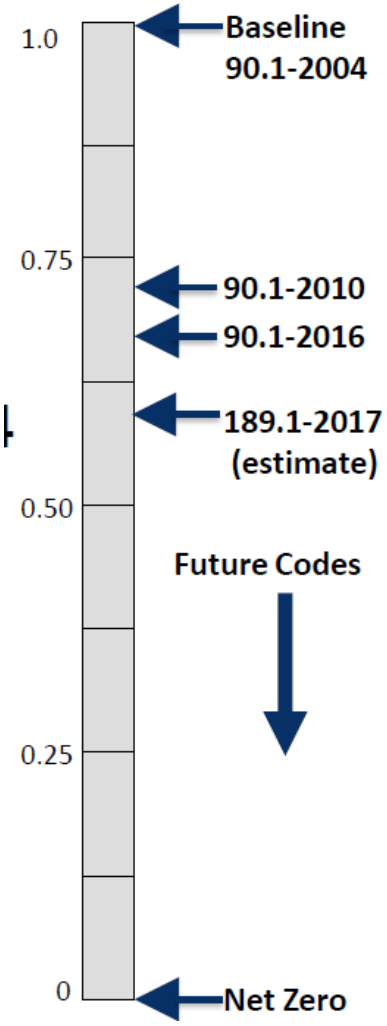
ASHRAE 90.1 – 2016 Performance Rating method used for energy modeled buildings (Appendix G)

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

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

- 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

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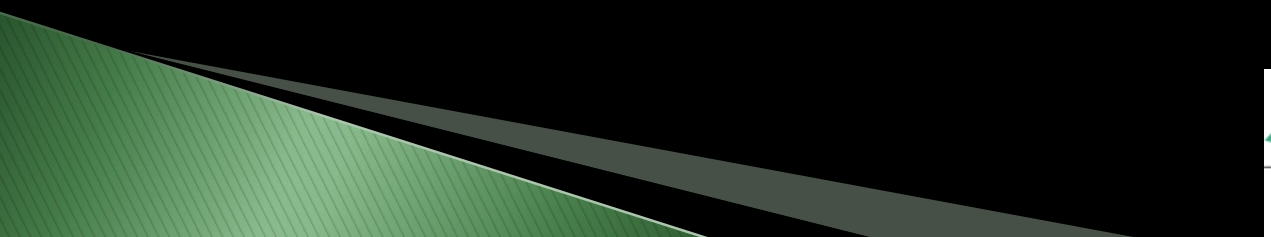
Performance Cost Index

- PCI shall be fuel neutral
  - PCI = BPF * (BBUEC + BBREC)/BBP, where
    - BPF = Building Performance Factor
    - BBUEC = Baseline Building Unregulated Energy Cost
    - BBREC = Baseline Building Regulated Energy Cost
    - BBP = Baseline Building Performance

Building Area Type	Proposed Code BPF
Multifamily	0.62
Healthcare/hospital	0.46
Hotel/motel	0.48
Office	0.43
Restaurant	0.50
Retail	0.44
School	0.39
Warehouse	0.53
All Others	0.45

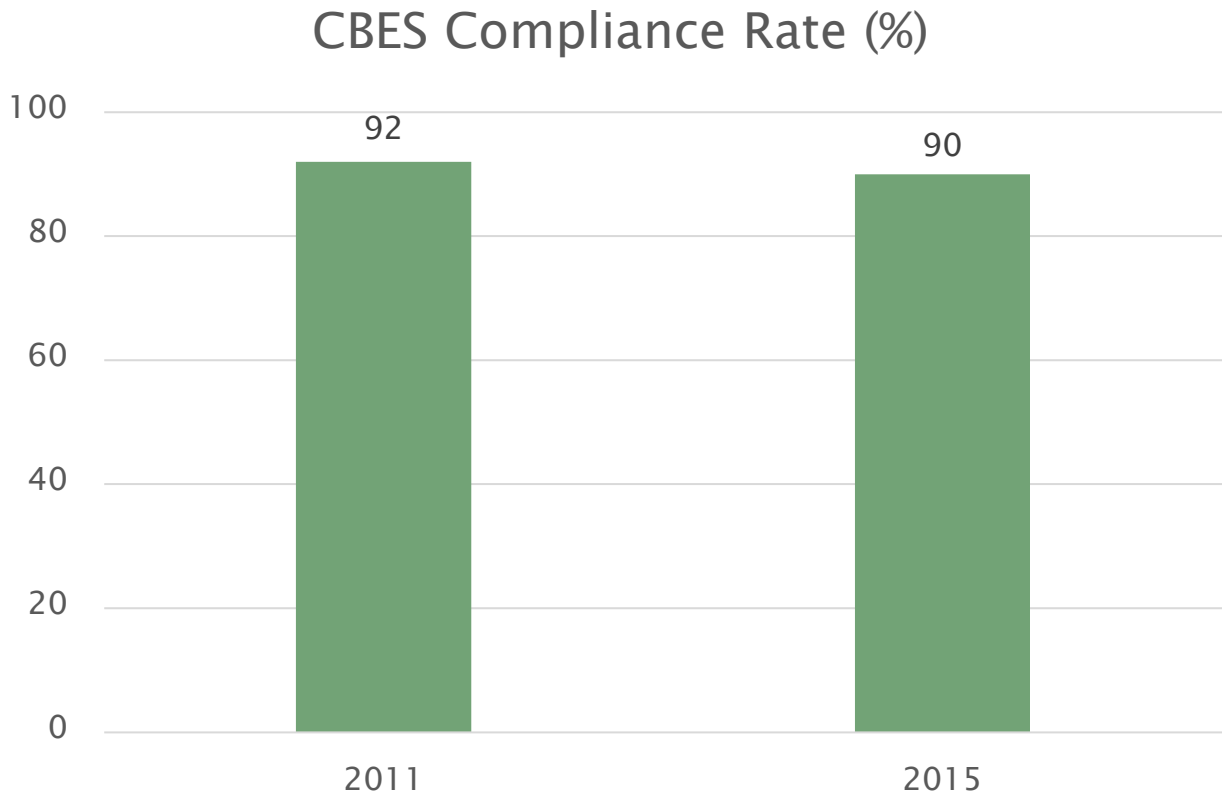
Code Compliance Studies



Market Baseline Studies

2012 Study: "Vermont Energy Code Compliance Plan – Achieving 90% Compliance by 2017"

Respondents reported that 66% of projects undertaken exceed the minimum CBES requirement



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Compliance Approach

	2020 Approach	Required Documents
	2020 CBES Prescriptive	CBES Certificate and COMcheck
	ASHRAE 90.1 – 2016 Sections 5-10 with Amendments	CBES Certificate and COMcheck
	ASHRAE 90.1 – 2016 Section 11 – Energy Cost Budget Method	CBES Certificate and all documentation as noted in Section 11.1.5 of ASHRAE 90.1-2016
	ASHRAE 90.1 – 2016 Appendix G – Performance Rating Method	CBES Certificate and all documentation as noted in Appendix G of ASHRAE 90.1-2016
	Above-Code Program Prescriptive	Contact Vermont DPS for approval of above-code program

Survey Response

- Would you support stricter code compliance?
  - All respondents said: **Yes**
- If yes, how would you suggest getting more code compliance
  - All respondents said: **on-site inspections by a code official**
- Comments:
  - We need code officials who are knowledgeable and assistive in explaining the code, making formal interpretations for unusual cases, and visiting job sites to confirm construction complies with critical design elements – exactly as is done for other issues of public welfare.
  - The state can have an energy evaluator that has space in the fire marshals' offices and reviews plans. A separate form and fee would be required. I think one or two people could cover the entire state from a review standpoint.
  - Compliance starts with contractor registration.

Compliance Questions

- If compliance is important, then how do you think we should do it?
- Would a builder Registry be effective?
- What are our options besides the builder Registry?
- Could builder certification be effective?
- What ideas besides code officials?
- Are you for or against builder licensure?