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Vermont Building Energy Code Stakeholder RBES Meeting

May 24, 2022
2:00 – 4:00

ENERGY FUTURES GROUP

Cx associates LLC

Guidehouse

nbi new buildings institute

Agenda

1. Code update overview and timeframe
2. Base and stretch packages
3. Points per building size
4. Points
5. Cost effectiveness
6. Multifamily approach
7. EV charging
8. Solar ready
9. HERS/ERI
10. Embodied carbon

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
    - Liz Bourguet & Richard Faesy
- Commercial Code Update
  - VEIC
    - Keith Downes
  - Cx Associates
    - Eveline Killian
  - Guidehouse
    - Anna Brannon & Andrew Volent
- National Insights
  - New Building Institute
    - Jim Edelson, Diana Burk & Sean Denniston

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Vermont Residential Building Energy Code

- 30 V.S.A. § 51 establishes residential building energy standards
  - Initially passed by the Vermont legislature in May 1997
- Minimum standard of energy efficiency for new and renovated residential buildings three stories or less

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Why Update the Vermont Building Energy Code?

- RBES has been updated in 2006, 2011, 2015, and 2020
- Updates are designed to provide reductions in energy use and emissions over the life of a building
- 30 V.S.A. § 51 requires that "appropriate revisions are made promptly after the issuance of updated standards for residential construction under the IECC."
- Significant work is underway focused on existing buildings
  - $80 million for weatherization in 2022 Vermont budget (ARPA funds)
  - Building efficiency goals, CAP & CEP weatherization recommendations
  - Other initiatives (EVT, WAP, utilities, etc.)

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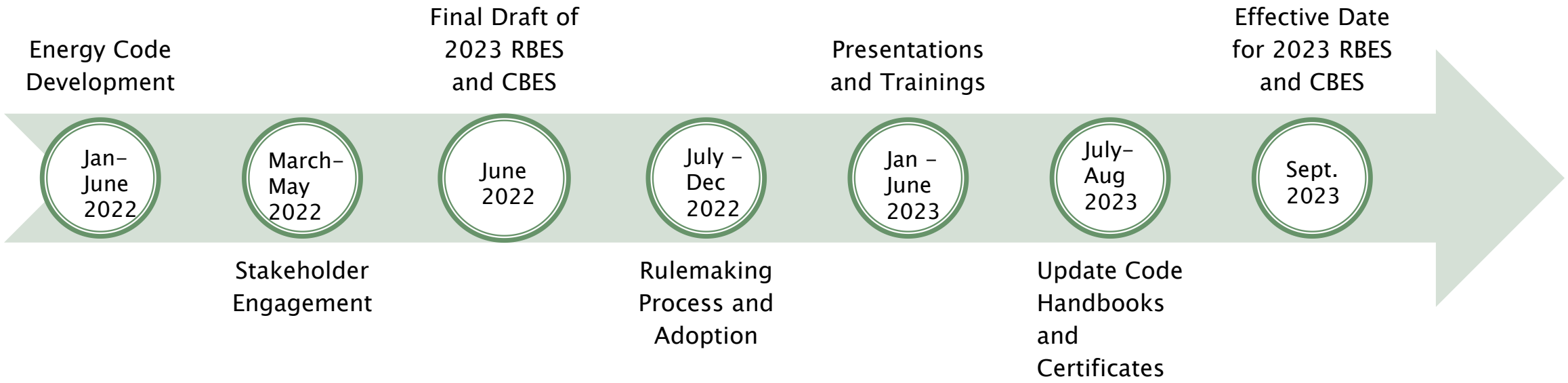
Timeline of 2023 Vermont Energy Code Update Process



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RBES Update Recommendations

RBES is a Work in Progress…

- Gathered recommendations
- Listened at Stakeholder, Advisory Committee meetings, conversations, comments…
  - https://publicservice.vermont.gov/content/energy-code-update-comments
  - Review and analysis
  - Energy Use Intensity (EUI) targets
  - Modeling to determine the potential Packages and Points
- Redlining the 2020 RBES with 2021 IECC and other recommendations
- Proposing updates today based on what we've heard
- Also need to consider cost-effectiveness analysis before final decisions
- PSD makes the final call

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Base Packages and Points

- 'Base' Package
  - All 'Base' packages are the same for Base and Stretch code
  - Stretch code requires more points to attain target EUI
  - All 'Base' packages assume NAECA minimum equipment
  - Packages options demonstrate minimum thermal envelope backstop
  - Points selected per builder discretion
- Target EUIs
  - Base: 32 kBtu/SF/yr.
  - Stretch: 26 kBtu/SF/yr.

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Packages – Base and Stretch Code (Pre-Points) Table R402.1.2.1

Assembly	Package 1	Package 2 (SIPS)	Package 3 ("Double Stud Wall")
Ceiling – flat attic	R-60 (U-0.017)	R-54 12 ¼" SIP (U-0.018)	R-60 (U-0.017)
Ceiling – slope (no attic)	R-49 (U-0.023)	R-54 12 ¼" SIP (U-0.018)	R-49 (U-0.023)
Above Grade Wall	R-19+15ci/R-13+18.8ci/R25ci (U-0.032)	R-28 8 ¼" EPS SIP (U-0.031)	R-35, 2x4 10" Double Stud (U-0.028)
Frame Floor	R-38 (U-0.029)	R-38 (U-0.029)	R-30 (U-0.036)
Basement/Crawl	R-20ci/R13+10ci	R-20ci/R13+10ci	R-20ci
Slab, below grade	NR	NR	NR
Slab, on grade (Heated: R-15 under)	R-20,4' (edge)/ R-15,4'(edge)+R-7.5(under)	R-20,4' (edge)/ R-15,4'(edge)+R-7.5(under)	R-20,4' (edge)/ R-15,4'(edge)+R-7.5(under)
Windows	U-0.27	U-0.27	U-0.27
Doors	U-0.37	U-0.37	U-0.37
Air Leakage	2 ACH50	2 ACH50	2 ACH50
Heating	NAECA (84% Blr/80% Fur)		
Cooling	NAECA (14 SEER)		
Hot Water (fixtures)	NAECA (.58 EF/.56 UEF), standard fixtures		
Ducts	Conditioned space		
Ventilation	Balanced: 100 cfm,24h,82w, 75SRE (79.7 ASRE)		
Lighting	100% LED		
EUI (kBtu/SF/yr.)	38.9	39.2	38.5
HERS	59	60	59

Base Code: Package plus Points (examples)

Assembly	Package 1 + Points A "~EVT 3.0"	Package 1 + Points B "All Electric"	Package 1 + Points C "Shell Only"
Ceiling – flat attic	R-60 (U-0.017)	R-60 (U-0.017)	R-80 (U-0.013)
Ceiling – slope (no attic)	R-49 (U-0.023)	R-49 (U-0.023)	R-60 (U-0.018)
Above Grade Wall	R-19+15ci/R-13+18.8ci/R25ci (U-0.032)	R-19+15ci… (U-0.032)	R-40 (U-0.025)
Frame Floor	R-38 (U-0.029)	R-38 (U-0.029)	R-30 (U-0.036)
Basement/Crawl	R-20ci/R13+10ci	R-20ci/R13+10ci	R-20ci
Slab, below grade	NR	NR	R-20, under all
Slab, on grade (Heated: R-15 under)	R-20,4' (edge)/ R-15,4'(edge)+R-7.5(under)	R-20,4' (edge)/ R-15,4'(edge)+R-7.5(under)	R-20,4' (edge) + R-20 under all
Windows	U-0.21	U-0.27	U-0.18
Doors	U-0.26	U-0.37	U-0.37
Air Leakage	1 ACH50	2 ACH50	1 ACH50
Heating	ENERGY STAR (90% Blr/95% Fur)	NEEP minimum ccASHP (9 HSPF)	NAECA (84% Blr/80% Fur)
Cooling	ENERGY STAR (15 SEER)	NEEP minimum ccASHP (15 SEER)	NAECA (14 SEER)
Hot Water (fixtures)	ENERGY STAR (.65 EF/.64 UEF), low flow	ES HPWH (3.4 EF/3.3 UEF), standard	NAECA (.58 EF/.56 UEF), standard
Ducts	Conditioned space	Conditioned space	Conditioned space
Ventilation	Balanced: 100cfm,24h,82w,79.7ASRE	Balanced: 100cfm,24h,82w,79.7ASRE	Balanced: 100cfm,24h,82w,79.7ASRE
Lighting	100% LED	100% LED	100% LED
EUI (kBtu/SF/yr.)	32.4	21.4	32.2
HERS	49	49	51

Stretch Code: Package plus Points (examples) Table R407.2.1.1

Assembly	Package 1 + Points A "EVT 3.0+"	Package 1 + Points B "All Electric"	Package 1 + Points C "Shell+"
Ceiling – flat attic	R-60 (U-0.017)	R-60 (U-0.017)	R-80 (U-0.013)
Ceiling – slope (no attic)	R-49 (U-0.023)	R-49 (U-0.023)	R-60 (U-0.018)
Above Grade Wall	R-35, 2x4 10" Double Stud (U-0.028)	R-19+15ci... (U-0.032)	R-44 (U-0.021), ~10.25" Neopor SIP)
Frame Floor	R-38 (U-0.029)	R-38 (U-0.029)	R-30 (U-0.036)
Basement/Crawl	R-20ci/R13+10ci	R-20ci/R13+10ci	R-20ci
Slab, below grade	R-20, under all	NR	R-20, under all
Slab, on grade (Heated: R-15 under)	R-20,4' (edge) + R-20 under all	R-20,4' (edge)/ R-15,4'(edge)+R-7.5(under)	R-20,4' (edge) + R-20 under all
Windows	U-0.21	U-0.27	U-0.15
Doors	U-0.26	U-0.37	U-0.26
Air Leakage	1 ACH50	2 ACH50	0.5 ACH50
Heating	ENERGY STAR (90% Blr/95% Fur)	NEEP minimum ccASHP (9 HSPF)	ENERGY STAR (90% Blr/95% Fur)
Cooling	ENERGY STAR (15 SEER)	NEEP minimum ccASHP (15 SEER)	ENERGY STAR (15 SEER)
Hot Water (fixtures)	ENERGY STAR (.65 EF/.64 UEF), low flow	ES HPWH (3.4 EF/3.3 UEF), low flow	ENERGY STAR (.65 EF/.64 UEF), low flow
Ducts	Conditioned space	Conditioned space	Conditioned space
Ventilation	Balanced: 100cfm,24h,82w,79.7ASRE	Balanced: 100cfm,24h,50w,85.5 ASRE	Balanced: 100cfm,24h,82w,79.7ASRE
Lighting	100% LED	100% LED	100% LED
EUI (kBtu/SF/yr.)	27.1	20.6	27.5
HERS	44	46	43

Points Per Building Size

Proposed TABLE R402.1.2.2 & R407.2.1.2
REQUIRED POINTS BY BUILDING SIZE (for Base and Stretch)

BUILDING/DWELLING SIZE	REQUIRED BASE POINTS	REQUIRED STRETCH POINTS
Alterations	0	0
Additions < 250 square feet	0	0
Additions 251 to 500 square feet	1	2
Addition 501 to 1,000 square feet	2	3
Addition > 1,000 square feet	3	4
Multifamily <1,000 square feet	2	3
Multifamily 1,000 to 2,500 square feet	4	5
< 2,500 square feet	5	7
2,501 to 4,000 square feet	7	12
> 4,000 square feet	10	15

Measure Options with approximate EUI 'point' gain

Envelope

Assembly	Value	EUI gain	Proposed Points	2020 RBES Pts
Slab	(R20 perim) + R20 under (slab on grade)	.4	1	1 pt
	R20 perim + R20 under (all slabs – on and below grade)	1.1	2	
Walls	U-.028 wall assembly (R-35 double stud, 2x4, R20cav+210.5ci)	0.4	1	
	U-.025 wall assembly (R-40 double stud, R-20+25ci, SIP 8 1/4" XPS)	0.9	1	3 pt
	U-.021 wall assembly (SIP 10 1/4" XPS)	1.6	2	
Ceiling	U-0.017 ceiling/all types(included non-attic slopes)	0.2	1	
	U-0.013 ceiling/flat attic (R-80) / U-.018 no attic/slope (R-60)	0.5	1	1 pt
Floor	U0.021 frame floor (R-49, TJI/open web)	0.1	1	
Windows	U-0.25	0.5	1	
	U-0.22	1.3		2 pt
	U-0.21	1.6	2	
	U-0.18	2.4	3	
	U-0.15	3.2	4	
Door	U-0.26	0.3	1	
Infiltration	~~2 ACH50~~ (Required in RBES 2023)			3 pt
	1 ACH50 (0.06 CFM50/Ft2 of Envelope Area (6 sided)	1.8	2	4 pt
	0.5 ACH50 (0.03 CFM50/Ft2 of Envelope Area (6 sided)	2.7	3	

Measure Options with approximate EUI 'point' gain
Mechanicals

Assembly	Value	EUI gain	Proposed Points	2020 RBES Pts
Ventilation	SRE: 80%/ASRE: 85.5% | .83 w/CFM (83w)	0.5	1	
	SRE: 83%/ASRE: 86.2% | .83 w/CFM (83w)	0.6		
	SRE: 75%/ASRE: 79.7% | .50 w/CFM (50w)	0.4		
	SRE: 80%/ASRE: 85.5% | .50 w/CFM (50w)	0.9	1	
	SRE: 83%/ASRE: 86.2% | .50 w/CFM (50w)	0.9		
Heating/Cooling	ES: 90 AFUE blr/95 AFUE frn/15 SEER AC	2.2	3	1 pt
	NEEP minimum ccASHP 9 HSPF (Region IV) w5kW backup/15 SEER	10.7	11	3 pts
	NEEP average ccASHP 10.5 HSPF (Region IV) w5kW backup/19.7 SEER (TBD)	11.6	12	
	Design hydronics for low-temp (120 deg.) distribution		3	
	Mid-level eff >Fed Min, < ES …. (TBD)			
Hot Water	ES: Gas tank, 0.65 EF / 0.80 RE (ES <=55 gal, MedDraw Pattern UEF ≥ 0.64)	0.7	1	1 pt
	ES HPWH: 2.20 UEF (2.0 EF): integrated 120v15a; split	4.0	5	3 pt
	ES HPWH: 3.30 UEF (3.4 EF); integrated	4.5	5	
	low flow	0.3	1	1 pt

Cost Effectiveness

- Method of calculating cost effectiveness
  - Simple payback
  - Return on investment
  - Cash flow
  - With and without avoided carbon benefits ("societal benefits")
- Costs sourced from:
  - Huntington Homes
  - US DOE Pacific Northwest National Lab
  - 2020 RBES analysis and costs, inflated
- Analysis under development, to be shared with Advisory Committee 6/1/2022

Multifamily Buildings

- Per the enabling legislation, residential portions of mixed-use buildings three stories or less must comply with RBES
- Multifamily buildings four stories or greater must comply with CBES
- Suggested approach in 2023 code update is to align language for MF buildings as much as possible
- Alignment is a work in progress:
  - Aligning R-values and U-values
  - Referencing CBES for central systems and common spaces
  - Referencing RBES for in-unit systems
- Multifamily Advisory Committee meeting on 5/31/2022

Electric Vehicle Charging

TABLE R404.3
REQUIRED LEVEL 2 READY ELECTRIC VEHICLE CHARGING
PARKING SPACES FOR ALL BUILDINGS (BASE and STRETCH CODE)

BUILDING/PARKING TYPE	MINIMUM REQUIRED NUMBER OF LEVEL 2 READY EV CHARGING PARKING SPACES
Single Family Home	1
Parking Garage, Car Port, or Other Parking Structure	1 per Dwelling Unit
Exterior Parking	25% (?)

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Solar Ready

- 2020 Stretch becomes requirement for Base & Stretch
- Total solar-ready zone area: not less than 300 sq ft unobstructed area
  - Multifamily/townhouses: not less than 150 square feet
  - Roof or ground-mount
- Construction documents show solar-ready zone
- Roof load documentation
- Interconnection pathway (conduit) from panel to zone
- Electrical service reserved space

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HERS/ERI

R406 and R407.2.2 HERS/ERI for Base and Stretch Code

HERS/ERI Scores	Base Code	Stretch Code
2020 RBES HERS/ERI	61	54
2023 RBES Proposed HEFS/ERI	54	45

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Embodied Carbon

- Simple table, simple calculation to determine key metric: Global Warming Potential (GWP)/square footage (kg CO2e/sq.ft)
- Points:
  - 1 pt – do the calculation No effort other than taking time to calculate
  - 2 pt – result is less than 0.5 Moderate effort needed to achieve
  - 3 pt – result is less than 0 Deep effort needed to achieve

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Embodied Carbon Calculation

Assembly	Material	R-value		Sq ft (gross)		Multiplier (from table)		Result (kg CO2e)
Foundation, horizontal (under slab)			X		X		=	
Foundation, vertical			X		X		=	
Above grade walls, cavity			X		X 0.8 X		=	
Above grade walls, continuous			X		X		=	
Roof, flat			X		X		=	
Roof, sloped, cavity			X		X 0.8 X		=	
Roof, sloped, continuous					X			

Material	GWP per 1m^2 RSI-1, kgCO2e	Factor
Straw - panel	-10.88	-0.178
Wood fiber - board	-7.13	-0.117
HempCrete - block	-5.67	-0.093
Cellulose - densepack, 3.55 pcf	-2.16	-0.035
Wood fiber - batt	-1.96	-0.032
Cellulose - blown/loosefill, 1.29 pcf	-0.83	-0.014
Fiberglass - batt	0.68	0.011
Fiberglass - blown/loosefill	1.30	0.021
Phenolic foam - board	1.54	0.025
SPF - open cell	1.59	0.026
Fiberglass - blown/spray	1.64	0.027
Polyiso - board, foil faced	2.32	0.038
EPS board, Type I - 10psi	2.63	0.043
Polyiso - board, GRF facers (roof)	2.63	0.043
Mineral wool - batt	3.25	0.053
EPS board, Type IX - 25psi	3.49	0.057
Cellular glass - aggregate	3.93	0.064
SPF - closed cell HFO	4.00	0.065
Mineral wool - board high density	4.06	0.066
SPF - roofing HFO	4.74	0.078
Mineral wool - blown	5.18	0.085
Fiberglass - board	7.37	0.120
XPS - board, 15psi HFO/HFC	7.41	0.121
XPS - board, 25psi HFO/HFC	8.83	0.145
XPS - board, 40psi HFO/HFC	10.26	0.168
XPS - board, 60psi HFO/HFC	12.55	0.205
SPF - closed cell HFC	14.86	0.243
XPS - board, 100psi HFO/HFC	17.10	0.280
SPF - roofing HFC	19.33	0.316
SPF - 2K-LP HFC	25.46	0.416
XPS - board, 15psi HFC	39.04	0.639
XPS - board, 25psi HFC	46.51	0.761
XPS - board, 40psi HFC	54.04	0.884
XPS - board, 60psi HFC	66.06	1.080
XPS - board, 100psi HFC	90.05	1.473

Kg CO_2e/sq.ft.

Values are from https://www.efficiencyvermont.com/news-blog/whitepapers/the-high-greenhouse-as-price-tag-on-residential-building-materials

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Energy Code Update Information & Comments

- **BUILDING ENERGY STANDARDS**
  - https://publicservice.vermont.gov/content/building-energy-standards
- **BUILDING ENERGY STANDARDS UPDATE**
  - https://publicservice.vermont.gov/content/building-energy-standards-update
- **ENERGY CODE UPDATE COMMENTS**
  - https://publicservice.vermont.gov/content/energy-code-update-comments

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Thank you for your time and input!

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