October 8, 2025, PhiusCon

Should Passive Building be a New Multifamily Reach Goal for Vermont?

2024 Efficiency Vermont Research & Development Project

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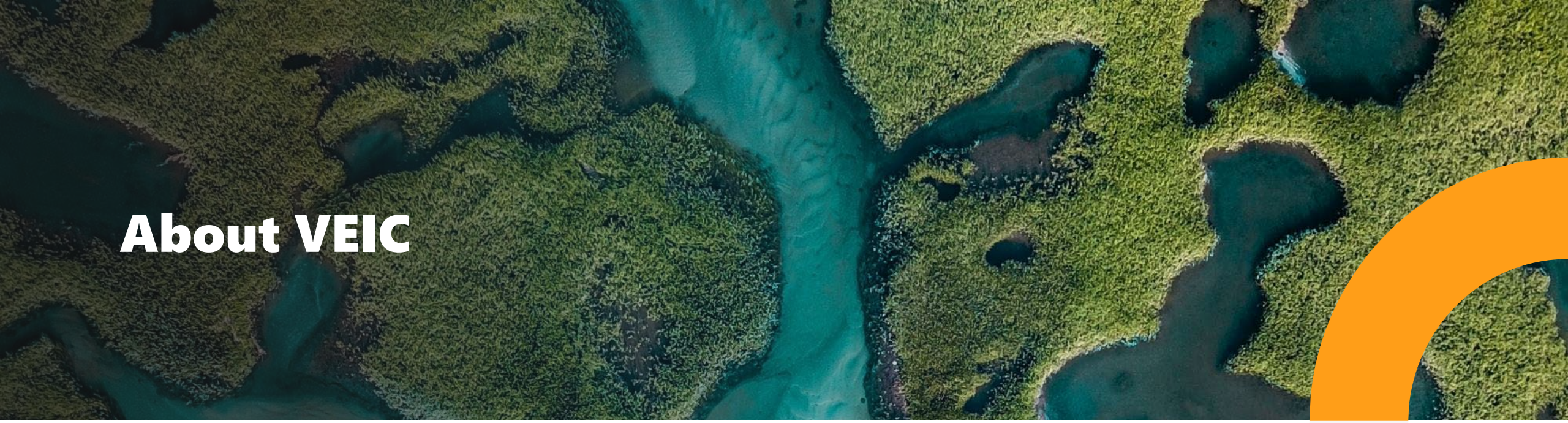


About VEIC

We are on a mission to generate the energy solutions the world needs.

VEIC works with organizations to create immediate and lasting change. Since 1986, we've served as an objective partner for our clients as they navigate complex energy challenges.

Efficiency Vermont

DISTRICT OF COLUMBIA SUSTAINABLE ENERGY UTILITY

EFFICIENCY SMART®

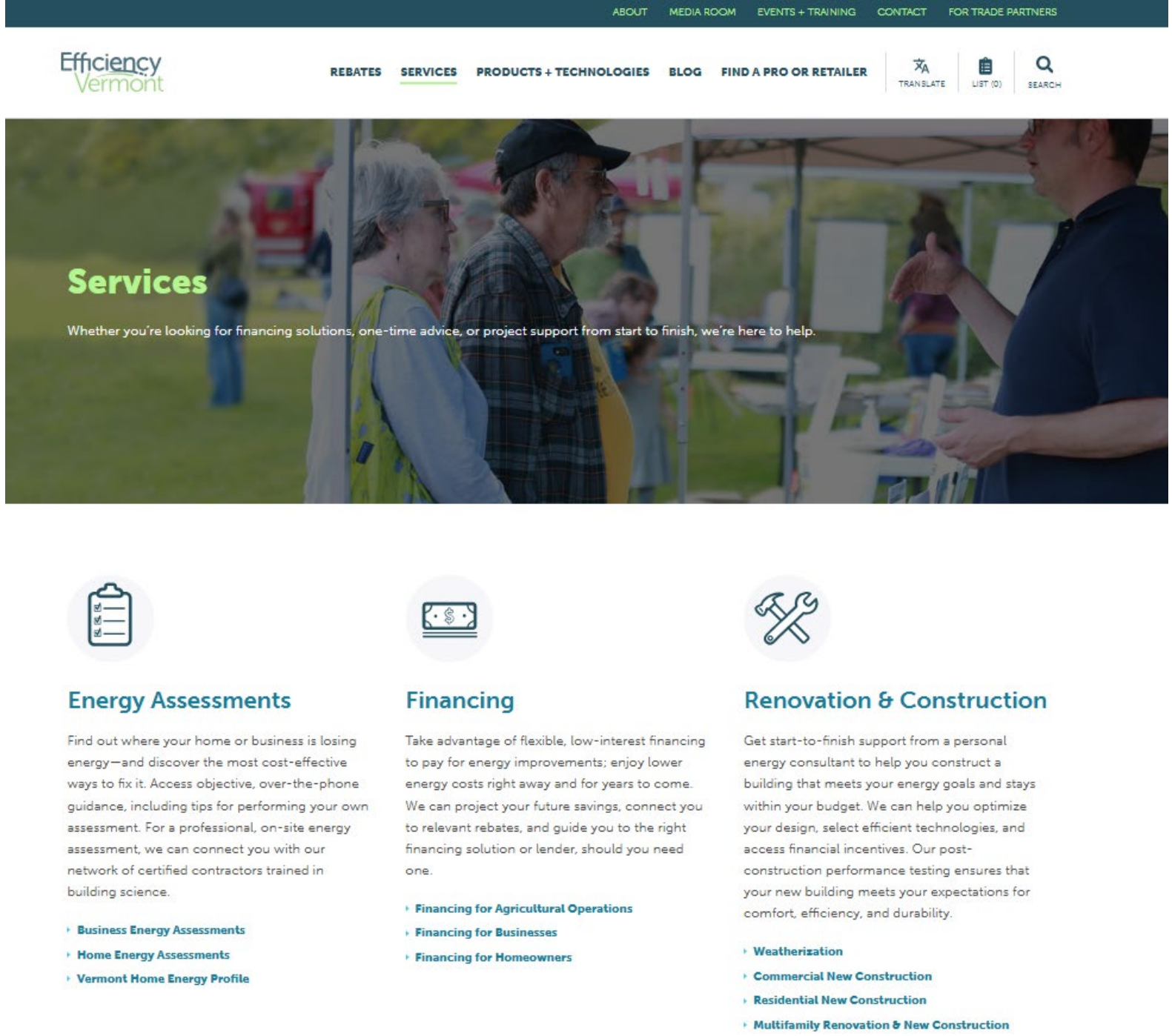
Efficiency Vermont (EVT)

Multifamily New Construction (MFNC)

High-Performance (HP or EVT HP)

Passive House (PH) =

Passive Building (PB)



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R&D Allows EVT to:

- **Create space for innovation** that would not otherwise achieve investment
- **Drive evolution** of Efficiency Vermont's services to better help ratepayers
- **Focus** staff and resources to **strategic** areas that need **investment**

Vermont

Statistics

Total population: 643,077

- Largest city: Burlington, pop. 45,000

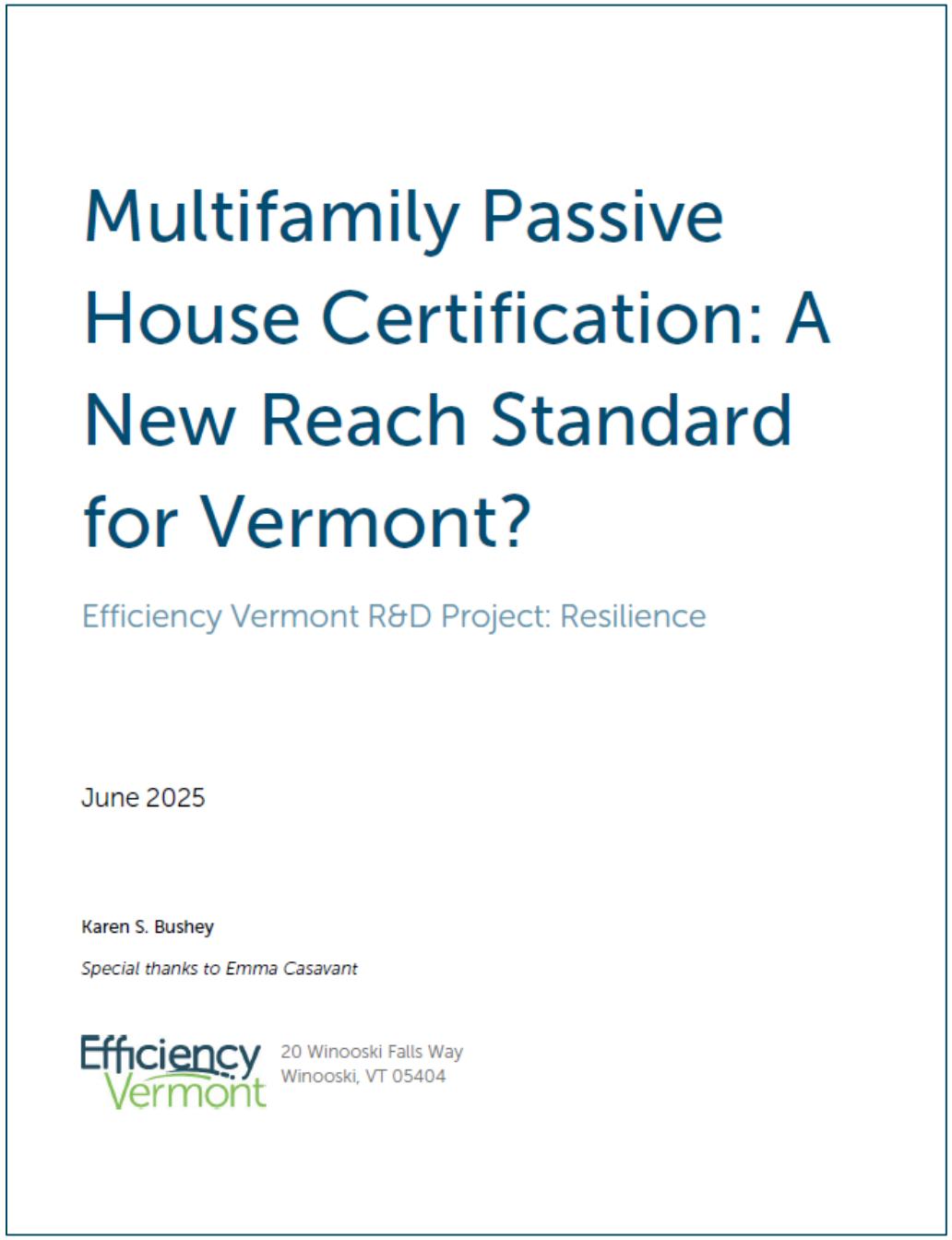
Total Housing Units: 343,166

Need to add 41,000 new homes by 2030

- No residential building code
- Energy code updated every 3 years

Lofty energy goals: 100% of new construction to be NET-ZERO-READY by 2030

Fun fact: VT is the largest producer of maple syrup in the US .



The report:

https://www.efficiencyvermont.com/Media-room/white-papers

multifamily-passive-house-certification-a-new-reach-standard-for-vermont

Agenda

Methodology, Selection Criteria

Results –

- Energy Consumption
- Costs
- Partner Feedback

Opportunities and Barriers

- Resilience
- Energy Modeling
- Prediction vs. Reality

Conclusion

Research Questions

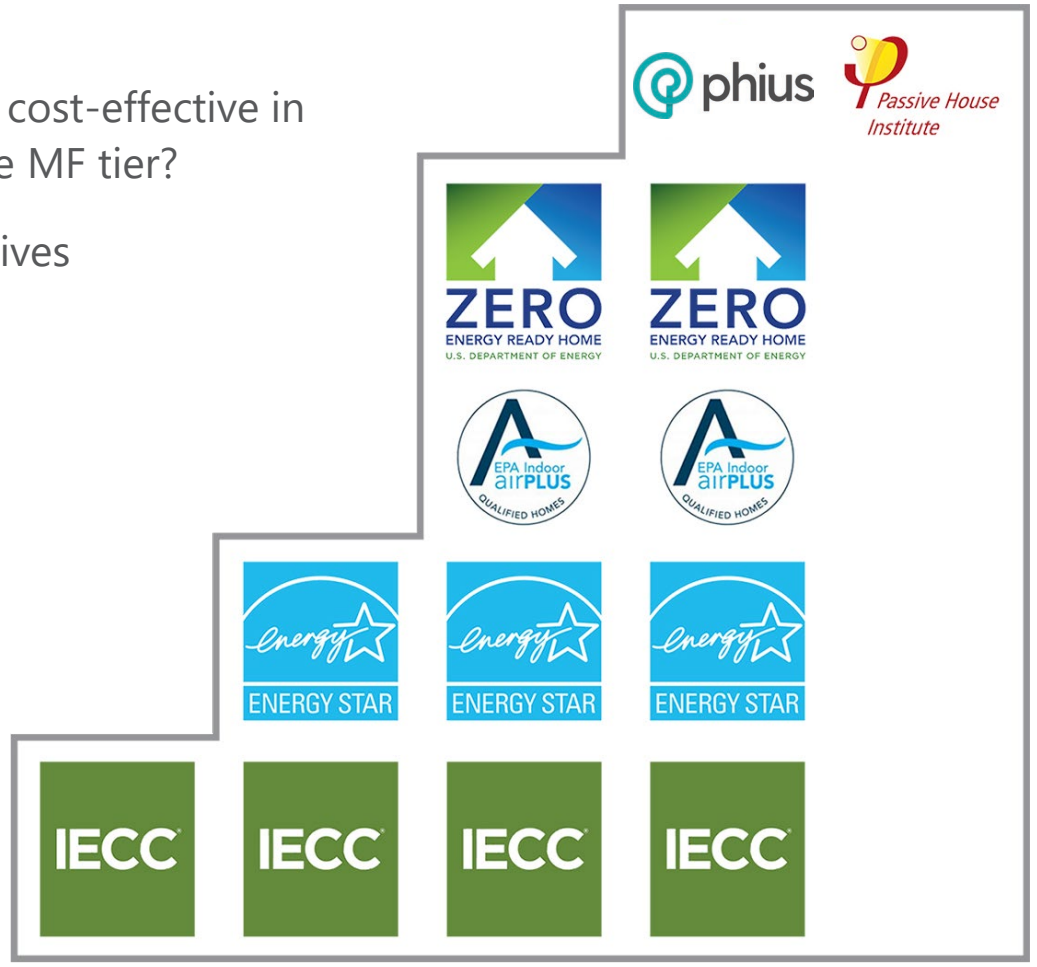
Passive Building Certification

1. Is Passive Building certification for new multifamily buildings cost-effective in Vermont compared to Efficiency Vermont's High Performance MF tier?
    - Consider costs with applicable tax credits and incentives
2. What are the added benefits?
    - Energy consumption savings
    - Qualitative data from interviews

Looked at 10 MF buildings, 2 in NH, 1 in ME

The study is unique in that it compared

2 high-performing standards



EVT MFNC Program Requirements

Thermal Shell[7]	Ceiling	☐	R-60 attic and/or R-49 Slope. Attic sheetrock plane air sealed. **R-45-60 roof**
	Flat Roof	☐	• R-45 continuous above roof deck • Sealed roof sheathing joints and connect roof sheathing to wall sheathing at perimeter
	Wood Framed Wall[8]	☐	• R-12 continuous exterior insulation (CBES or RBES) • R-21 cavity minimum • Sheathing joints taped/sealed. • See Footnote 8 for guidance for steel framed **R-33 wall**
	Exposed Floor[9]	☐	U-0.27, Example: R-38 cavity with minimum R-6 continuous exterior insulation.
	Below Grade Wall	☐	R-20 Continuous. **R-20 foundation wall**
	Slab Edge (on grade)	☐	R-20 for 48" below. **R-20 slab-on-grade, 4 feet**
	Windows	☐	• NFRC U value 0.27 or less • Storefront: U-0.33 or less **Double-pane windows**
	Elevator & Stairwell Vestibules	☐	For buildings with parking garages under living space. Required at parking level, recommended in corridors.
Air Leakage[10]	Maximum Allowed	☐	0.075 cfm50/ft2 (0.10 cfm75/ft2) of total thermal boundary surface area (6 sides include above grade walls, below grade walls and slab)[10]. Must be verified by blower door test. If blower door test indicates higher air leakage, expect reduction of per unit incentive. Building envelope commissioning incentives of 50% (up to $5,000) available to achieve this air tightness target.
Incentives	Base	☐	$3700 per apartment (includes VGS portion when in VGS territory) up to 75 units. Incentives for projects above 75 units determined on a custom basis. Incentives may be affected by available budgets.

+ Additional incentives

Lighting	In-unit[11] and Common area fixtures	☐	• ENERGY STAR or Design Lights Consortium qualified LED fixtures • If screw-based fixtures are installed, must install ENERGY STAR qualified LED lamps.
	Interior common area controls	☐	• Occupancy controls included in all hallways, stairways, laundry rooms, etc. • Day lighting control included in common areas with glazing.
Appliances (Common Area or In-Unit)	Heating System	Air Source Heat Pump/ Cold Climate Heat Pump (ASHP/CCHP) [2]	☐	Heat pumps must meet criteria for CEE Highest Tier of efficiency for Northern climate listed under the searchable list at NEEP | ASHP (https://ashp.neep.org/).; Units maintain greater heating capacity at lower temps and meet IRA criteria for tax benefits for Vermont.
		Water Source Heat Pump (WSHP)	☐	Water source heat pumps must be ENERGYSTAR Certified. If Ground Source Heat Pump (GSHP) or Air to Water Heat Pump (A2WHP) system is utilized, it is important for the developer to contact the local electric utility early on for possible Tier 3 incentives, which would come from the electric utility.
		Packaged Terminal Heat		Cold climate PTACs suitable for studio apartments must meet Northeast Energy Efficiency
Ventilation	Central Domestic Hot Water	Wood Pellet	☐	Advanced Wood Heat System: Use indirect-fired storage tank.
		Natural Gas or Propane	☐	Natural Gas or Propane: Use ENERGY STAR® labeled, condensing, sealed combustion stand-alone water heater with minimum thermal efficiency of 95%. This allows shut off of space-heating boilers outside of heating season.
		Electric	☐	All electric central DHW option: ENERGYSTAR or NEEA-listed integrated or split (monobloc) heat pump water heater(s). If geothermal system, contact Efficiency Vermont.
		All Recirculation Systems	☐	DHW recirculation loop system design consultation must happen in design phase and resulting design must be approved by Efficiency VT/BED/Vermont Gas: » Design shall utilize mixing valve(s) capable of operating at no more than 1.35 gpm. » The recirculation pump shall have an electrically commutated motor (ECM) and be equipped with "smart" controls (proportional pressure). The in-mechanical room recirculation system piping must comply with the (mixing) valve manufacturers recommended piping schematic. » Utilize non-powered thermostatic balancing valves (Circuit solver or equal) at the end of each DHW branch where a recirc water connection is made. Every effort should be made to limit the number of recirc water connections made to no more than 3 per central water heating plant. » GC to schedule site visit by EVT/BED/VGS staff to assist/verify DHW setup
		Pipe Insulation	☐	See table for hot water pipe insulation under Heating System.
		Drain Water Heat Recovery[5]	☐	$500/unit additional incentive for each unit served by drain water heat recovery unit.
		Water Conservation	☐	• Specify WaterSense toilets, fixtures • Aerators = 1.5 gpm; Showerheads = 2.0 gpm; Toilets = 1.28 gpf

EVT HP and PH/PB comparison

EVT High-Performance (HP)	Passive House (PH)/ Passive Building
Prescriptive checklist	Performance standard, based on energy targets and verified by predictive energy modeling
Customizable requirements and incentives to encourage action	Energy targets are fixed - building elements are customizable within maximum total energy demand
No enrollment or participation fee	Fee for consultants and certification paid by owner/developer
EVT staff involvement – experienced technical assistance at no cost	3rd party consultants, hired by developer, provide energy modeling, verification, and coordination
Qualifies for EVT HP incentives Eligible for 45L tax credit if pursued Eligible for additional EVT incentives if energy modeling or commissioning is pursued	Qualifies for EVT HP and additional incentives. Qualifies for 45L tax credit due to ENERGY STAR and ZERH Receives one QAP checkmark for LIHTC
Mid and post construction verification by EVT staff, included in program; staff verify for savings claim	Mid and post construction verification by 3rd party consultant and commissioning agents Documentation submitted to Passive House certifying body for final verification

Selection Criteria

Compared 6 EVT High-Performance and 4 Passive Multifamily Buildings

Selection criteria:

- EVT High-Performance– or Passive Building–certified
- In ASHRAE climate zone 6A
- Double-loaded corridor layout
- Mid-size – 3 to 4 stories in height and 24 to 42 dwelling units
- 21,000 sf to 44,000 sf
- **Low air leakage** – Most buildings had at or below Passive Building maximum requirements (0.06 cfm50 per sf thermal envelope).
- Affordable Housing

Methods - Energy

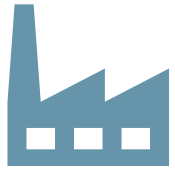
Included and not included

Energy consumption only

Energy costs not in scope

AMI data and fuel bills were converted to kBtu and site EUI was calculated

Source EUI not in scope



Also out of scope: embodied carbon, cost, carbon intensity of grid, GHG emissions

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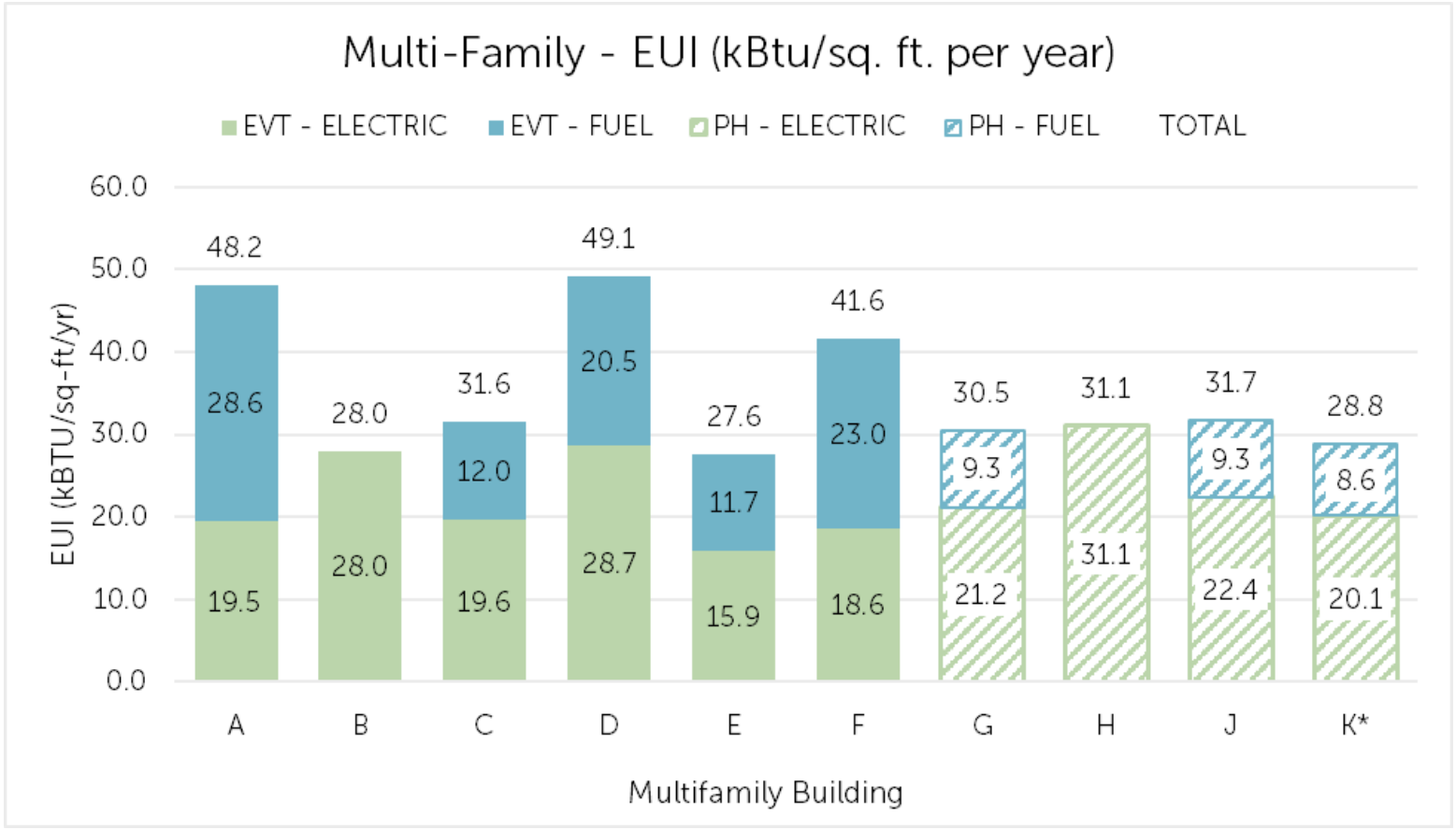
EVT HP

Multifamily Building	Conditioned Area (sq. ft.)	Housing Type	No. Units	No. Bedrooms	Mechanicals
A	31,640	Family	30	43	Cooling: ASHP (Electric) Heating: Boiler (Natural Gas) DHW: Boiler (Natural Gas)
B	21,038	Family	24	28	Cooling: ASHP (Electric) Heating: ASHP (Electric) DHW: HPWH (Electric)
C	27,876	Family	30	42	Cooling: ASHP (Electric) Heating: ASHP (Electric/Oil Backup) DHW: Boiler (Oil)
D	25,914	Family	26	31	Cooling: ASHP (Electric) Heating: ASHP (Electric/Electric Resistance Backup) DHW: Boiler (Propane)
E	33,042	Family	30	45	Cooling: ERV (Electric) Heating: Electric Resistance (Electric), Propane backup in ERV DHW: Boiler (Propane)
F	43,875	Senior	39	45	Cooling: VRF (Electric) Heating: Boiler (Natural Gas) DHW: Boiler (Natural Gas)

Passive Buildings

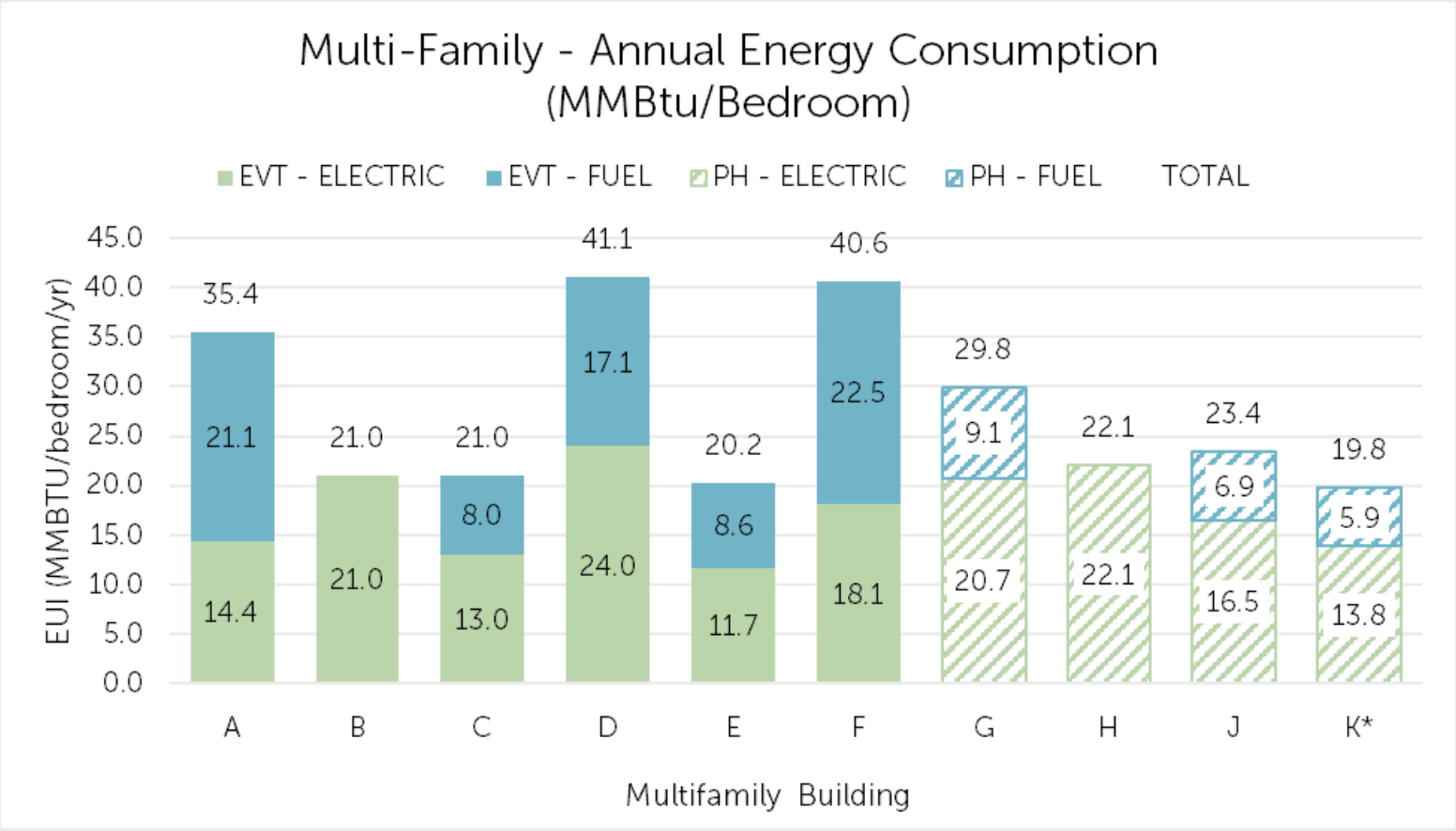
Multifamily Building	Conditioned Area (sq. ft.)	Housing Type	No. Units	No. Bedrooms	Mechanicals
G	29,350	Senior	30	30	Cooling: ASHP (Electric) Heating: ASHP (Electric/Natural Gas Backup) DHW: Boiler (Natural Gas)
H	27,700	Family	29	39	Cooling: ASHP (Electric) Heating: ASHP (Electric) DHW: Boiler (Electric)
J	30,970	Senior	42	42	Cooling: VRF (Electric) Heating: VRF (Electric) DHW: Boiler (Propane)
K	37,815	Family	45	62	Cooling: None Heating: Electric Resistance (Electric) DHW: Boiler (Natural Gas)

Results: Energy Consumption per SF



Annual energy use intensity (EUI) in kBtu/sf

Results: Energy Consumption per Bdrm.



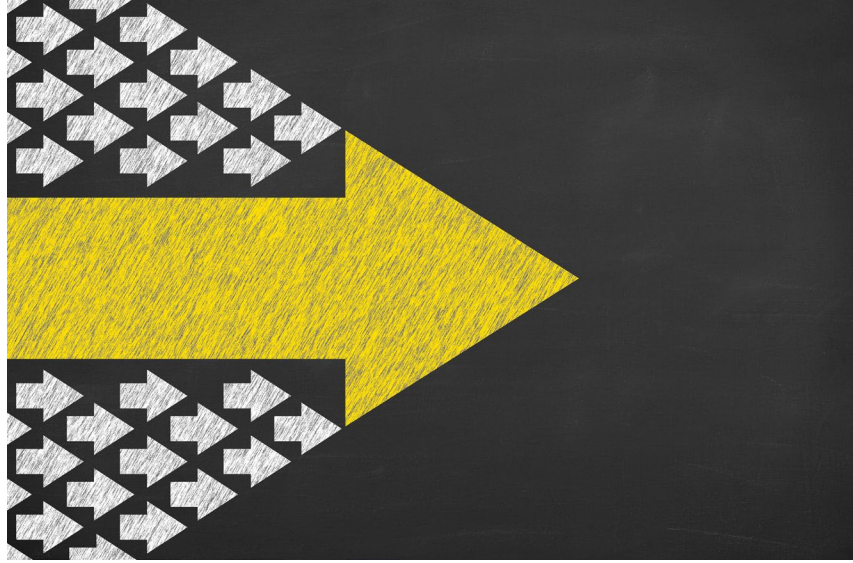
Annual energy consumption in MMBtu/bedroom

Results: Energy Consumption

Summary of performance and savings:

Energy metric	EVT High-Performance (HP)	Passive Building (PB)	% Improvement PB over HP
Average EUI (kBTU/sf/year)	37.7	30.5	**19%**
Average energy consumption (MMBTU/bedroom)	29.9	23.8	**20%**
Range highest to lowest EUI (kBTU/sf/year)	21.6	2.9	-
Range energy consumption (MMBTU/bdrm)	20.8	10.1	-

Further thoughts on data



What makes a low EUI building?

HP Buildings B, C & E – very low energy consumption

B – Family housing, all-electric with heat pumps

C – Family housing, oil boiler back-up heating and DHW

E – Family housing, propane back-up heating and DHW, electric resistance heat

Other projects not in study were even lower – 23, 24 EUI – both all-electric with heat pump heating and ER DHW, low air-leakage

Heat pump heating helps to lower EUI, but not a guarantee (ex: building D)

Costs

Developers strained by high interest rates, tariff uncertainty and construction costs

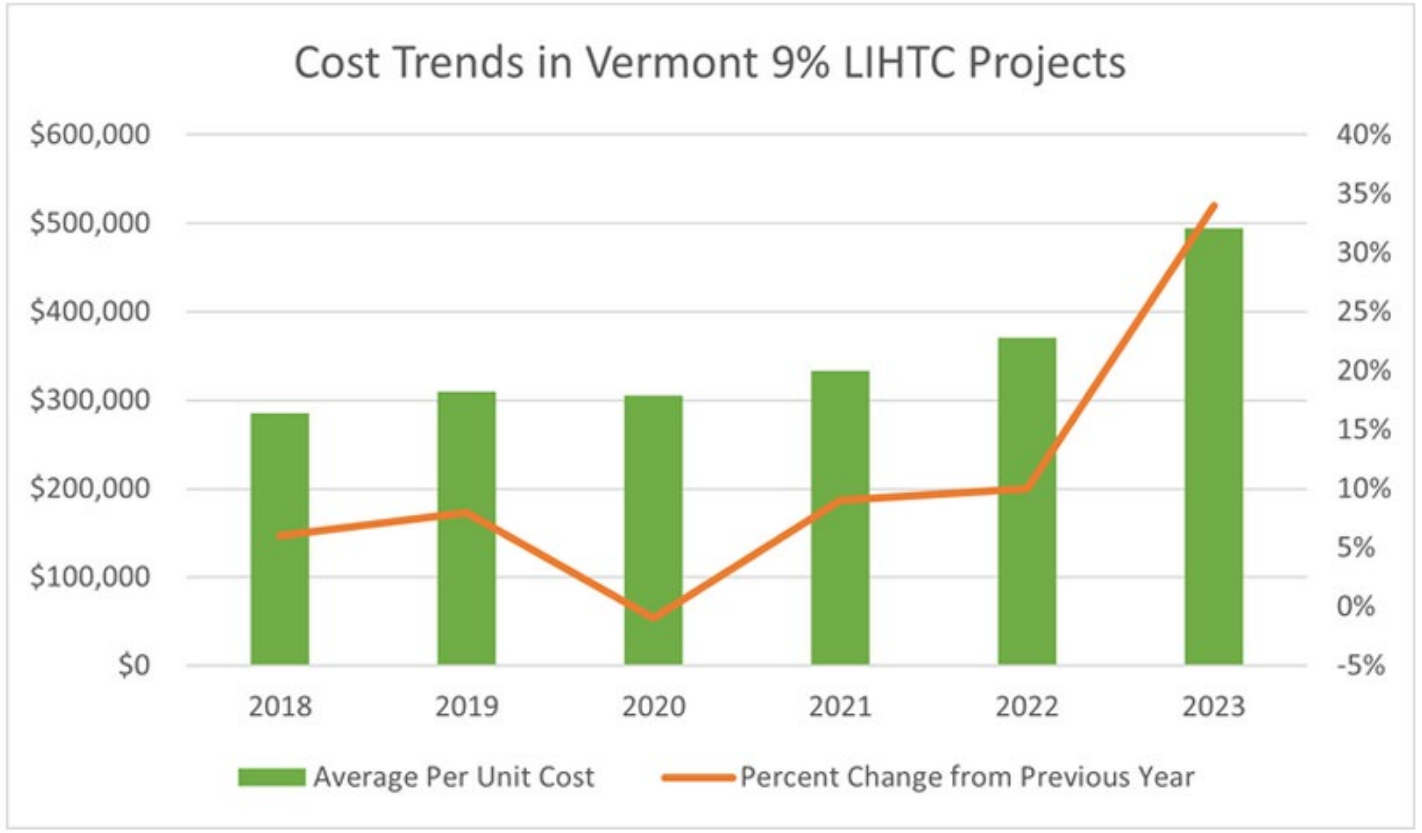
A perfect storm — that's how industry leaders describe the challenges Vermont developers face in 2025.

By Helen Argraves
March 25, 2025, 7:49 pm

vtdigger
News in pursuit of truth

Affordable Housing Development Costs

"Vermont's per unit cost of multifamily rental development has **increased 76% since 2018**."



VHFA 2023 Housing Investment Fund Annual Report

Higher Costs for Passive

Soft, Hard and Design Costs

- Total costs are 1 – 4% higher than standard development, per studies
  - Decrease with experience
- Verification is at least half of soft costs due to time and travel
- Soft costs (consultants, certification fees) have doubled in past 5 years
  - Higher demand for consultants
- Incentives are significant, but the same for HP and PB

SOFT – consultant fees (energy modeling and verification), certification fee

HARD – materials, equipment, construction costs

DESIGN – additional time it takes to integrate the requirements, which diminishes with increased experience

Other Cost Studies

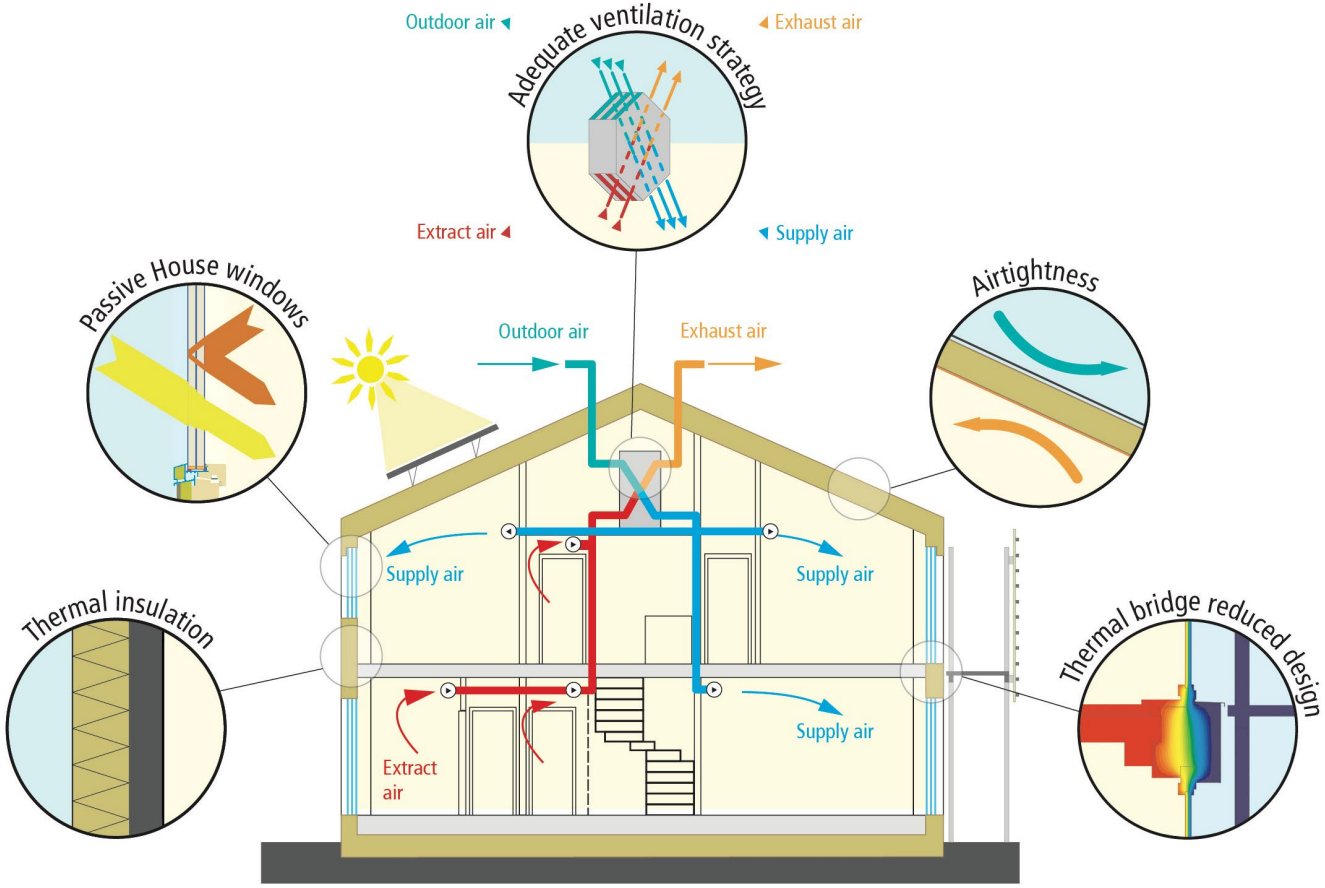
Sponsor/ Author	Source and Reference	Incremental cost of building to the Passive House standard and other findings.
NYSERDA (New York State Energy Research and Development Authority)	June 2024 Buildings of Excellence Construction Cost Data (NYSERDA, 2024)	• Passive House projects in rounds 1-4, beyond early design stage, showed average of 2.7% higher cost without incentives. • 67% of those projects had a net gain in costs after credits and incentives were applied. • 71% of projects in MF competition followed Passive House.
Massachusetts Clean Energy Center	Scaling Up Passive House Multifamily: The Massachusetts Story (Simmons, Craig, McKneally, & Lino, 2022)	• Passive House Design Challenge demonstrated average increase of 2.3% over energy code with a sample size of 7 MF projects. • Projects received incentives in milestone payments which are not included in incremental cost. • The report also demonstrates PH energy savings of 52% over non-PH MF projects.
Phius	Memo: Summary of Cost Data Research on Multi-Family buildings built to the Phius Standard (Elnecave, 2022)	• Increase of 1–4% over energy code was demonstrated in Massachusetts. • Pennsylvania MF PH projects started at 5.8% average increase in 2015, 1.6% in 2016, and by 2018 they showed average 3.3% savings over conventional construction. • Federal tax credits can lower cost additionally.
The Passive House Network (PHN)	Is Cost the Barrier to Passive House Performance (Bronwyn Barry, 2021)	• NAPHN demonstrated increase of 1–8% over standard costs with a sample size of 16 MF buildings, with an average of 4% increase. • The higher increases were attributed to teams with less or no PH experience.
Vermont Architectural Firm	NESEA Building Energy Boston Presentation on MF PH in NH, March 2019	• Architects demonstrated increase of $8 more per square foot or less than 3% over standard costs.

Hard Costs

Additional Elements for PB:

- Higher levels of insulation in exterior walls, floor slab, and roof
- Triple-pane windows in place of double-pane
- Higher levels of air sealing (not applicable for this study)
- More efficient HVAC equipment, notably ventilation systems
- Greater distribution (more ductwork) for the ventilation system

Windows – added $28,000 - $70,000



https://passiv.de/en/02_informations/02_passive-house-requirements/02_passive-house-requirements.htm

Vermont Multifamily New Construction Incentives

Incentive	EVT High-Performance qualifies	Passive Building qualifies	Amount per dwelling unit or total
EVT per unit program incentive	✓	✓	$2700, (2020 – 2024) $3700, (2024+)
EVT: energy modeling	optional	✓	50% up to $5,000 total
EVT: building envelope commissioning	optional	✓	50% up to $5,000 total
EVT: mechanical commissioning	optional	✓	50% up to $5,000 total
45L federal tax credit	optional	✓	Up to $5000 per unit, if prevailing wage requirements are met
VHFA Low Income Housing Tax Credit (LIHTC) Qualified Allocation Plan (QAP)	**X**	✓	One checkmark or point for PB or Net Zero certification can be advantageous for 9 percent tax credits, affordable development only
Vermont Passive House (VTPH) training grant	**X**	✓	$500 cost reimbursement towards Phius and Passive House Institute (PHI) accreditation training

No More ☹

Total Costs

30-unit building example

+ 3% or $400,000 for $15 million project

Approx. $100k of that is soft costs

BEFORE: **$276,000** incentives (available for both HP and PB)

AFTER: **$126,000** (with no 45L)

Partner Feedback

- Benefits are seen and felt, but construction cost and complexity are drawbacks
  - Comfortable, quiet, low cost to operate
- First costs are primary obstacle
  - Must chase highest return opportunities
    - No PB incentives since 2017
  - QAP check mark is not enough
- PB does not prevent maintenance and controls issues.
- To certify or not?

Affordable Housing developers are dealing with many challenges today (i.e., BABA, rising development costs, mental health challenges, etc.)

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Opportunities and Barriers

- **Resilience**
- **Energy Modeling**
- **Prediction vs. Reality**

Conclusion

Opportunities

- Energy modeling leads to cost optimization and predictable results
- Flexibility of a performance standard
- Limit change orders during construction
- Market transformation from project team PB training and higher demand for PB consultants
- Independent review and rigorous verification would satisfy regulatory requirements
- Opportunity for even greater savings with post-occupancy monitoring and commissioning

Barriers for Passive

- Higher cost – hard and soft costs
- Lack of PB certified professionals in VT
- Lack of incentives for PB over EVT HP
  - EVT HP provides simple, lower-cost option

Greater incentives are needed

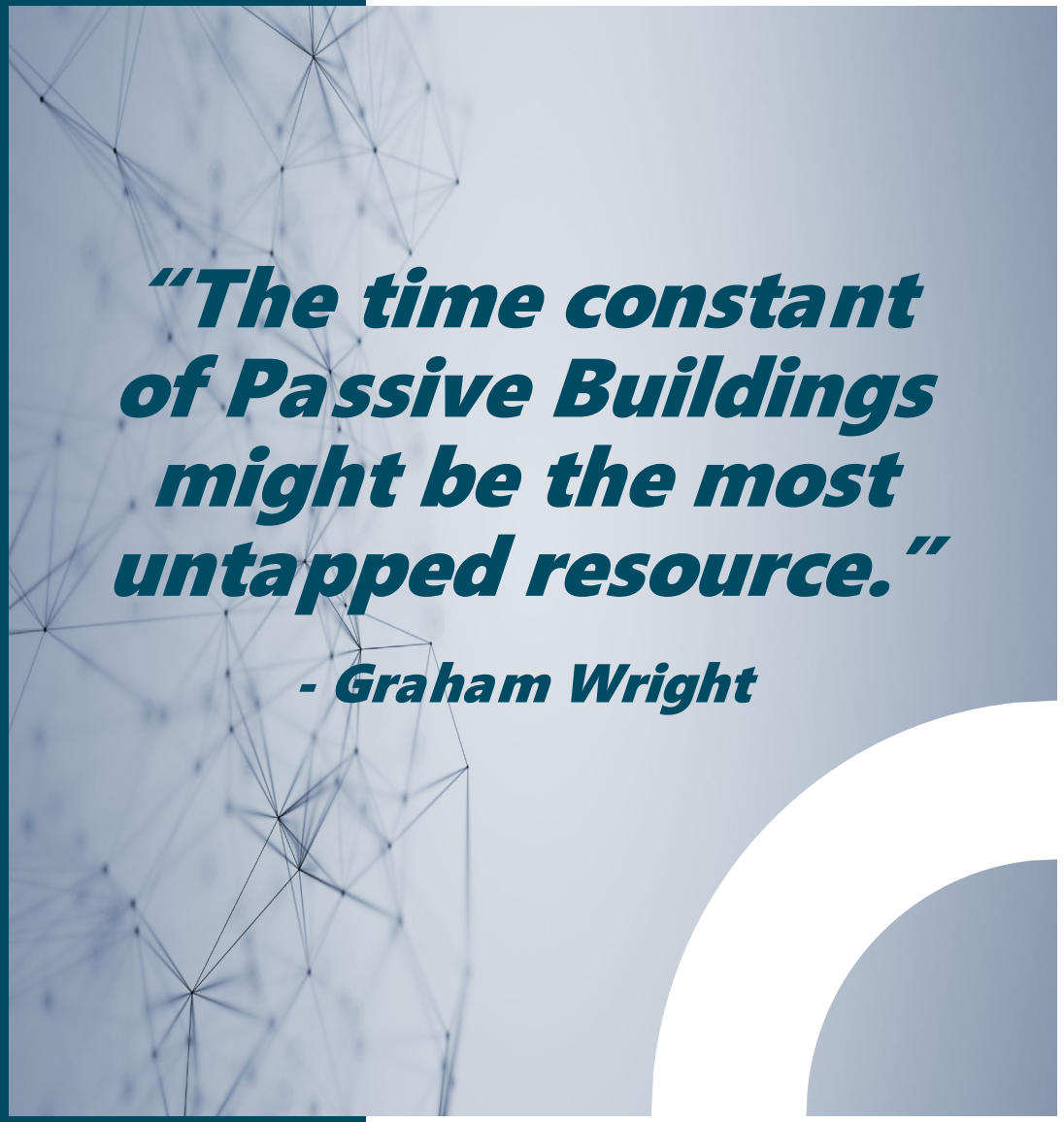
Greater support for initial project would benefit partners

Benefits - Resilience

In addition to the benefits to occupant health, safety, and well being…

- Passive buildings have the potential for load flexibility with space conditioning loads
    - Can shift load to influence grid at specific time
- Interior temperatures can be maintained at loss of power or heating/ cooling source

= Possible strategy for demand response programs (group buildings for greater impact)



Benefits – Energy Modeling

Generates predicted EUI (pEUI)

- Allows for optimization of design, trade-offs and cost savings
- Post-occupancy comparison of energy use
    - Option for performance guarantee
- Proprietary software can be an obstacle – METr, WUFI Passive, PHPP
    - Need separate baseline model to calculate savings
    - *ASHRAE 227P*, Passive Building Standard still in development

Prediction vs. Reality

pEUI is good and bad

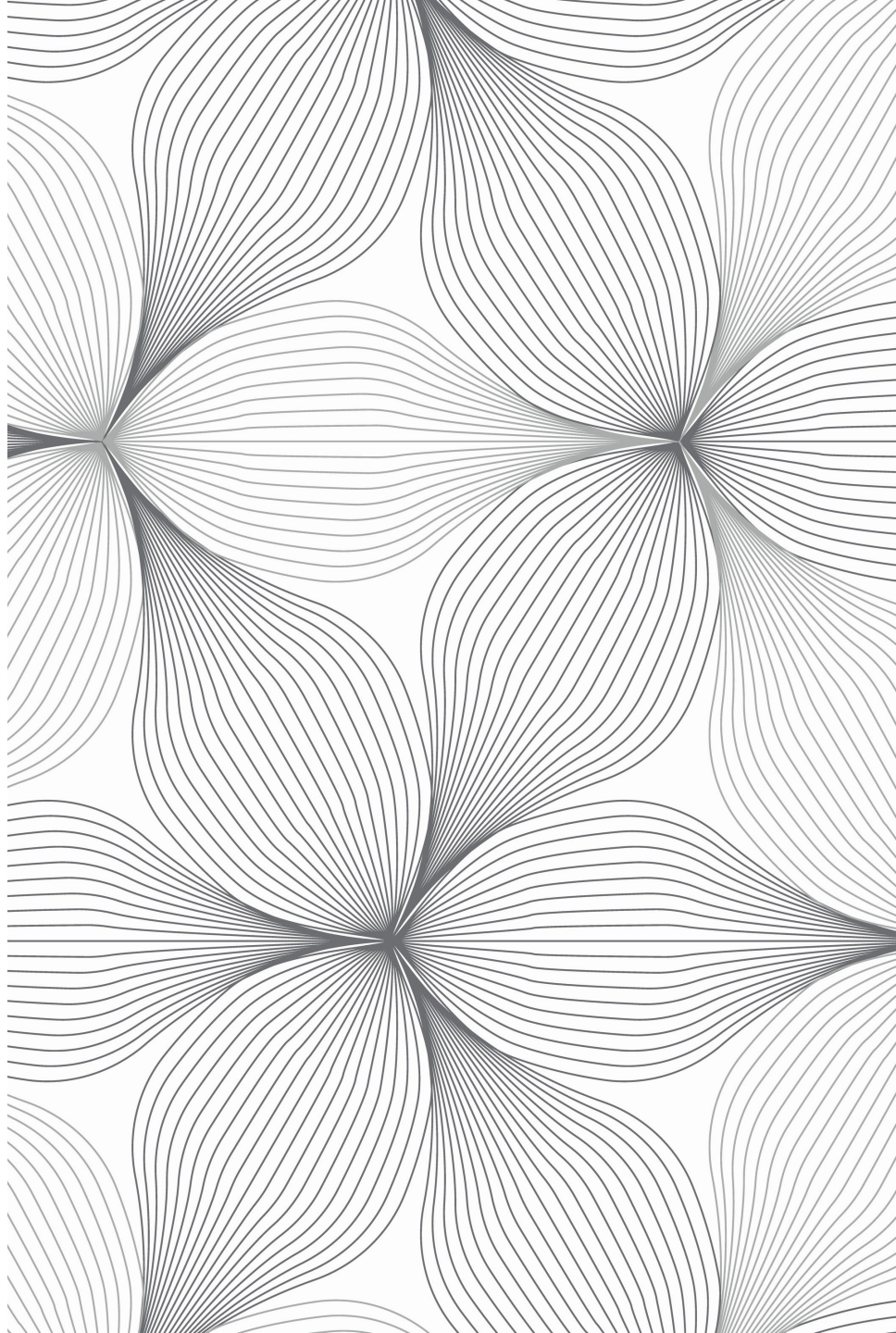
Brings additional scrutiny when real-world consumption doesn't match prediction

- Modeling software historical shortcomings
    - And continual improvements

Energy monitoring has revealed mechanical issues in several projects

- Higher than predicted energy use, yet lower than most HP
- Able to diagnose and remedy

Thermal envelope shortcomings can be ruled out due to rigorous site verification.



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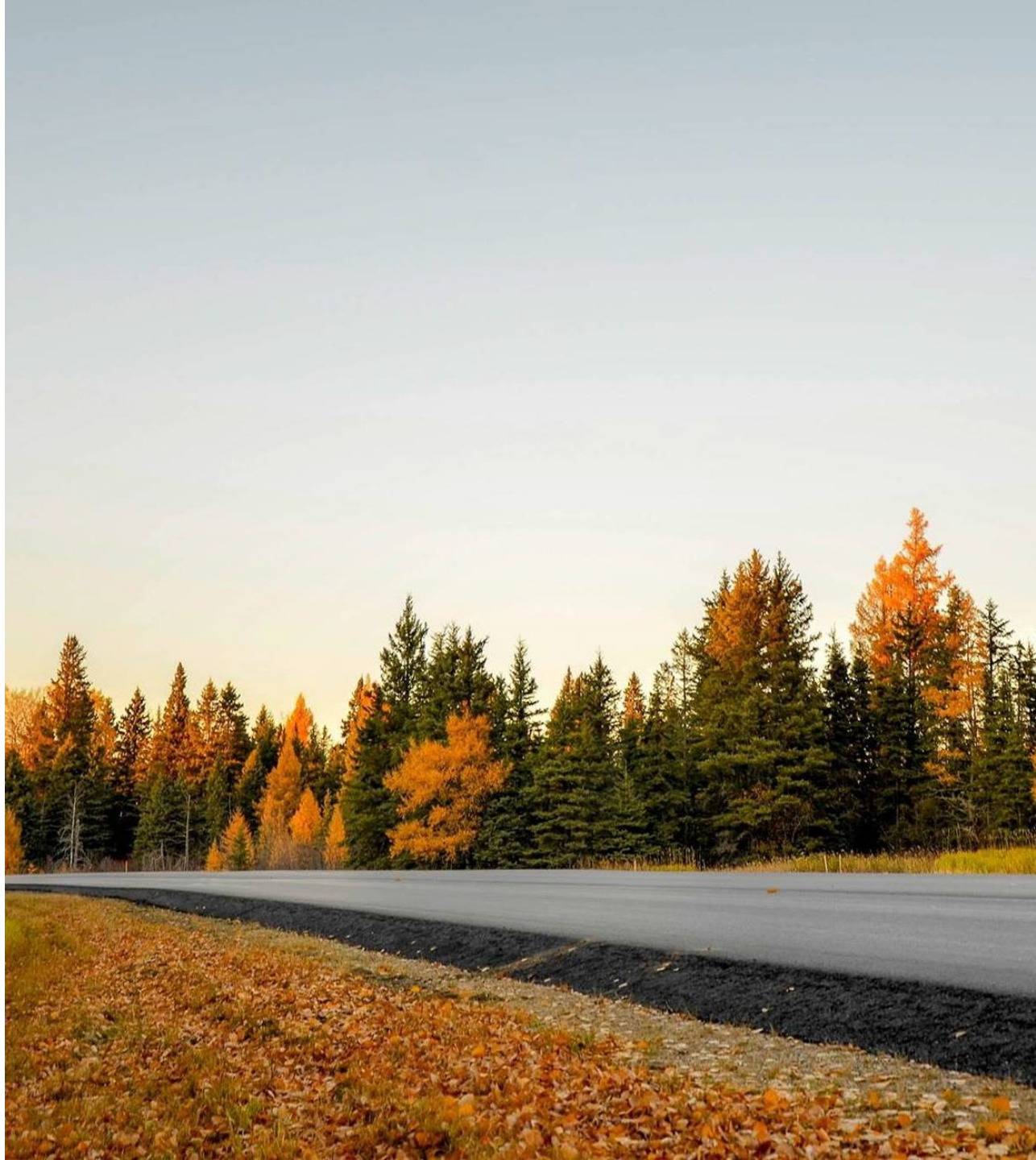

Facing Headwinds

Vermont's Executive Order

VT Governor Scott issued an EO on Sep. 17th to promote housing construction

Eases requirements, barriers… **and codes**

Energy code rolled back to 2020 version

Where do we go from here?

Conclusion

Incentives are needed to realize benefits

MF Passive Building certification provides:

- Higher, predictable savings,
- Flexible, cost-optimized standard,
- Independent review and verification,
- Modeled pEUI, and load-shifting opportunities

Higher incentives and training support are needed to move forward

- More support for first-time projects
- Build market for third-party passive building consultants

Greater adoption of MFPB outside of VT offers many examples to look to

Next Steps

Compliance Path

- EVT can add Passive Building as a compliance path for earning HP incentives (include add-ons automatically?)

Another cost study?

- Compare HP cost to PB cost in current market dollars based on current energy codes.

MF buildings in VT are significant state assets – Passive Building better guarantees long-term savings over the life of the building.

The report: https://www.efficiencyvermont.com/Media-room/white-papers

Appendix – Other State Incentives

State	Incentive agency or		Source and Reference	Details
CT	MA	Stretch Energy Code	22 Ma Re En Mu Sp (M De Re	
		Mass Save	Pa	
		Massachusetts Clean Energy Center (CEC)		
		Massachusetts Department of Housing and Community Development (DHCD)		
	NYSERDA			
			Homes (Rhode Island Energy, 2023)	unit building can receive up to $2,750 per unit.
		RI Housing	State of Rhode Island 2024 Qualified Allocation Plan (Rhode Island Housing, 2024)	QAP awards up to three points for meeting PH standards.

States with only low-income housing tax credits (LIHTC) for incentives			
ME	Maine Housing	2023 - 2024 LIHTC Qualified Allocation Plan (MaineHousing, 2022)	QAP allows a greater Total Development Cost (TDC) per unit for PH certification.
NH	NH Housing Finance Agency	New Hampshire Qualified Allocation Plan (New Hampshire Housing, 2024)	QAP awards eight points for PH certification and allows a greater TDC per unit.
PA	PA Housing Finance Agency	Pennsylvania Housing Finance Agency Allocation Plan for Program Year 2024 (Pennsylvania Housing Finance Agency, 2023)	QAP awards ten points for PH certification.


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Thank you!
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