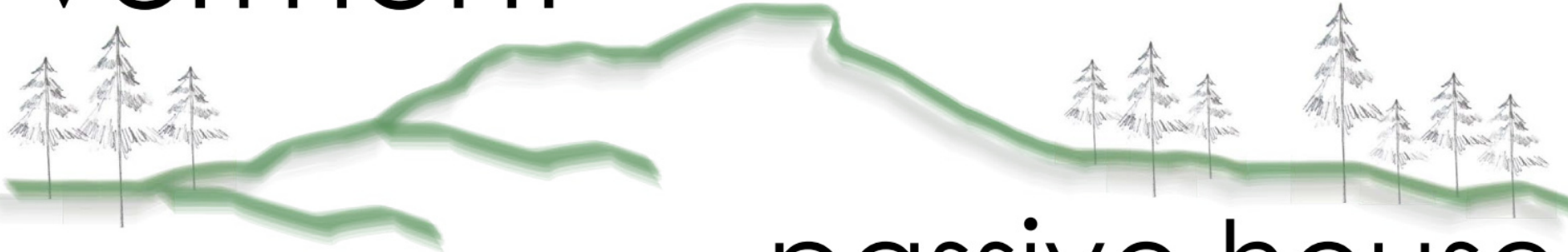


vermont



passive house



Energy Efficient Buildings



Solutions to Mitigate Climate Change from Buildings

Implementing the Passive House Building Standard to minimize the energy intensity and CO₂ emissions in buildings

House Committee on
Energy & Technology
H.688

www.vtph.org

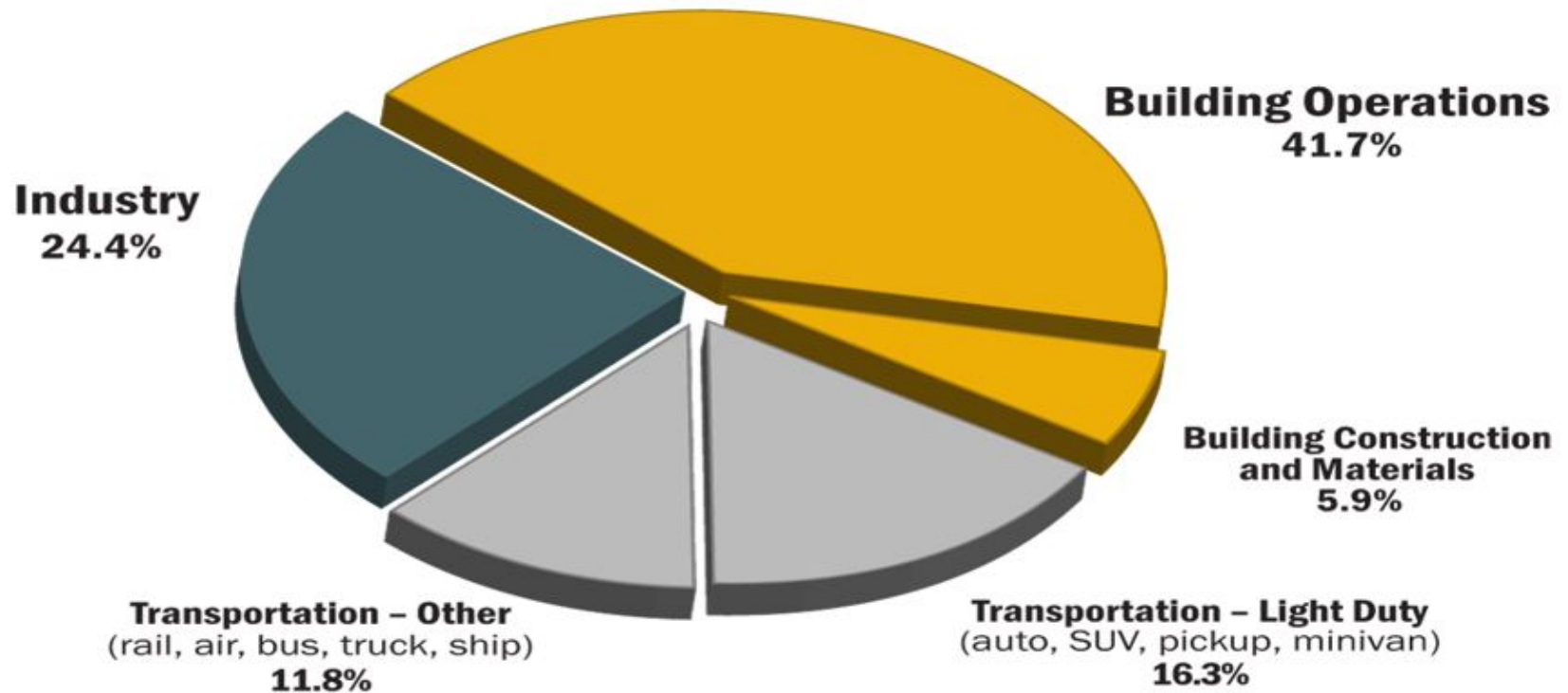
January 29, 2020

Presenter's Credentials

Enrique Bueno

- Chemical Engineer
- VT Resident since 1992
- 40 Years experience in basic industries – Cement, Aluminum and Steel production
- 9 Years specialized in Building Science and Passive House Buildings
- Founding member of the VT Passive House NPO 5013C
- Board Chair of the VT Passive House organization
- Certified Passive House Consultant

The Problem

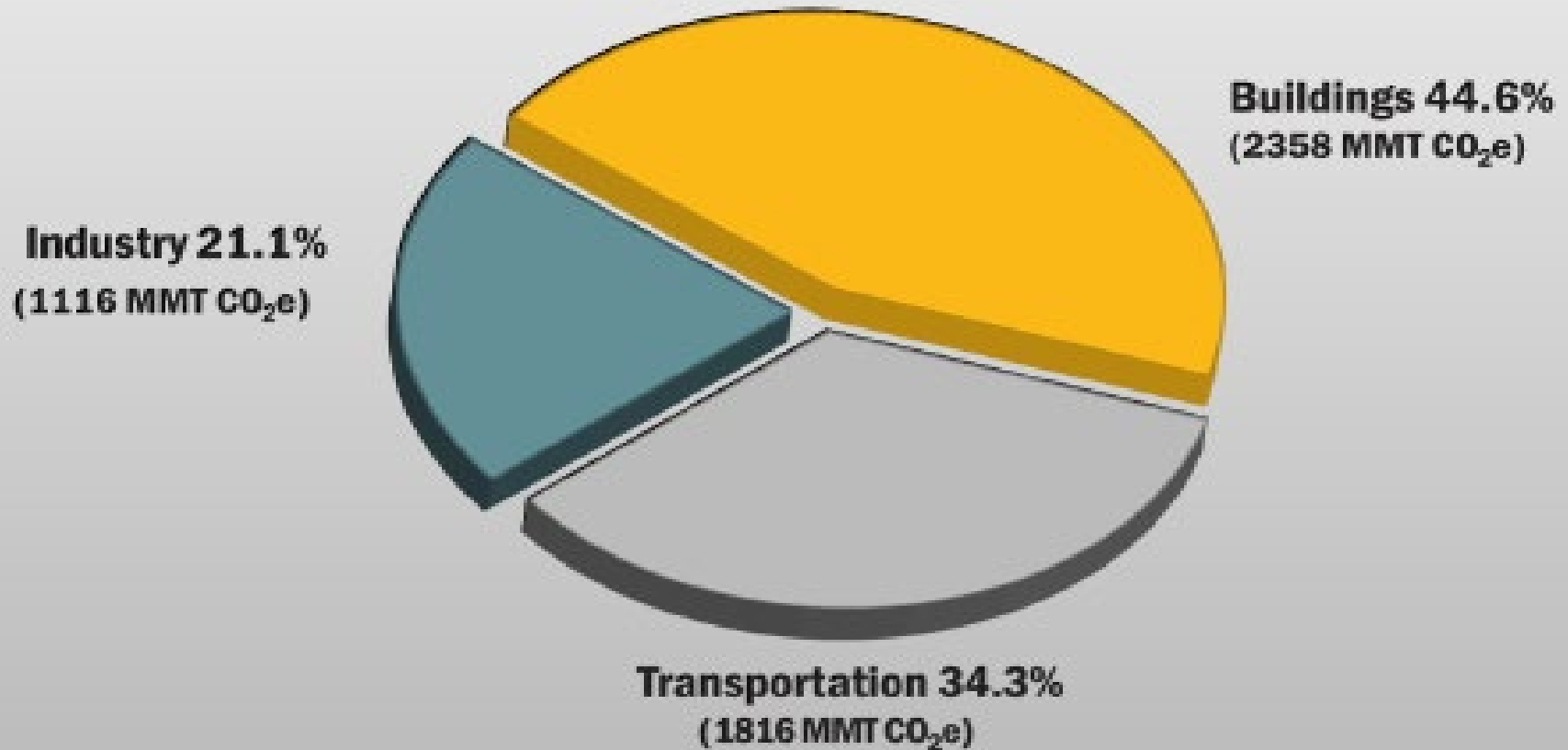


U.S. Energy Consumption by Sector

Source: ©2013 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2012).

The Problem

Building Operations and Materials have a mayor impact on CO₂ emissions

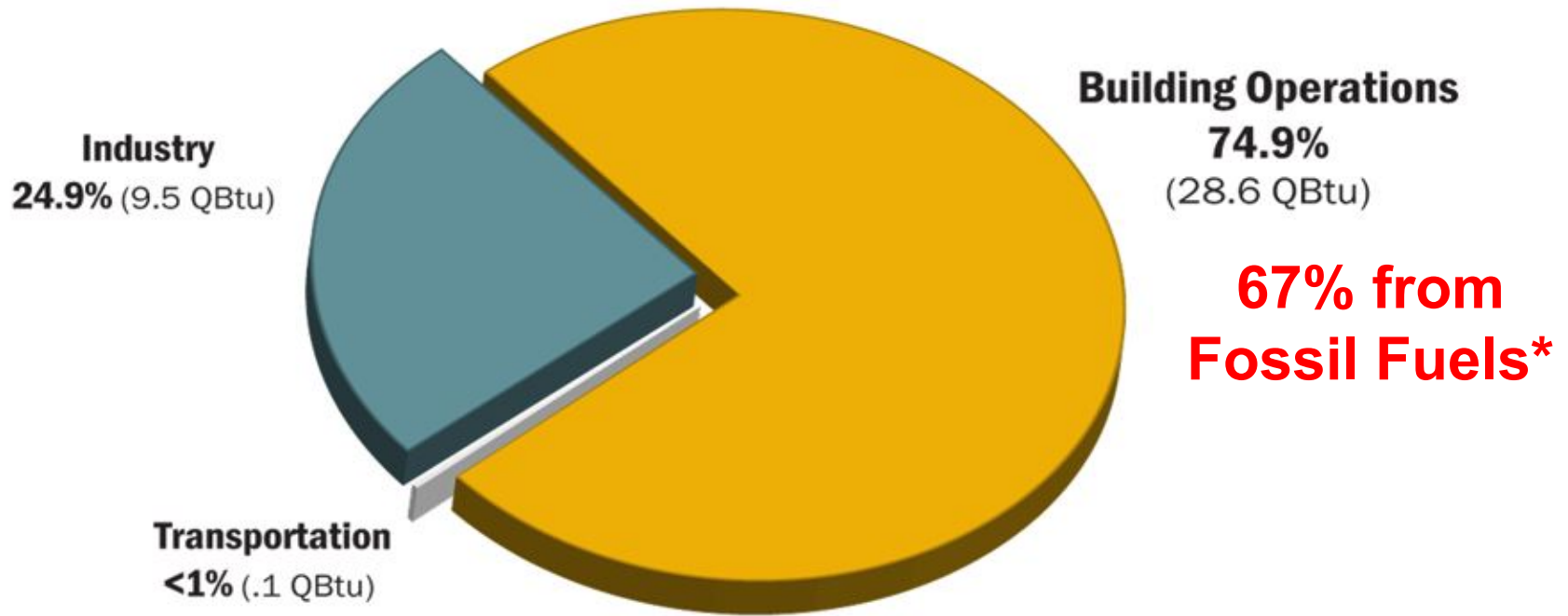


U.S. CO₂ Emissions by Sector

Source: ©2013 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2012).

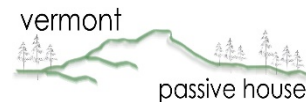
The Problem

Building Operations use 75% of Total Electricity



U.S. Electricity Consumption by Sector

Source: ©2013 2030, Inc. / Architecture 2030. All Rights Reserved.
Data Source: U.S. Energy Information Administration (2012).

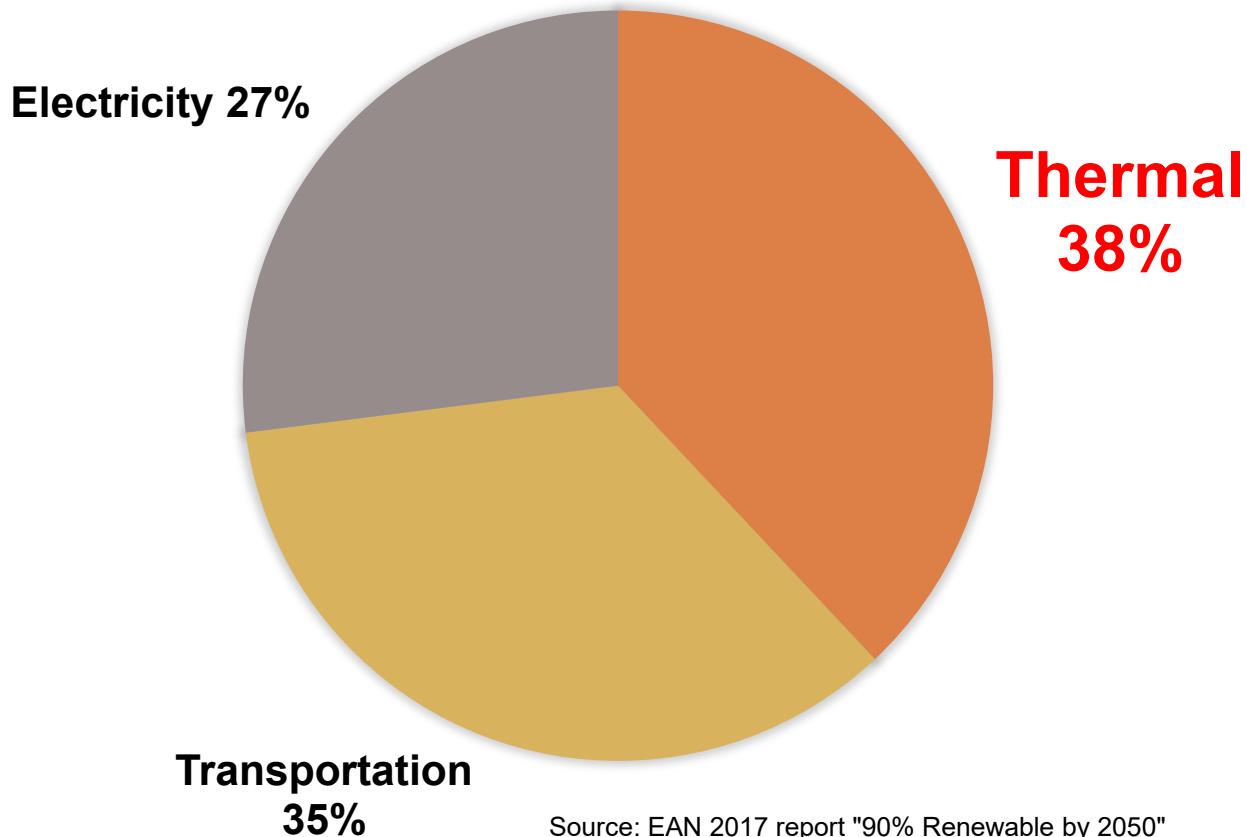


*US-EIA 2014

The Problem in VT

76% of Thermal comes from Fossil Fuels

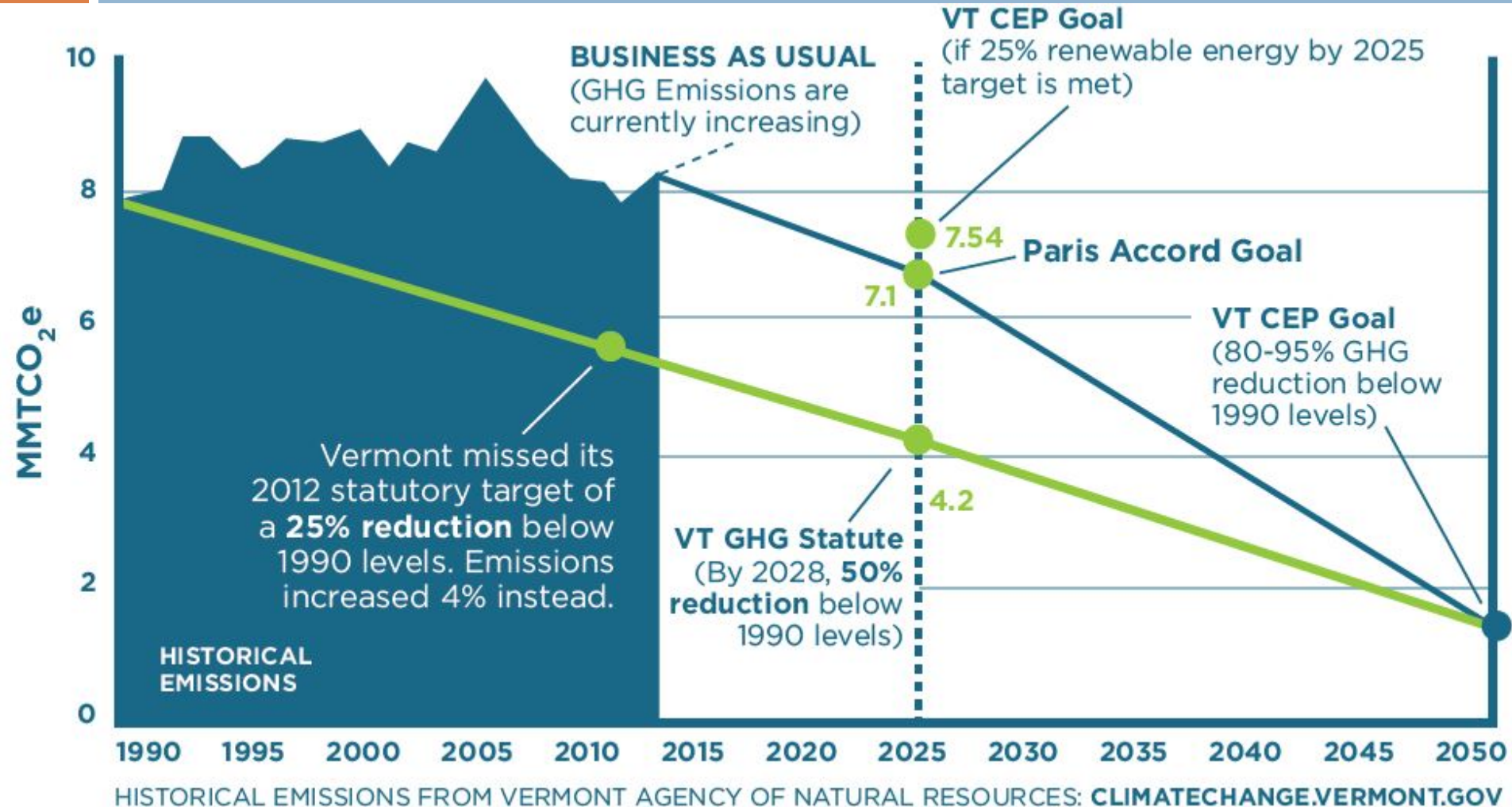
VT ENERGY USE BY SECTOR



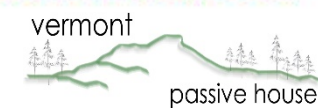
Source: EAN 2017 report "90% Renewable by 2050"

The Problem in VT

**VT's CO2 emissions increased by 11% from 2012 to 2015
by 2015 we were 55% above the goal**



Source: EAN 2017 report "90% Renewable by 2015"





What are we proposing to contribute to the Solution?

Adoption of the Passive House Standard as RBES

Why?

- The Passive House Standard is based on specific energy intensity performance benchmarks which if met, you pass, if not you fail
- It allows for accountability since the benchmarks are well defined
- It requires field 3rd party verification to comply with design parameters

DOE Recognition of the Passive House Standard

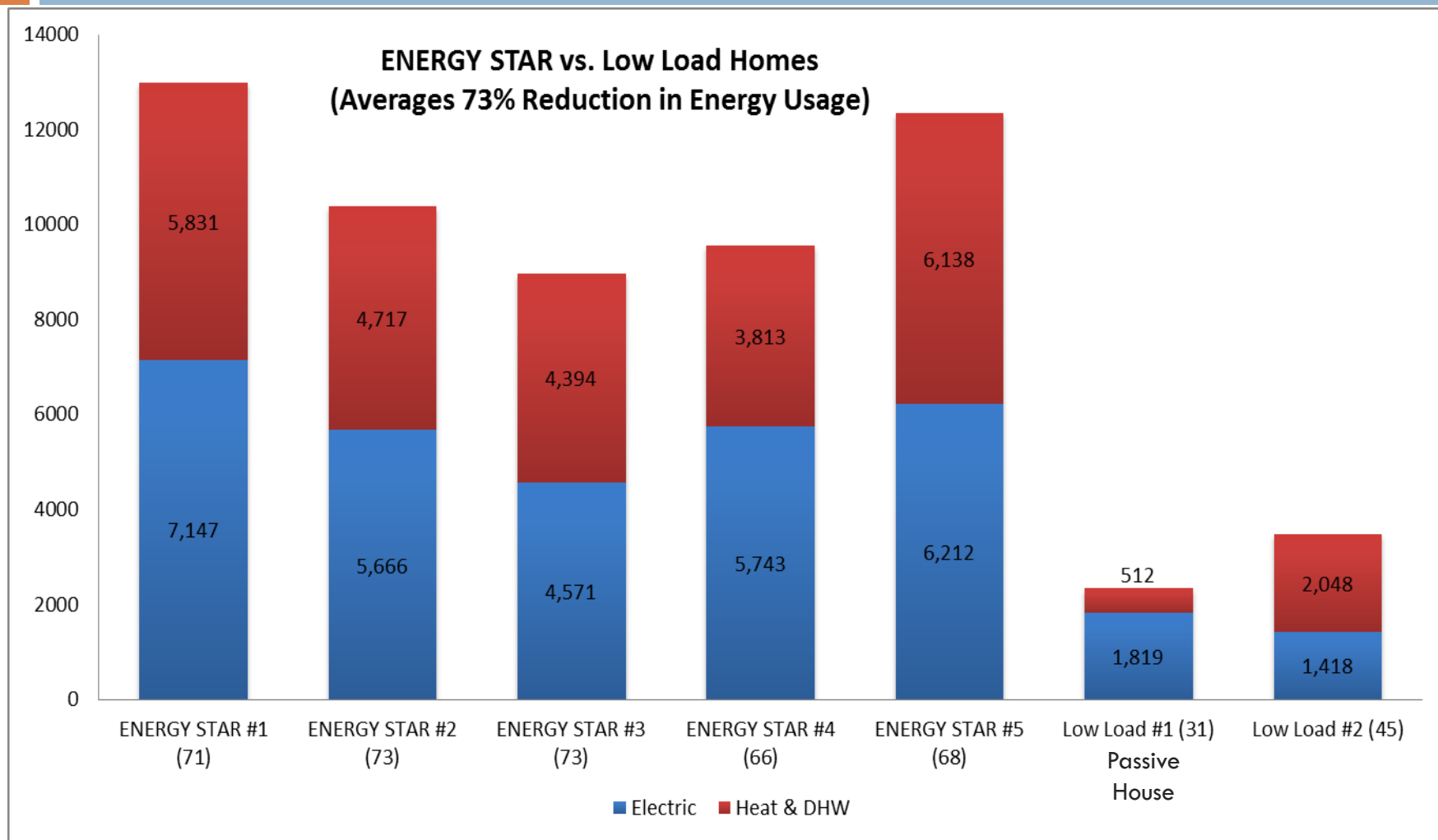
ZERH Staircase

U.S. DEPARTMENT OF
ENERGY | Energy Efficiency &
Renewable Energy



				Solar Ready	Solar Ready
				Eff. Comps. & H ₂ O	Eff. Comps. & H ₂ O
				EPA Indoor Air Package	EPA Indoor Air Package
				Optimized Duct Location	Optimized Duct Location
		HVAC QI with WHV	HVAC QI with WHV	HVAC QI with WHV	HVAC QI plus HRV
		Water Management	Water Management	Water Management	Water Management
Independent HERS Verif.	Independent HERS Verif.	Independent HERS Verif.	Independent HERS Verif.	Independent HERS Verif.	Independent PHIUS Verif.
IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Encl./ES Win.	Ultra-Efficient Enclosure
HERS 85-90	HERS 70-80	HERS 65-75	HERS 55-65	HERS 48-55	HERS 35-45
IECC 2009	IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	PHIUS+

Actual Energy Consumption Comparison of five Energy Star Homes, one Passive House and one Low Load



Source: Efficiency VT 2012

RBES Stretch Code is stuck !

ZERH Staircase

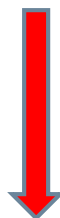
U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy



**70 % Short from
where it could
and should be**

here



Independent HERS Verif.	Independent HERS Verif.	HVAC QI with WHV	HVAC QI with WHV	Solar Ready	Solar Ready
IECC 2009 Enclosure	IECC 2012 Enclosure	Water Management	Water Management	Eff. Comps. & H ₂ O	Eff. Comps. & H ₂ O
HERS 85-90	HERS 70-80	Independent HERS Verif.	Independent HERS Verif.	EPA Indoor Air Package	EPA Indoor Air Package
IECC 2009	IECC 2012	IECC 2009 Enclosure	IECC 2012 Enclosure	Optimized Duct Location	Optimized Duct Location
		HERS 65-75	HERS 55-65	HVAC QI with WHV	HVAC QI plus HRV
		ENERGY STAR v3	ENERGY STAR v3.1	Water Management	Water Management
				Independent HERS Verif.	Independent PHIUS Verif.
				IECC 2012/15 Encl./ES Win.	Ultra-Efficient Enclosure
				HERS 48-55	HERS 35-45
				ZERH	PHIUS+

How long is it taking ?

From RBES 2015 Stretch Code to RBES 2020 Stretch Code the improvement is just 15 to 20% energy reduction

10 Years

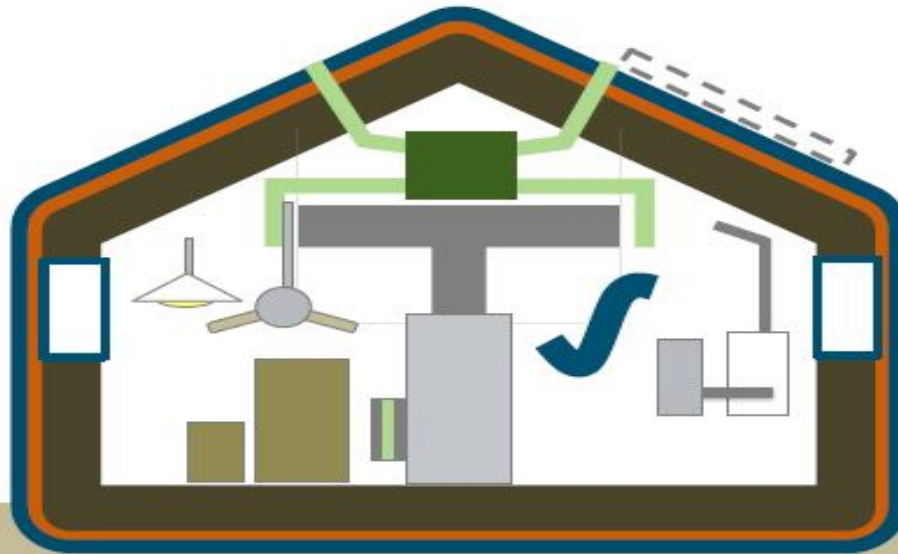
???

IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2009 Enclosure	IECC 2012 Enclosure	IECC 2012/15 Encl./ES Win.	Ultra-Efficient Enclosure	Ultra-Efficient Enclosure
HERS 85-90	HERS 70-80	HERS 65-75	HERS 55-65	HERS 48-55	HERS 35-45	HERS < 0
IECC 2009	IECC 2012	ENERGY STAR v3	ENERGY STAR v3.1	ZERH	PHIUS+ PHIUS+	PHIUS+ SourceZero
		Independent Verification	Independent Verification	Independent Verification	Independent Verification	Independent Verification
		Water Management	Water Management	Water Management	Water Management	Water Management
		HVAC QI w/WHV	HVAC QI w/WHV	HVAC QI w/WHV	Micro-load HVAC QI	Micro-load HVAC QI
		Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space	Ducts in Condit. Space
		EPA Indoor airPLUS	EPA Indoor airPLUS	EPA Indoor airPLUS	EPA Indoor airPLUS	EPA Indoor airPLUS
		Eff. Comps. & H2O Distrib	Eff. Comps. & H2O Distrib	Eff. Comps. & H2O Distrib	Eff. Comps. & H2O Distrib	Eff. Comps. & H2O Distrib
		SOLAR READY Depends on climate	SOLAR READY ALWAYS	SOLAR READY ALWAYS	SOLAR READY ALWAYS	SOLAR READY ALWAYS
		Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV	Balanced Ventilation HRV/ERV
		Source Zero Renewable Energy System	Source Zero Renewable Energy System	Source Zero Renewable Energy System	Source Zero Renewable Energy System	Source Zero Renewable Energy System

Where does a Zero Energy Ready Building Start According to the DOE ?

Zero Starts with the Enclosure

U.S. DEPARTMENT OF **ENERGY** | Energy Efficiency & Renewable Energy



Optimized
Enclosure
System

Water
Protection
System

Optimized
Comfort
System

Complete
IAQ
System

Efficient
Comps
System

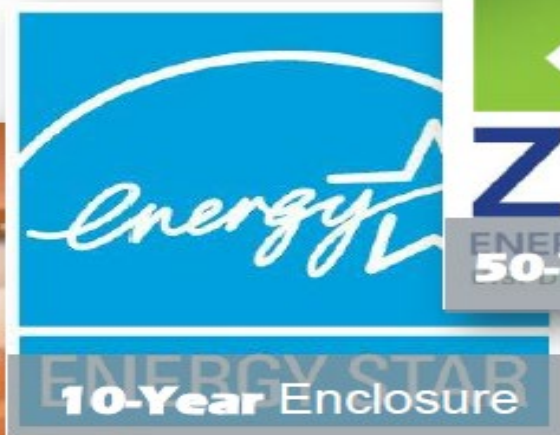
Solar
Ready
System

DOE's Recognition of the Passive House Standard

Consumer Choice Made Simple

U.S. DEPARTMENT OF
ENERGY

Energy Efficiency &
Renewable Energy

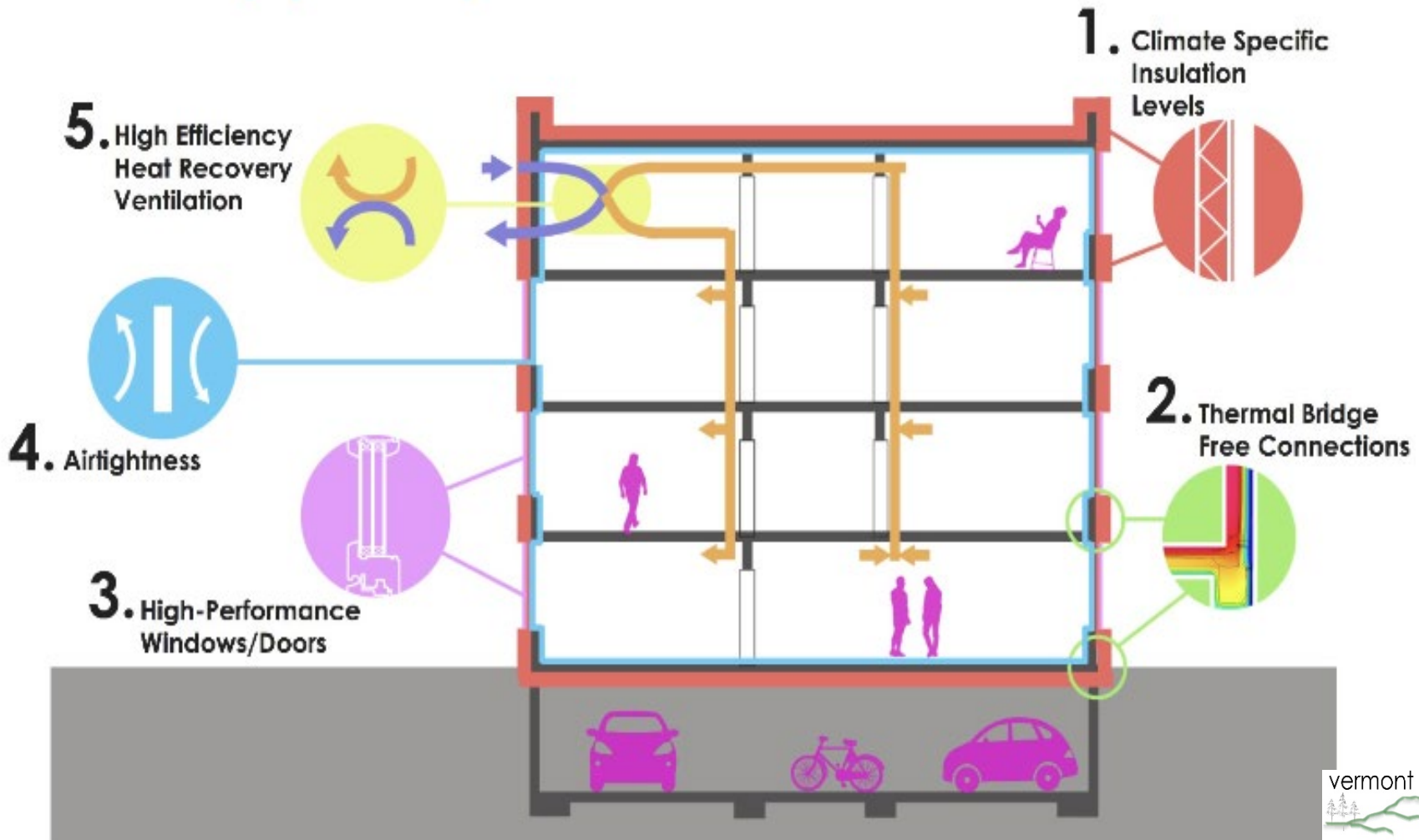


Efficiency VT's Multifamily Incentives for the Passive House Standard

Incentives	Energy modeling for building	50% of modeling cost (up to \$5,000) if conducted early in support of integrated design process; must include EVT Energy Consultant in process.
	Thermal Shell commissioning	50% of commissioning cost (up to \$5,000) if air leakage target is 0.10 cfm50/sq. ft. exterior building shell area or less
	Passive House	Additional \$300 per unit incentive for successful Passive House certification.

PASSIVE BUILDING PRINCIPLES

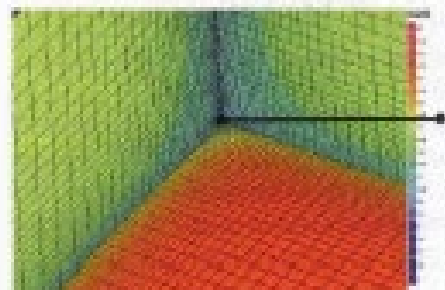
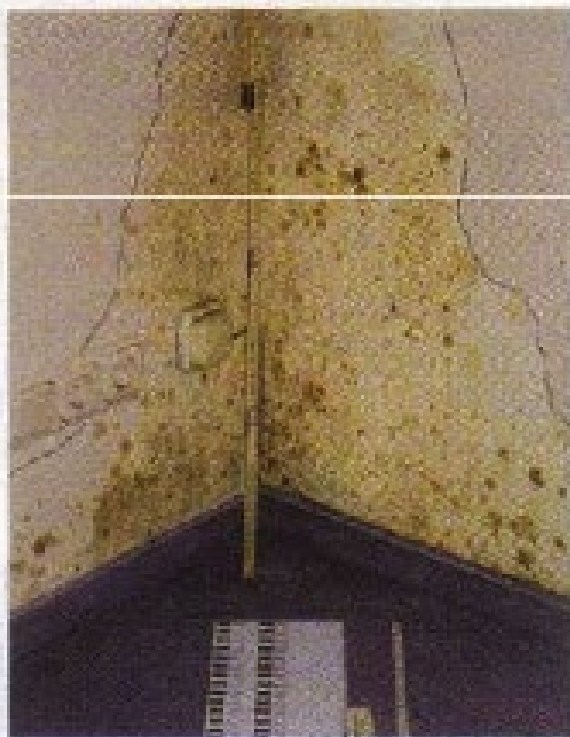
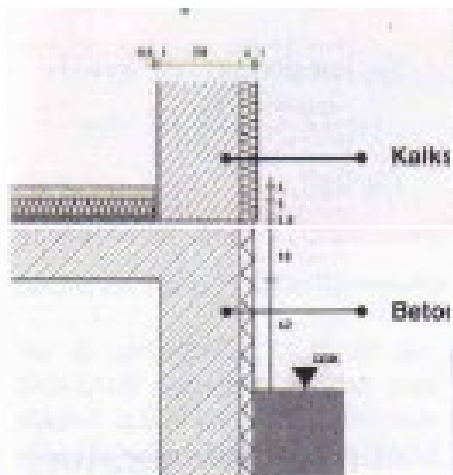
Five key principles:



MINIMIZE LOSS:

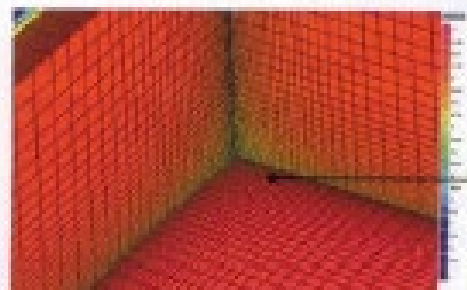
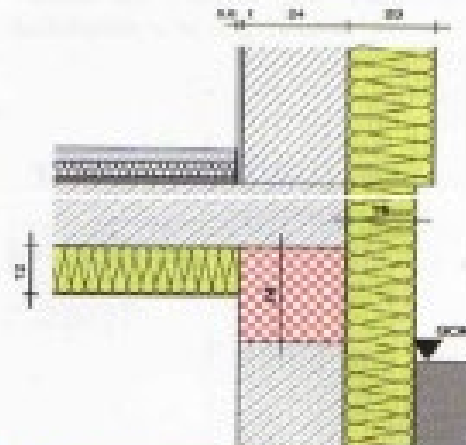
ELIMINATING THE THERMAL BRIDGE MINIMIZES HEAT LOSS
CONDENSATION/BUILDING DETERIORATION

BAD = high heat loss + risk of condensation



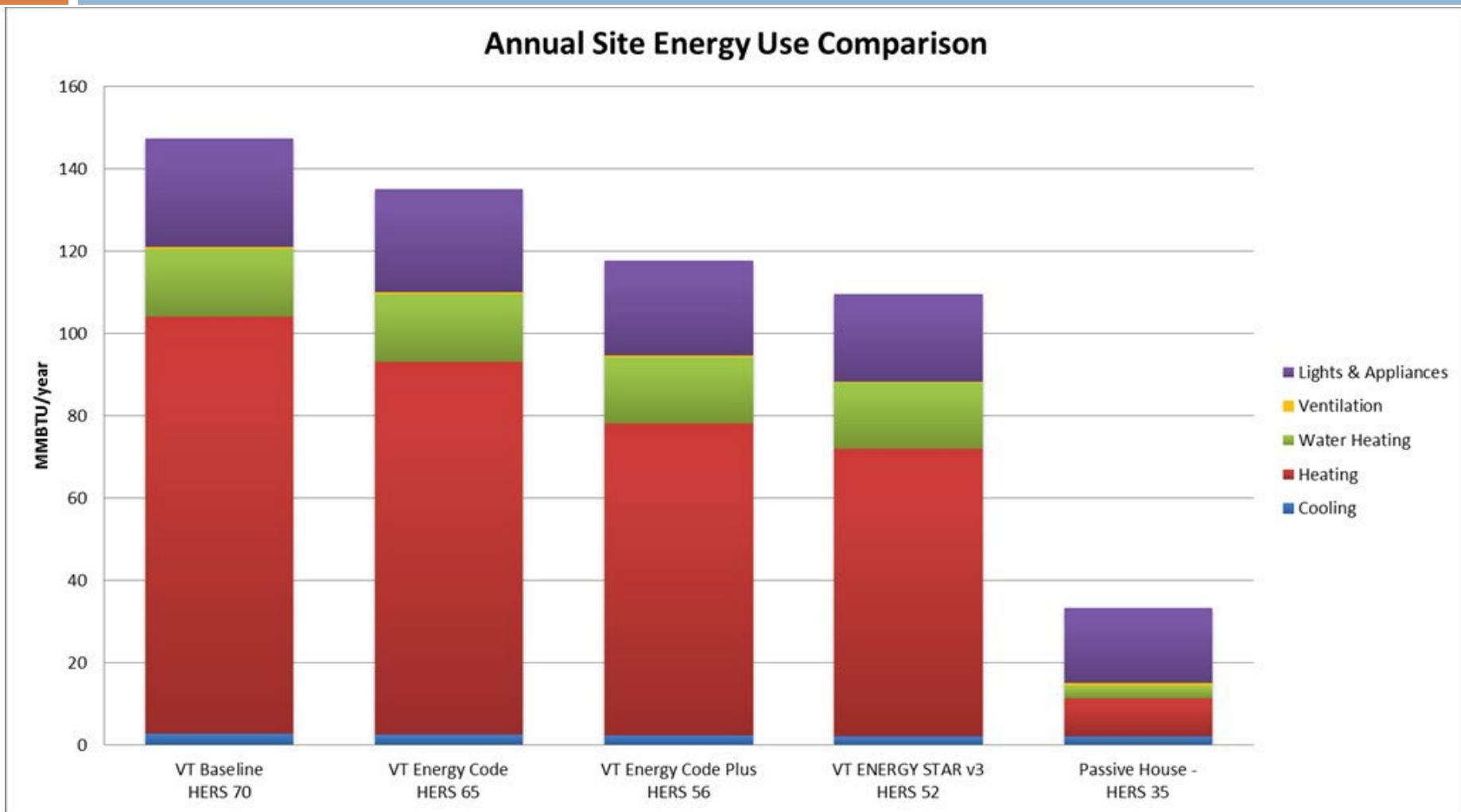
Minimum temperature 48 F below dew-point, risk of condensation

GOOD = low heat loss, warm interior surface + no condensation



Minimum temperature 58 F above dew-point, no risk of condensation

Energy Usage Comparison



Source: Efficiency VT - 2012

How does it relate to other programs?

Energy Efficient Housing Concepts in the US:

- Vermont Energy Code (RBES): required for all new construction **but not enforced**
- Energy Star 3.0: DoE Program (30% more efficient than Code)
- Building America: DoE super energy savings Program (15% better than EStar)
- Passive House: **90% more efficient than VT RBES Code**
- 70% more efficient than Energy Star
- 55% more efficient than Building America

Can be cost equivalent to conventional building for single family and equal or less for multifamily and commercial construction.

Passive House Projects Vermont



**THIRD ANNUAL PASSIVE
PROJECTS COMPETITION
WINNERS!**

**ELM PLACE -
Best Overall
Passive Building
Winner**

Multifamily project category Winner
Affordable project category Honorable
Mention

2017 PHIUS Passive House Projects
Competition

**83% less energy for heating/cooling than
a conventional building**

@ only 2% more cost

Elm Place Senior Housing, Milton-VT

Passive House vs. Stretch Code 2020

Space heating	Heating demand	5.38	kBTU/(ft ² yr)
	Heating load	4.91	BTU/(hr.ft ²)
Primary energy	dehumidification, DHW, lighting, electrical appliances	59	kBTU/(ft ² yr)
Airtightness		0.7	ACH50

Passive House
68% better than
Stretch Code

Space heating	Heating demand	17.06	kBTU/(ft ² yr)
	Heating load	11.90	BTU/(hr.ft ²)
Primary energy	dehumidification, DHW, lighting, electrical appliances	75	kBTU/(ft ² yr)
Airtightness		3	ACH50

Stretch Code
217% More
Heating Demand
27% More Primary
Energy

Passive House Projects North East USA



Handel Architects

High Rise – Cornell-Tech - NYC



School

Portland ME



**Affordable Senior Housing
Milton VT**



**Affordable Housing
Brewer - ME**

East Harlem - NYC

East 111th Street development



- Mixed-use, 655 affordable apartments complex including
- Seniors' housing
 - Harlem RBI/Dream Charter School
 - YMCA facility
 - Mount Sinai Health Center
 - Urban Market & Retail Space
 - Public gardens
- Income from \$19,050 to \$106,080

Rendering Courtesy of Handel Architects

Village Center Apartments Brewer, ME



48 Affordable
Housing Units
51,778 SqFt Interior
Floor Area
1,2 & 3 Bedroom
units
3 common areas
1 dog washing room

\$135/sqft
construction cost

Village Center Apartments Brewer, ME



**Conventional
Double Stud-
Wall filled with
cellulose that
any builder can
build
Not Rocket
Science**

Twin Pines Housing – West Lebanon NH

Maclay Architects – Waitsfield VT



Tracy Street - Twin Pines Housing

AREA: 27,000 sf

Net Positive Energy

ILFI Net Zero Energy

PHIUS+ 2015

ENERGY INTENSITY: 25 kBtu/sf-yr (modeled)

Air Infiltration: 0.044 cfm50/sf (actual)

Solar PV array size: 180 kW

COMPLETION: 2019

Habitat for Humanities East Montpelier, VT



Built by Volunteers

Construction: Timber

Insulation: Cellulose

Gross Area : 1,318 ft²

HERS Score: 9

Certification: PHIUS+ 2015

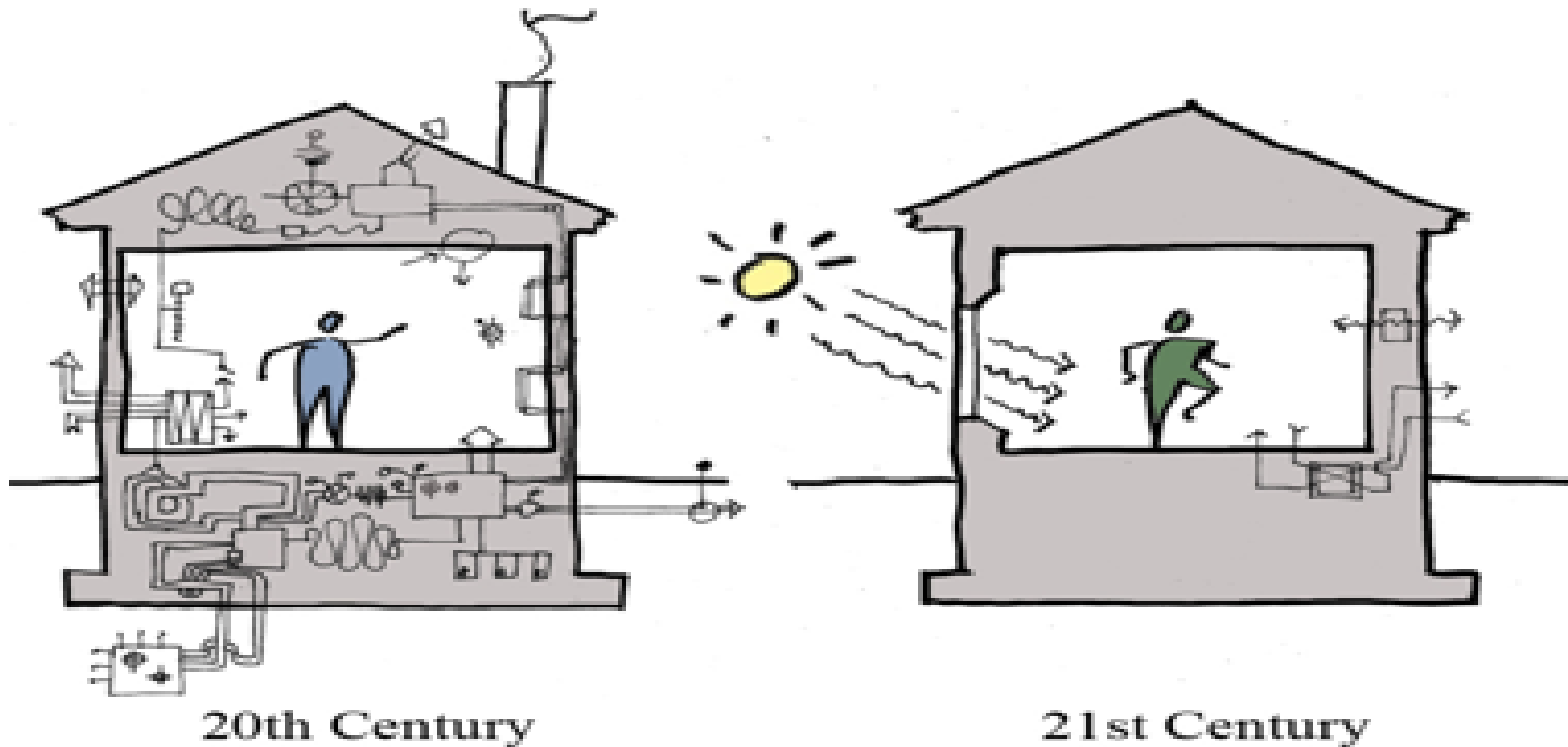
**The first year without PV
their energy cost was
\$63/month total**

**All electric
July2017-June2018 = 4984kWh**

**Air Tightness: 0.011 cfm50/ft2
Heat/Cool: ASHP**

**Ventilation: Central HRV
Windows: Triple glazed avg U-0.11 (R9)**

Passive House Moves Toward Simplicity





Economic Opportunities for VT

Bio Mass and Bio Fuels are not the Answer



We could turn our forest into carbon sequestration materials



LSL



Wood Fiber insulation Boards

Instead of



Pellets

=



+CO₂

There are lots of plant-based carbon-storing building materials



Timber



Wood Fiber Board



Cork




ReWall



Waste Textiles



Cellulose



Straw



Mycelium



Rice Hulls



Bamboo /
BamCore



Coconut Coir



Hemp OSB



+ more

Materials with negative embodied energy that can have a serious impact in reducing GHG emissions

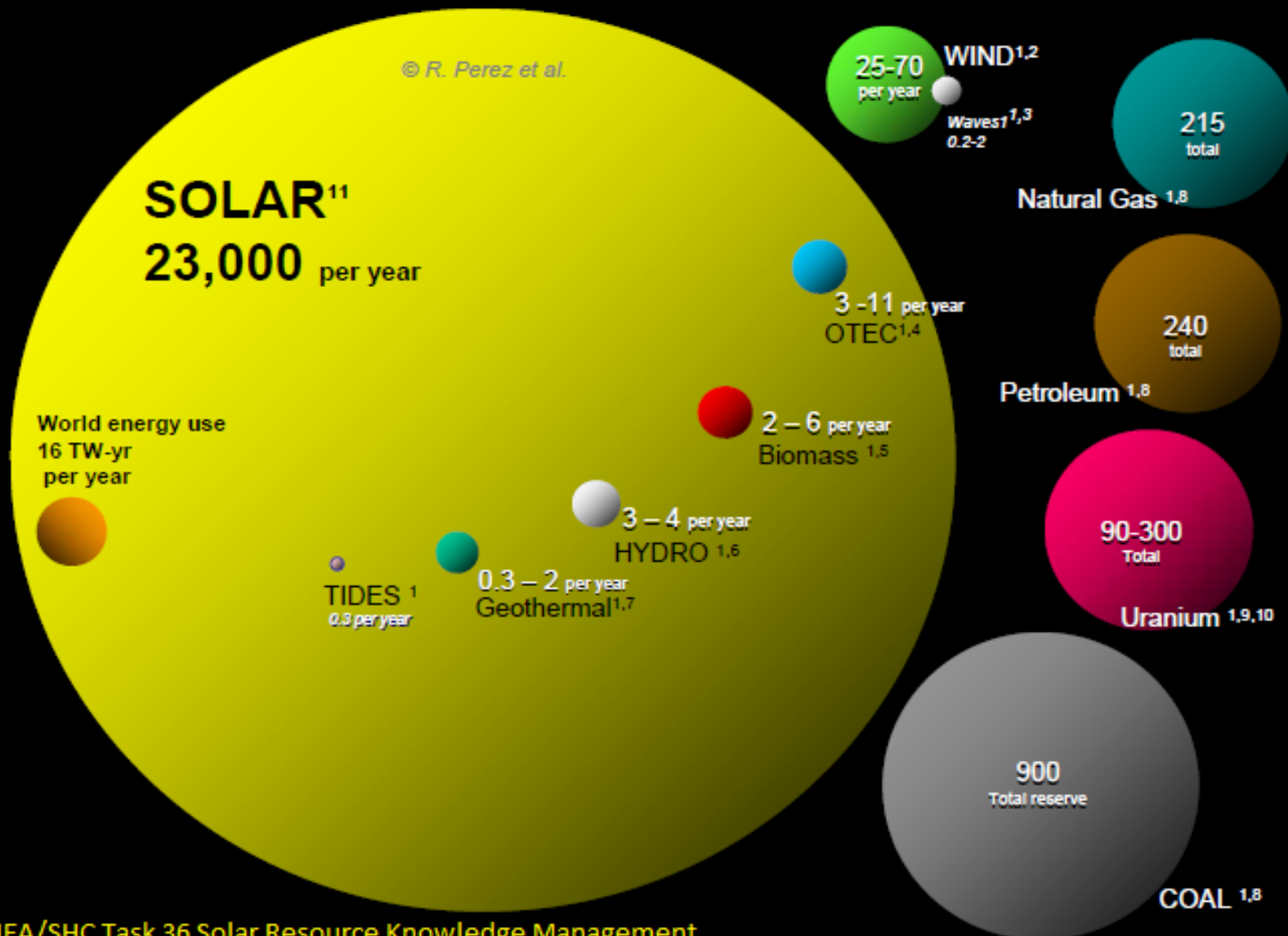


Figure 1: Comparing finite and renewable planetary energy reserves (Terawatt-years). Total recoverable reserves are shown for the finite resources. Yearly potential is shown for the renewables.



What We Have and What We Lack

- We have the science
- We have the craftsmanship
- We have of shelf materials and components
- **We lack legislation !**

VT Legislature's URGENT MISSION

VT Legislature must act now to reduce the energy waste and CO2 emissions related to buildings by:

- 1) Enacting legislation to require builders and contractors' registration
- 2) Requiring builders and contractors' certification
- 3) Designate an authority for work verification
- 4) Designate an authority to enforce the newly adopted building code
- 5) Boldly and immediately upgrading the VT building code RBES to Passive House levels of energy and carbon reductions

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- 4) Designate an authority to enforce the newly adopted building code



**Covered
by
H.719**

- 5) Boldly and immediately upgrading the VT building code RBES to Passive House levels of energy and carbon reductions



**Not in
consideration
yet**

Thank you

vermont



passive house

Because we care about you saving money and living healthy, and care about the environment, our legacy and our future, we design and build **energy efficient buildings.**



Enrique Bueno - ebueno@eplusbuildings.com

