



Zero Energy Now

A Whole-Home Energy Transformation

Path to achieving Vermont's sustainable energy goals

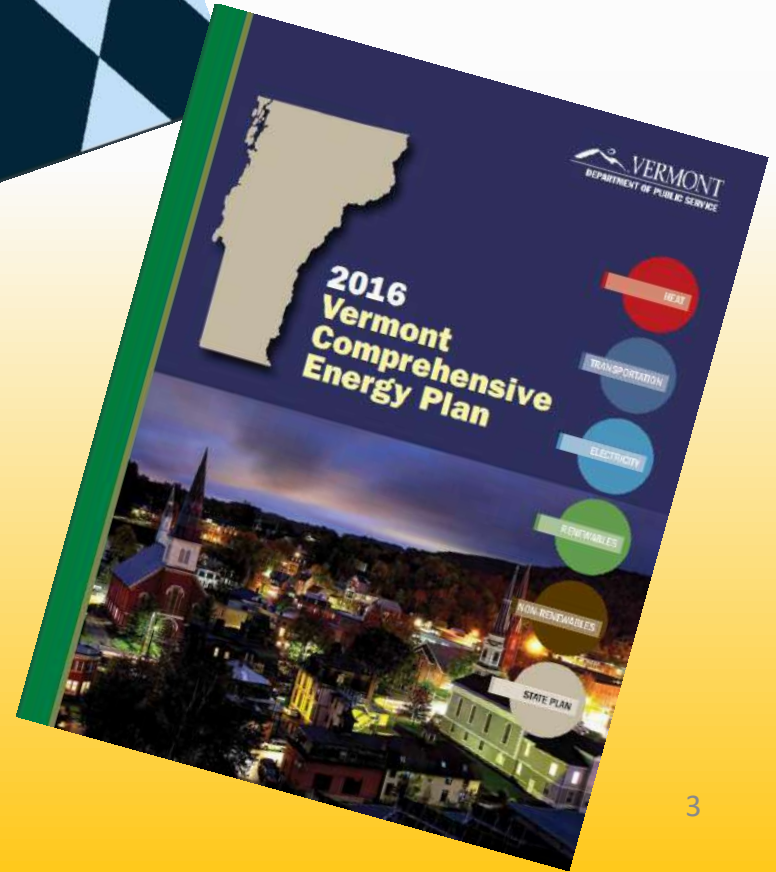
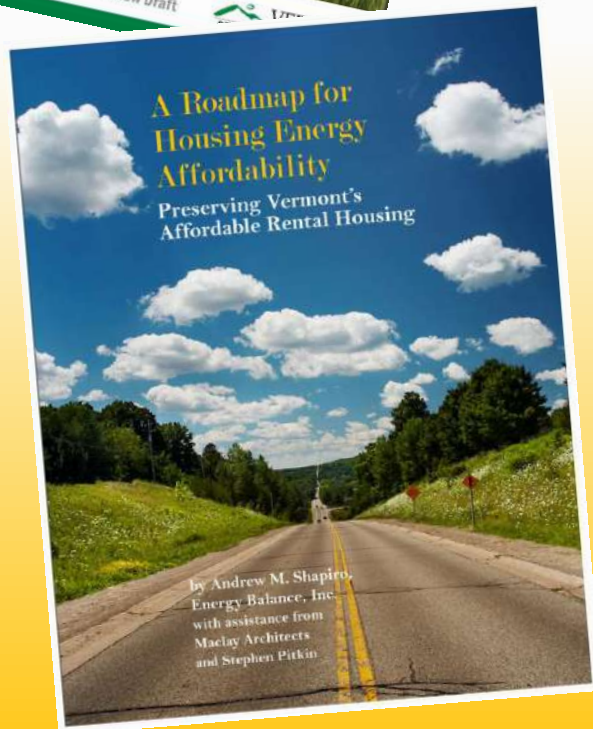
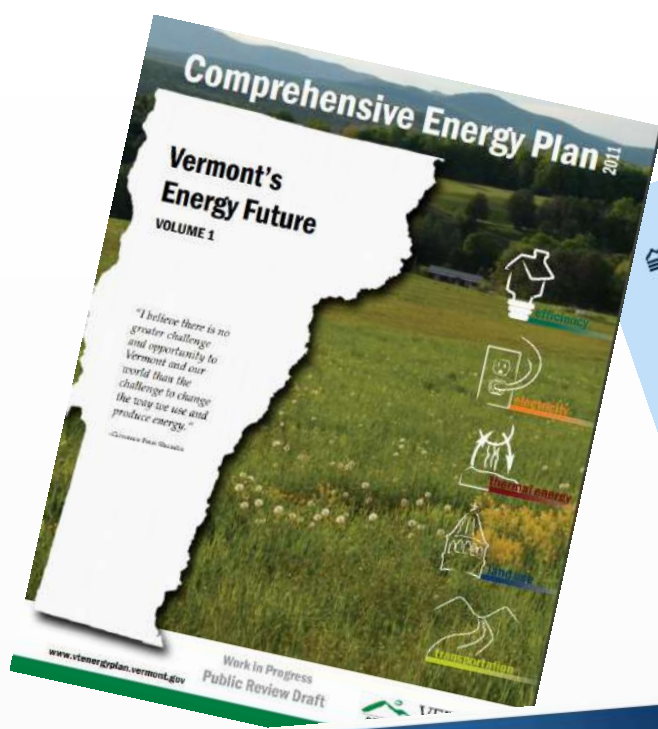
Richard Faesy, Energy Futures Group

Chuck Reiss, BPPA

Li Ling Young, VEIC



Vermont Greenhouse Gas Emissions Inventory June 2018





- Reduce total energy consumption per capita by 15% by 2025, and by more than one third by 2050.
- Meet 25% of the remaining energy need from renewable sources by 2025, 40% by 2035, and 90% by 2050.

Efficiency Vermont's Home Performance Program

- 10,398 Homes 2005-2019
- 13.5 MMBtu average savings per home
- 2,601,028 MMBtu total reduction over 13 years

- 900 homes/year current pace



Efficiency Vermont's Home Performance Program

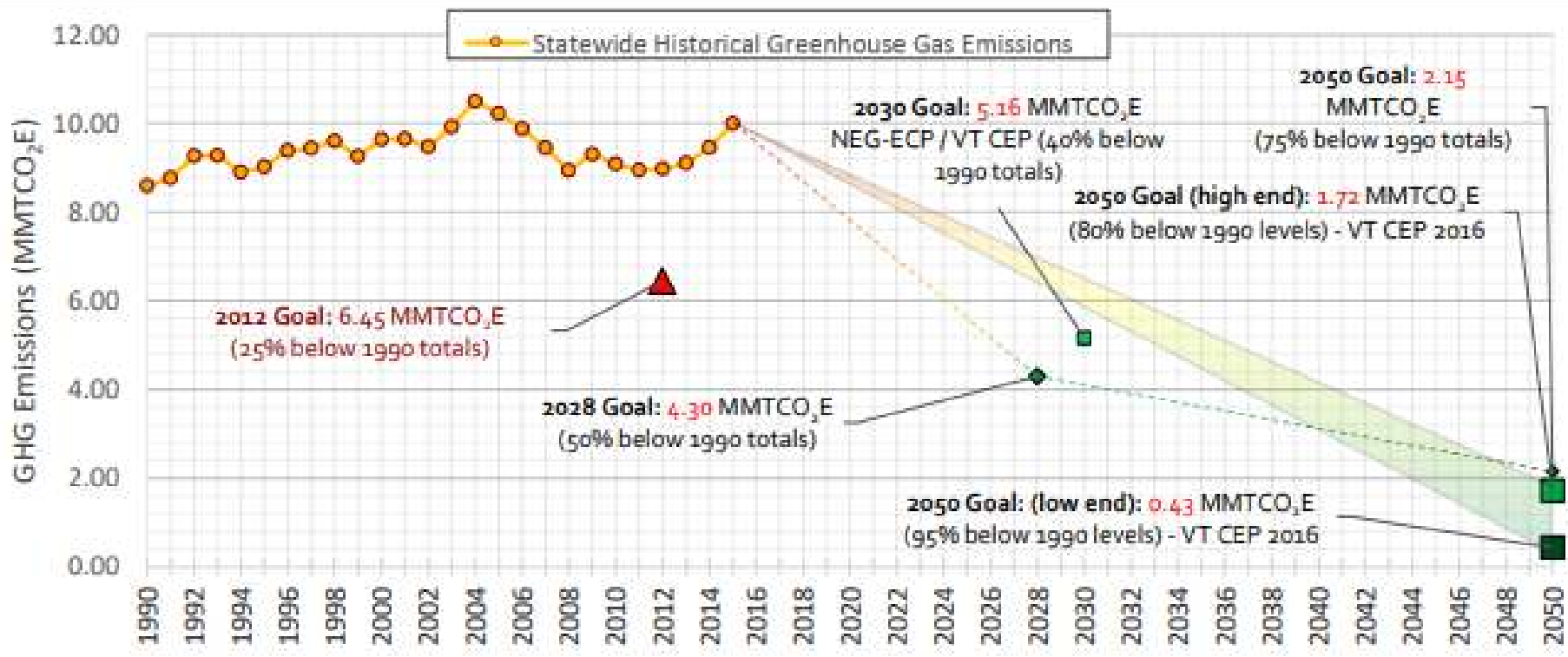
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Vermont's Housing Stock

- 240,000 homes +/-
- 65 MMBtu average household energy consumption
- 8,000 homes comprehensively improved each year to meet goal
- 35% reduction required each home





Vermont Greenhouse Gas Emissions Inventory June 2018

ZERO ENERGY NOW

90

by

50



Provides...

1. A Turn-Key Comprehensive Approach
2. Affordability for the Building Owner
3. >2000 Good-Paying Vermont Jobs
4. A Road Map to 2050
5. A Program That Links The Existing Market To Our 2050 Goals

The Genesis of Zero Energy Now

- Building Performance Professionals Association of Vermont (BPPA-VT)
- Contractors, Builders, Energy Consultants, Weatherization companies, Plumbing and Heating Contractors, Eff Vt
- Retreat in 2015
- “The whole is greater than the sum of the parts”
- Pilot in 2016 with the help of GMP CEED funding

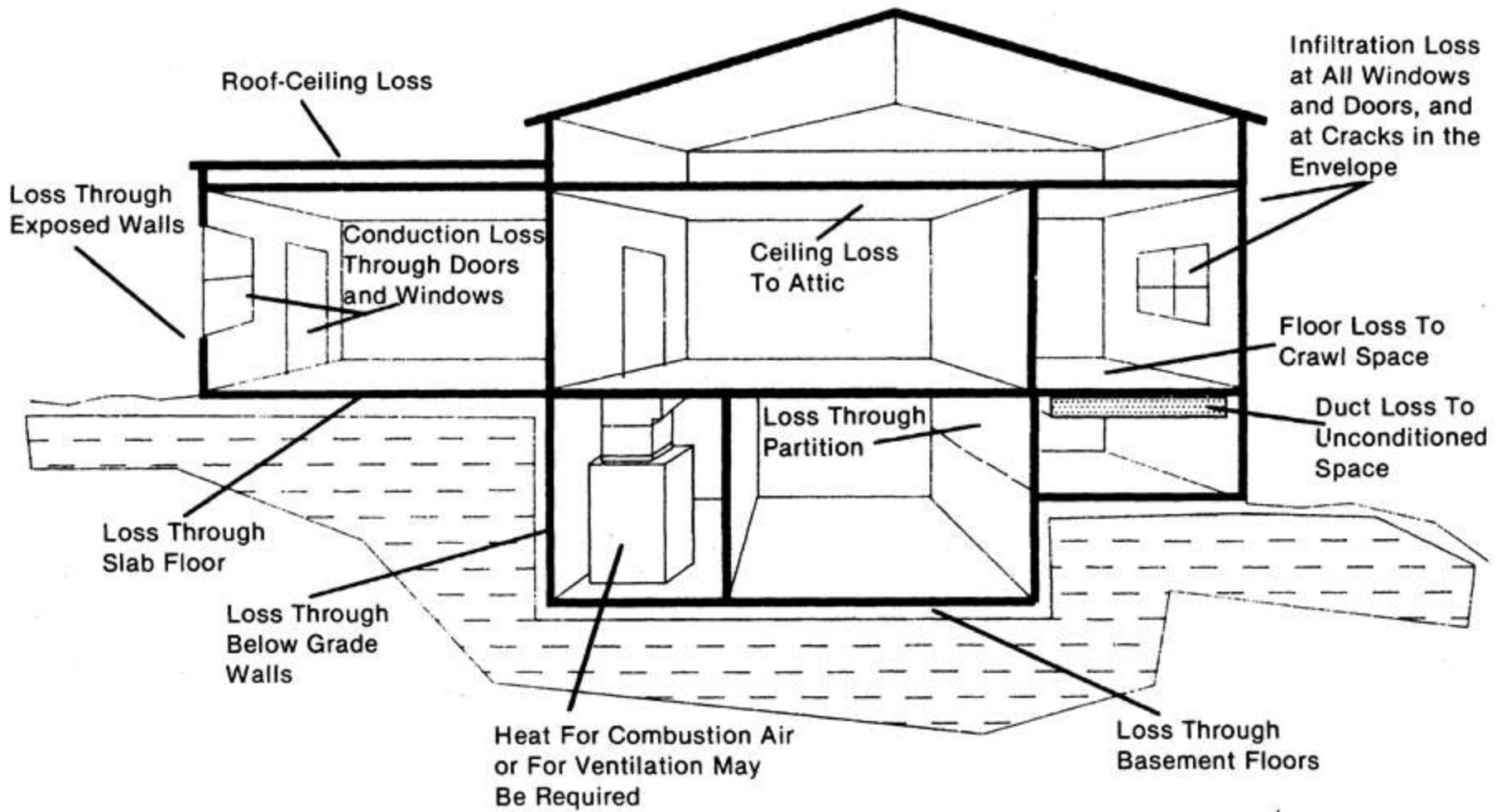
Typical Components of Zero Energy Now Building

- Analysis/ Evaluation/ Modeling
- Weatherize: air seal, insulate
- Add electric / wood heat and hot water
- Renewable energy (solar pv, biomass)
- Battery storage
- Train homeowner



Evaluate- Know Thy House







Spot 15.3 °C

FLIR



17



13

Thompson Heat Take Off		Btu Load / hr					3/28/2019
Silver Street							
Hinesburg, Vt							
Design Temp -10 degrees F							
Indoor temp 68 degrees F							
	Ft2	R-Value	U-factor	Ft2 x U	Delta T	Btu/ hr	
Walls 1st floor	968.75	19	0.05	48.4	78	3778.1	
Windows 1st floor	208.25	3	0.33	68.7	78	5360.4	
Doors 1st floor	98	3	0.33	32.3	78	2522.5	
Band joists	150	19	0.05	7.5	78	585.0	
Floor 1st fl over basement	780	5	0.2	156.0	18	2808.0	
Floor on slab	322	5	0.2	64.4	23	1481.2	
					Sub total btu/hr	16,535.2	
	Sum 1st floor + .35 of btu/hr air exchange					22,250.2	
Walls 2nd floor	717.5	19	0.05	35.9	78	2798.3	
Windows 2nd floor	175	3	0.33	57.8	78	4504.5	
Ceiling 2nd floor	1102	62	0.02	22.0	78	1719.1	
					Sub total btu/hr	9,021.9	
	Sum 2nd floor +.32 of btu/hr air exchange					14,246.9	
Walls Rm over garage	322.5	19	0.05	16.1	78	1257.8	
Windows Rm over garage	37.5	3	0.33	12.4	78	965.3	
Floor Rm over garage	460	58	0.02	9.2	78	717.6	
Ceiling slant Rm over garage	280	40	0.03	8.4	78	655.2	
Ceiling flat RM over garage	240	62	0.02	4.8	78	374.4	
					Sub total btu/hr	3,970.2	
	Sum Rm over garage + .12 air exchange					5,929.2	
					Total btu/hr	29,527.3	
Total Volume (V)	27,047			Blower Door	2650 cfm50		
Air exchange	ACH N=	0.43					
Btu/ hr air exchanged	(Vol x ACH N) x HC Air x Delta T						
	(27047 x .43) x .018 x 78					16,328.8	
Total Btu/hr at -10 F including Rm over garage + air exchange						45,856.1	
Heat pump out put 1st floor (Btu/hr at -10 degrees C)	12+15 = 27 kbtu/hr x .80					21,600	
Heat pump out put 2nd floor (Btu/hr at -10 degrees C)	15 kbtu/hr x .80					12,000	
Heat pump out put Rm over garage (Btu/hr at -10 degrees C)	9 kbtu/hr x .80					7,200	

Projected BTU/hr load

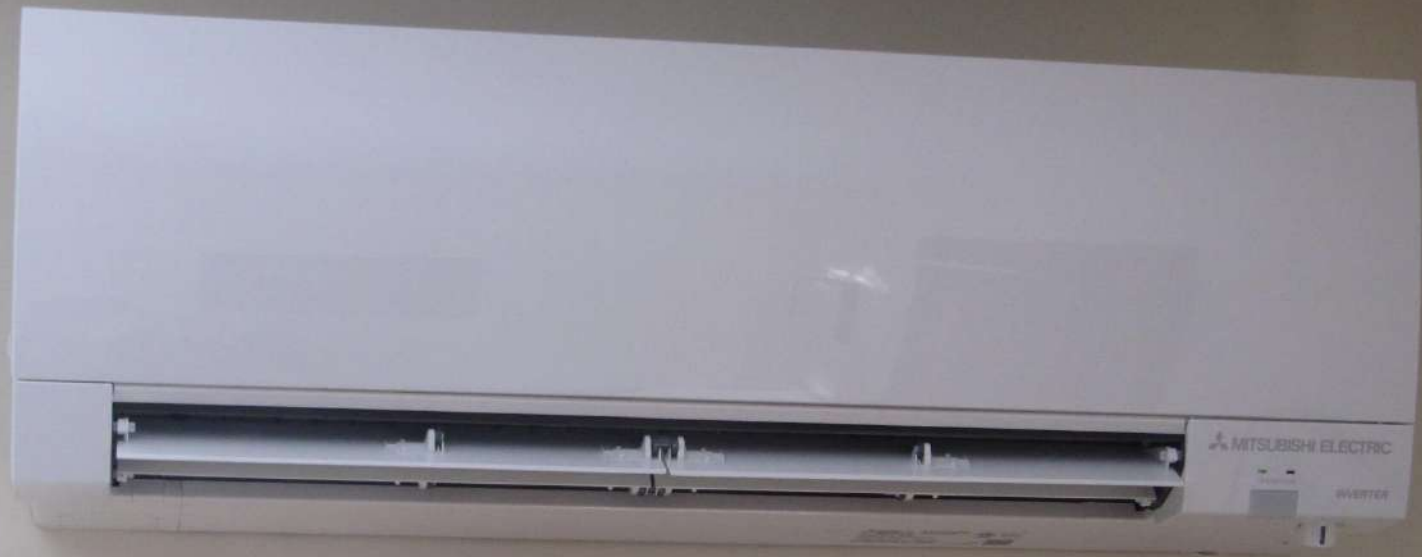
• 1 st Floor	16,535
• 2 nd Floor	9,021
• Room over garage	5,929
• Air exchange	<u>16,328</u>
	47,813







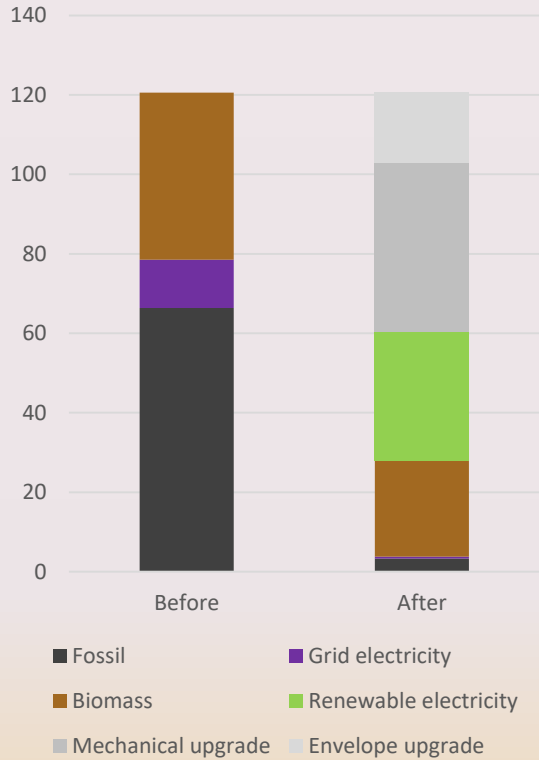




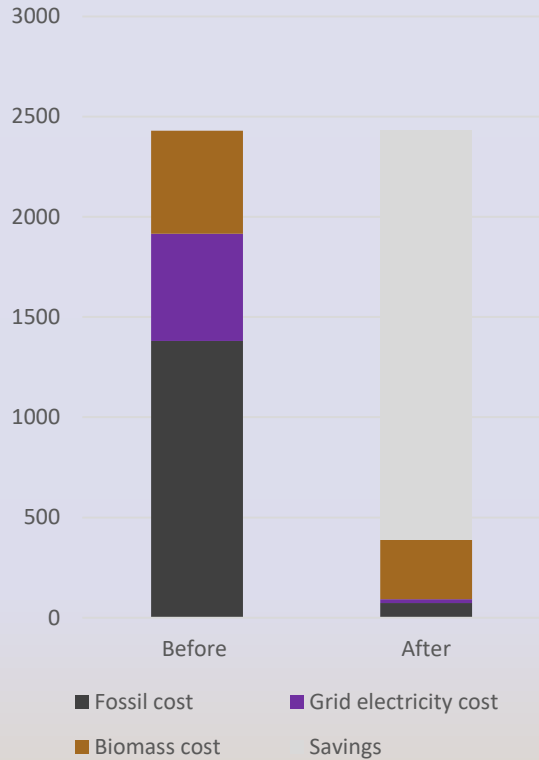




Energy Savings, MMBtu



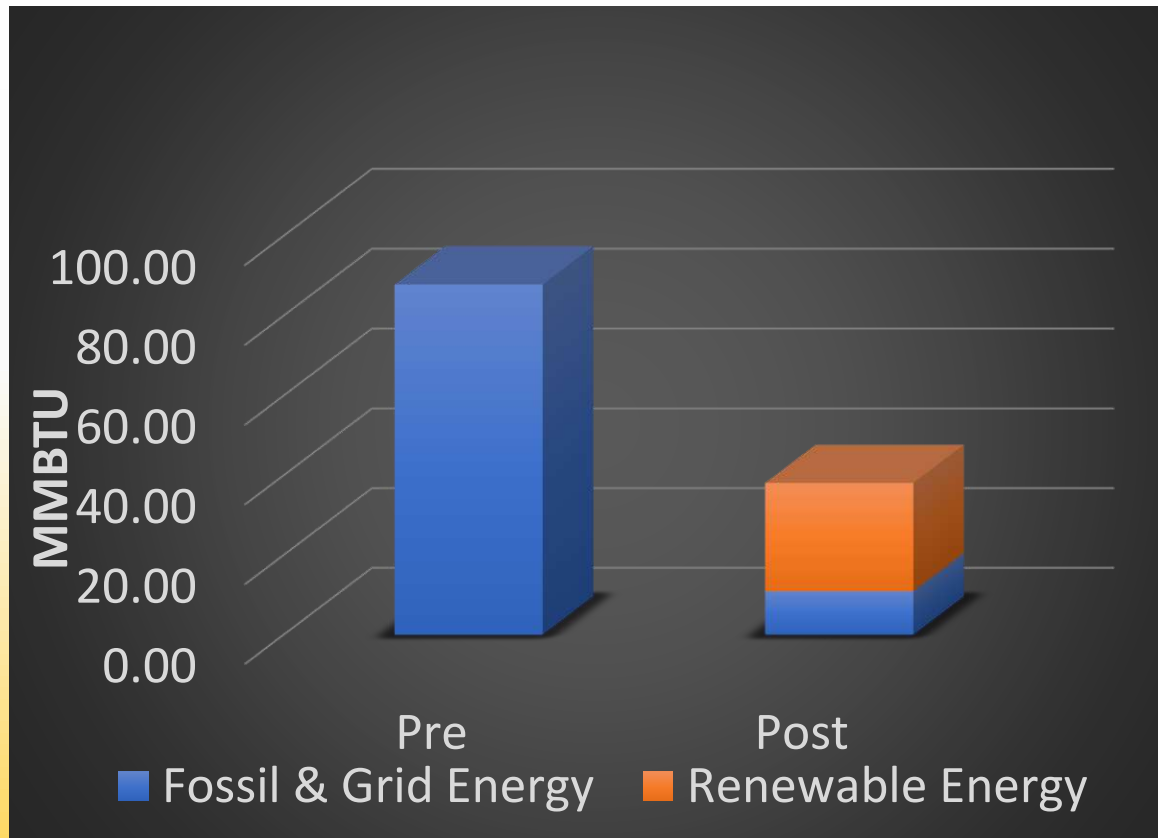
Annual Cost



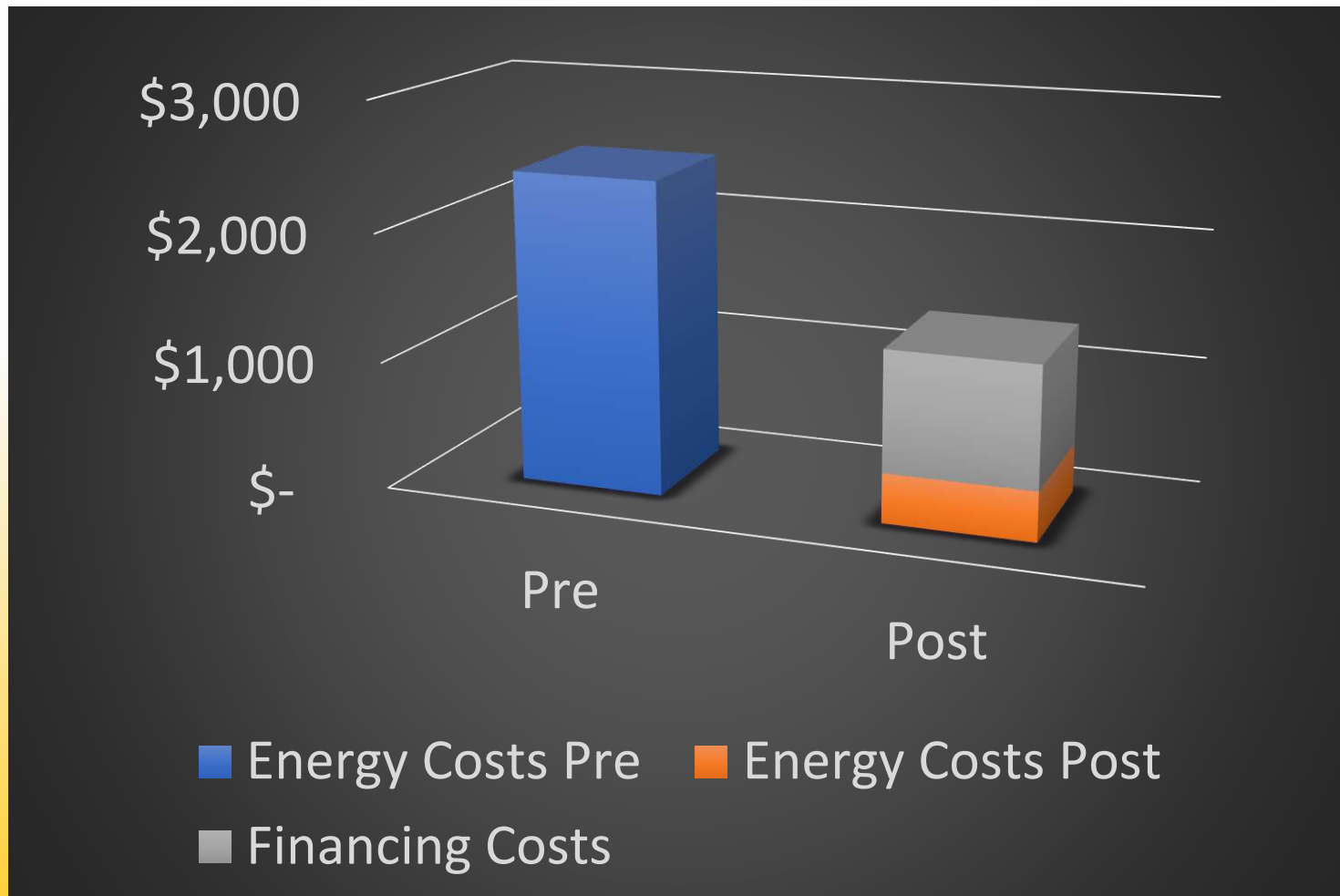
Cash Flow



Turn-Key Comprehensive Approach



Affordability



Zero Energy Now Program Key Elements



- Building energy modeling
- Custom recommendations
 - Weatherization
 - Heat pumps & wood heating
 - Heat pump water heater
 - Solar PV
 - (Battery storage, demand management controls, EVs, charging stations...)
- Savings Guarantee
- Financing
- ZEN Contractors for turn-key design & delivery
 - Subcontractors
 - Program rebates
 - Customer communication & coordination
 - Reporting
- Program implementation
 - Partnerships
 - Marketing
 - Coordination
 - Management
 - Reporting



ZEN Pilot 2016-17

- 35 homes
- 24 evaluated
- Post-improvement
 - Fuel use
 - Electricity use
 - Customer satisfaction

Each year...

- Not burned
 - 8,820 gallons fuel oil
 - 3,103 gallons propane
 - 21 cords wood
- Generated
 - 201,468 kWh electricity
- Saved
 - \$44,670 in energy costs
 - 114 metric tons CO₂

Averages...

- Energy saved
 - ✓ 39%
 - Renewable energy
 - ✓ 56%
 - Annual energy cost savings
 - ✓ \$1861

Home type: Ranch, 1336 sq ft
Net Project Cost: \$43,209



- Building efficiency improvements
- Mini-split heat pumps
- Heat pump water heater
- 8 kW solar array

	Pre-Project	Post-Project
Fossil & Grid MMBtu	77.57	3.94
Annual Energy Costs	\$1,926	\$194
Monthly out-of-pocket	\$160	\$307

“It started with a broken garage door opener...”



Home type: Colonial, 1832 sq ft
Net Project Cost: \$23,924



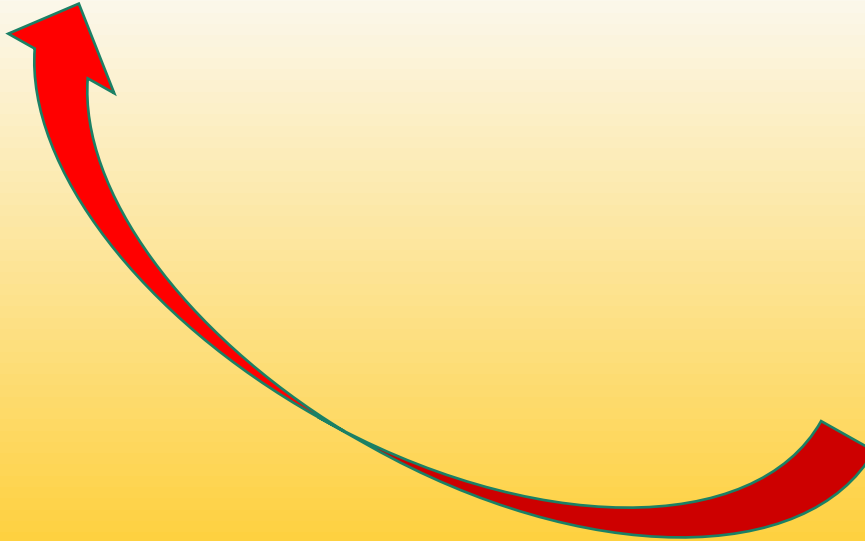
- Building efficiency improvements
- Wood heat
- Mini-split heat pumps
- Heat pump water heater
- 6.4 kW solar array

	Pre-Project	Post-Project
Fossil & Grid MMBtu	78.57	10.96
Annual Energy Costs	\$4,538	\$653
Monthly out-of-pocket	\$378	\$233





MBTUs			Energy Costs & Savings - 12 Yr Avg			Project Costs & Financeability - 12 Year Average					Original EUSAVE & C	
Pctge Renewable Total	Fossil & Grid BTUs / Sq Ft Post	Total BTUs / Sq Ft Post	Annual Costs Prior	Annual Costs Post	Annual Savings	Project Cost	Incentives & Solar Rebate	Net OP/mo 20 yr @ 5 1/4%	Return on Investment	Return on 20 yr OP Investment	F&G Prior	Projected F&G Post
52.22%	9,180.73	20,630.96	\$3,505.72	\$1,802.37	48.59%	\$53,995.00	\$13,898.50	\$128.24	4.25%	5.53%	119.11	9.30
93.94%	900.00	13,973.68	\$3,029.69	\$128.70	95.75%	\$169,334.00	\$21,734.00	\$752.85	1.97%	1.61%	134.90	0.00
94.35%	2,467.25	53,673.58	\$2,718.03	\$993.38	63.45%	\$37,474.00	\$13,549.82	\$17.49	7.21%	41.09%	46.26	11.17
90.04%	2,949.10	24,378.74	\$1,926.28	\$194.46	89.90%	\$56,612.00	\$13,402.65	\$146.85	4.01%	4.91%	38.25	1.50
32.52%	25,764.26	37,353.61	\$2,484.43	\$1,215.05	51.09%	\$33,075.00	\$7,332.02	\$67.69	4.93%	7.81%	85.48	45.20
58.05%	21,495.96	47,066.49	\$6,587.84	\$1,627.62	75.29%	\$127,046.00	\$26,171.06	\$266.00	4.92%	7.77%	187.23	-3.18
											98.58	2.76
57.04%	7,434.52	17,082.88	\$1,697.50	\$908.37	46.49%	\$99,386.00	\$12,548.38	\$519.39	0.91%	0.63%	65.10	0.00
53.66%	15,095.49	35,203.99	\$2,110.27	\$1,254.88	40.53%	\$32,389.00	\$6,507.20	\$103.12	3.30%	3.46%	61.14	13.84
33.03%	25,622.60	36,295.67	\$5,418.93	\$3,220.49	40.57%	\$88,712.00	\$17,476.48	\$296.81	3.09%	3.09%	55.59	-5.42
											127.80	0.00
											28.68	-9.74
32.38%	31,890.00	45,732.50	\$4,963.77	\$2,571.29	48.20%	\$51,934.00	\$12,762.56	\$64.58	6.11%	15.44%	198.07	86.03
											214.11	4.07
											125.89	34.67
											191.98	71.96
72.33%	10,223.88	38,248.46	\$2,723.73	\$1,320.32	51.53%	\$30,011.00	\$9,245.30	\$22.98	6.76%	25.45%	63.18	8.26
64.41%	22,481.99	65,435.49	\$3,196.26	\$1,247.33	60.98%	\$32,142.76	\$9,233.67	-\$8.04	8.51%	n/a	86.43	17.66
											83.87	26.20
56.46%	7,901.02	18,033.58	\$3,115.03	\$789.50	74.66%	\$46,700.00	\$13,020.59	\$33.15	6.90%	29.23%	72.24	11.24
Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average	Average
57.78%	17,867.39	38,677.94	\$3,160.75	\$1,299.52	59.59%	\$54,565.46	\$13,021.67	\$124.59	5.58%	10.03%	104.82	19.82
			\$75,857.91	\$31,188.41		\$1,309,571.10	\$312,520.08				93.09	17.44



Bottom line ...

64%

reduction in fossil and grid energy

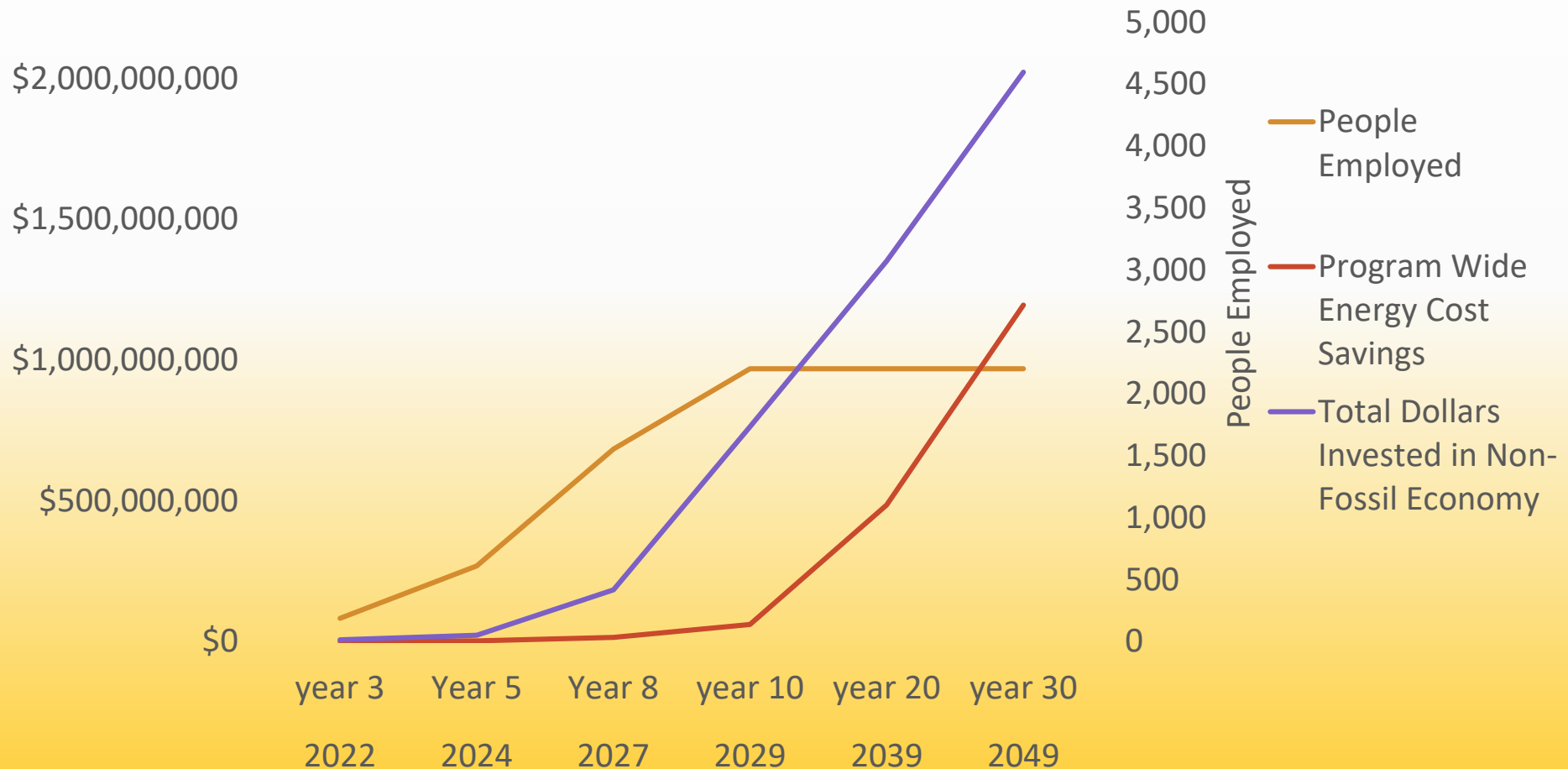
Pilot Findings

1. 90% of interviewed homeowners are very happy with the project.
2. Rooftop solar is the most common renewable energy, but a sizeable portion participate in a net meter group, either as donor or recipient.
3. Energy savings through building improvements are costly, but reliable
4. Heating
 - a. Mostly mini-split heat pumps
 - b. Some supplement with wood, others with fossil fuel
 - c. One ground-source heat pump
5. Integrated design improves satisfaction and performance
6. Most common “next steps”: batteries, electric vehicle



Proposed Statewide Program

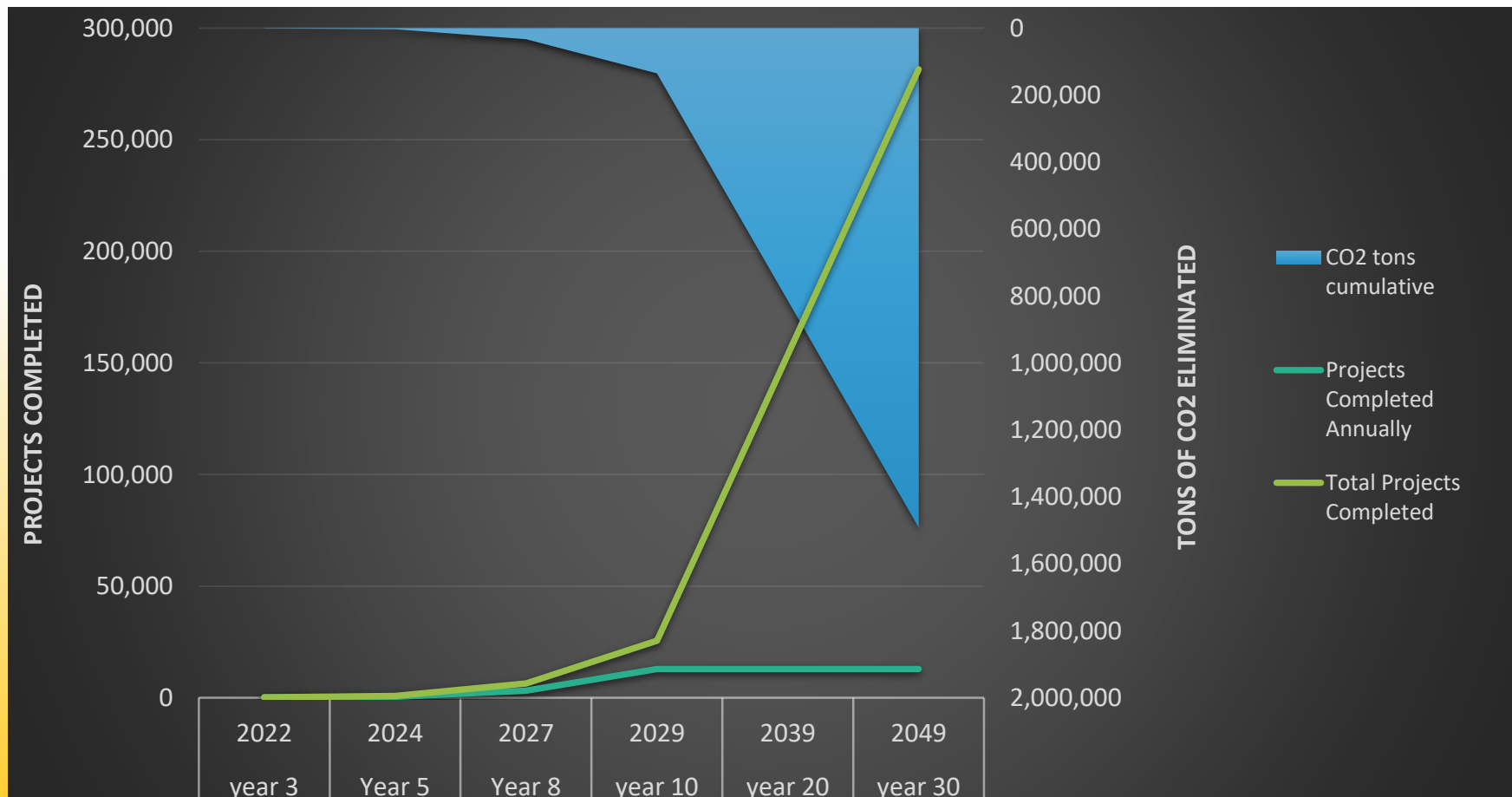
Meeting 2050 Goals Will Create >2000 New Jobs



Our Road Map to 2050



How to get 280,000 buildings to 90% renewable in 30 years, plus grow the Vermont economy.



Budget for 5 Years

	Year 1	Year 2	Year 3	Year 4	Year 5	Total
	2020	2021	2022	2023	2024	2020-2024
Target Number of Projects	10	20	75	150	300	555
Total w/ incentives	\$ 334,000	\$ 424,000	\$ 704,001	\$ 1,099,002	\$ 1,859,003	\$ 4,420,006
Total w/o incentives	\$ 284,000	\$ 324,000	\$ 329,001	\$ 349,002	\$ 359,003	\$ 1,645,006
Program Cost per project	\$ 23,400	\$ 21,200	\$ 9,387	\$ 7,327	\$ 6,197	\$ 7,964
Savings	\$ 20,000	\$ 60,000	\$ 210,000	\$ 510,000	\$ 1,110,000	\$ 1,910,000

Where are we now?

- Spreading the word
- Partner solicitations
 - Utilities
 - Green Mountain Power
 - Burlington Electric Department
 - Washington Electric Cooperative
 - Efficiency Vermont
 - Budget and staff commitment
 - Energy Action Network
 - Northeast Energy Efficiency Partnerships (NEEP)
 - Vermont then other states

Where are we now? (con't)

- Funding
 - U.S. DOE
 - (Vermont Low Income Trust for Electricity (VLITE))
 - High Meadows Fund
 - Efficiency Vermont
 - \$25,000
 - Energy Foundation
 - \$100,000

What's Next?

- Partners
- Funding
 - Program development
 - Incentives
 - Savings Guarantee
 - Implementation
- PUC regulations that recognize GHG savings and cover thermal (Act 62)
- Stable program goals and budgets
- Climate leadership

How Can You Help?

- Encourage your utility to partner
- Mention Zero Energy Now to your legislators
- Include ZEN in your town energy plans
- Advocate and protect regulations
 - Net metering
 - Smart grid
 - Solar tax credit
 - Building energy standards
 - Carbon emission pricing
- Hold leaders accountable for progress
 - All targets at least as aggressive as VCEP
- Invite us to your town energy committee
- Tell your neighbors and contractor about ZEN

A PROGRAM OF

Building Performance Professionals Association

Presenters:

Chuck Reiss

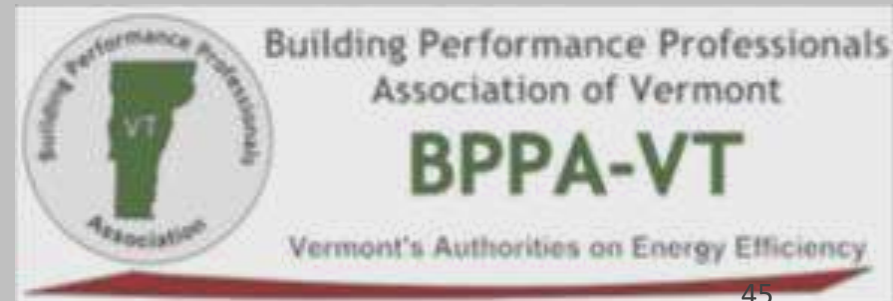
Reiss Building and Renovation

Richard Faesy

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Li Ling Young

Efficiency Vermont





EMAIL

General Information: Info@BPPA-VT.org

Jonathan Dancing: JDancing@BPPA-VT.org

MAILING ADDRESS

BPPA-VT

PO Box 8125

Brattleboro, VT 05304

PHONE

802-552-4677