Net Zero and Multifamily Housing: Is It an Attainable Goal?

HOUSINGVERMONT
Building possibilities.

CUDDLY PUPPIES AND KITTIES

AND A MELLOW COUGAR IN A ROOM

A SYMBOL FOR NET ZERO?

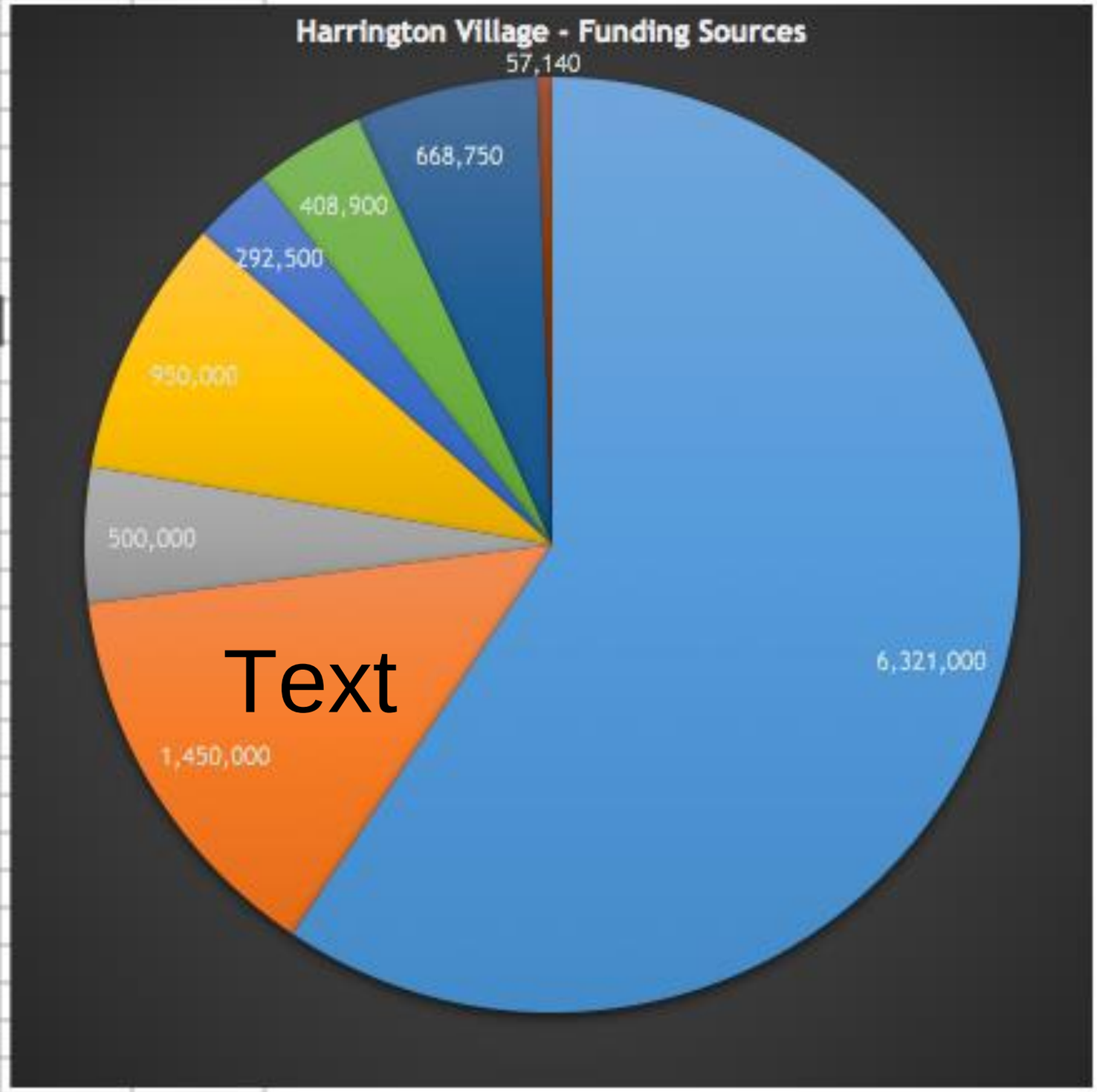
TAKING ENERGY CODE ++ TO NET ZERO

AFFORDABLE RENTAL HOUSING

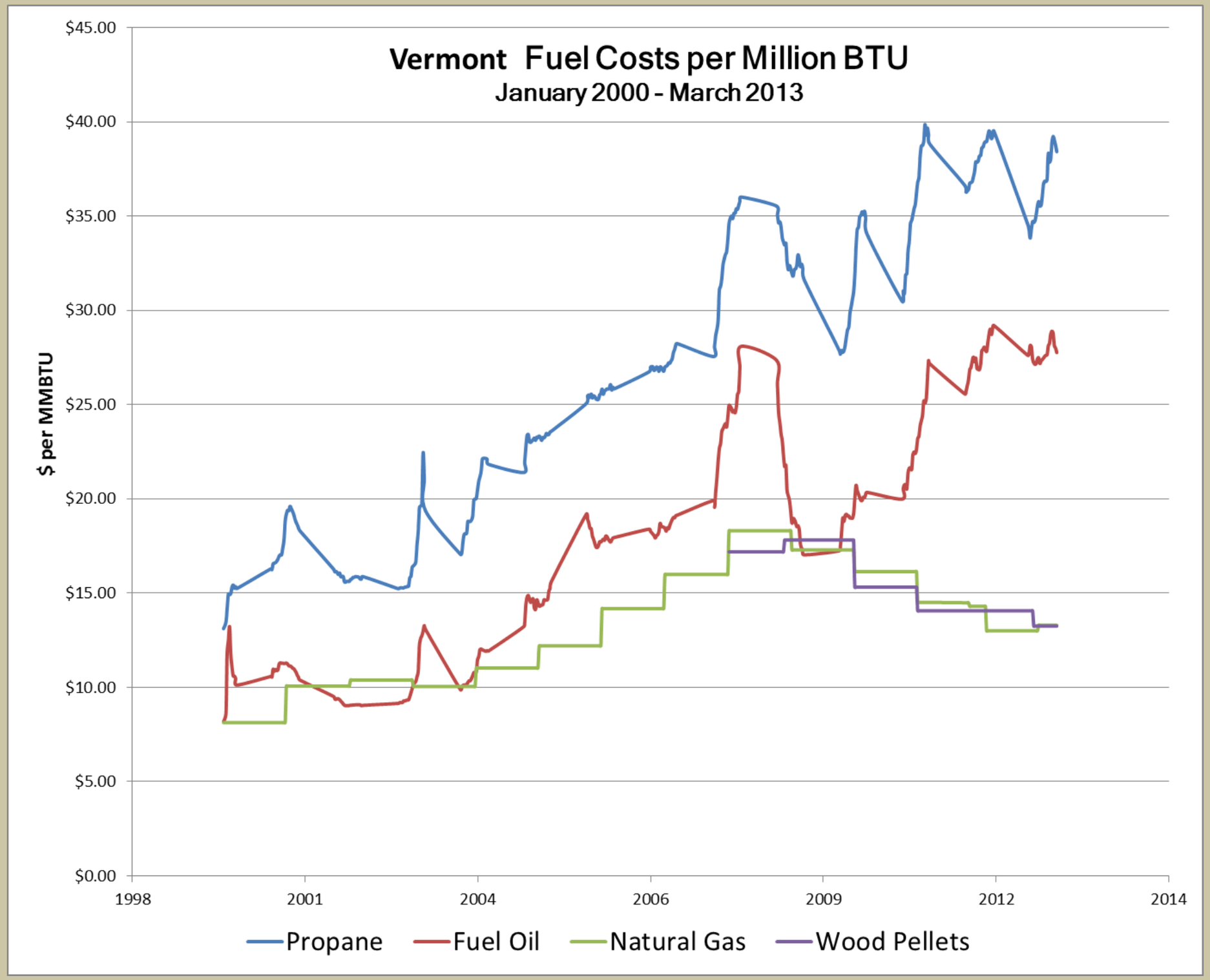
How the Non-Profit World Works


SPEED
LIMIT
10
Juneberry Ln

Equity - LIHTC	6,321,000	59%
Bank debt	1,450,000	14%
VHCB- G. F. Loan	500,000	5%
HOME	950,000	9%
Neighborworks	292,500	3%
State Tax credits	408,900	4%
VCDP	668,750	6%
REEP & VT Gas	57,140	1%
TOTAL SOURCES	10,717,845	100%
Tax Credit 1BR rent	$765	
Operating expenses	$565	$200
Debt service	$217	
Cash flow	($17)	
Market Rate 1BR rent	$950	
Operating expenses	$565	$385
Debt service	$217	
Cash flow	$168	
Tax Credit 2BR rent	$800	
Operating expenses	$585	$215
Debt service	$217	
Cash flow	($2)	
Market Rate 2BR rent	$1,200	
Operating expenses	$585	
Debt service	$217	
Cash flow	$398	



FUNDING SOURCES FOR A TYPICAL PROJECT



“In order to deliver on our core mission, we have to be great at energy efficiency.”

Overarching Policy Question

Invest in new construction “net zero” multi-family units

vs.

The need to create more affordable housing units

1/3 of our housing stock was built prior to 1950

13,000 renters currently pay more than 50% of their income towards rent

Total Energy Considerations

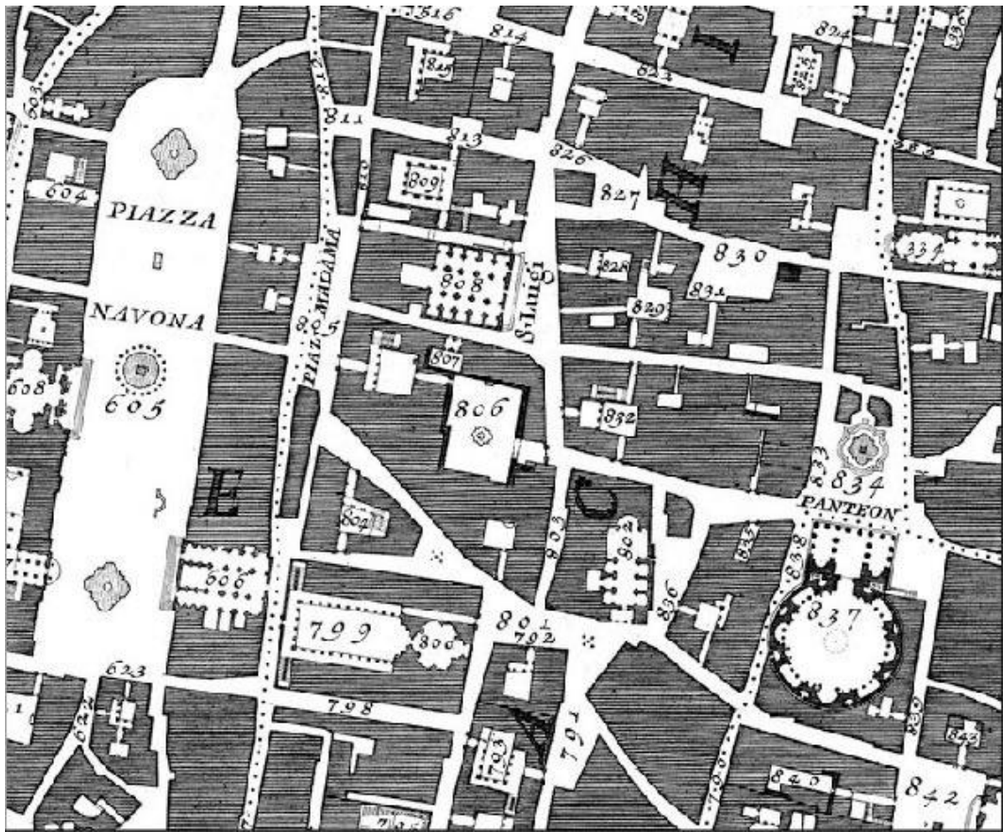
- **Transportation**
  - **Proximity of housing to jobs**

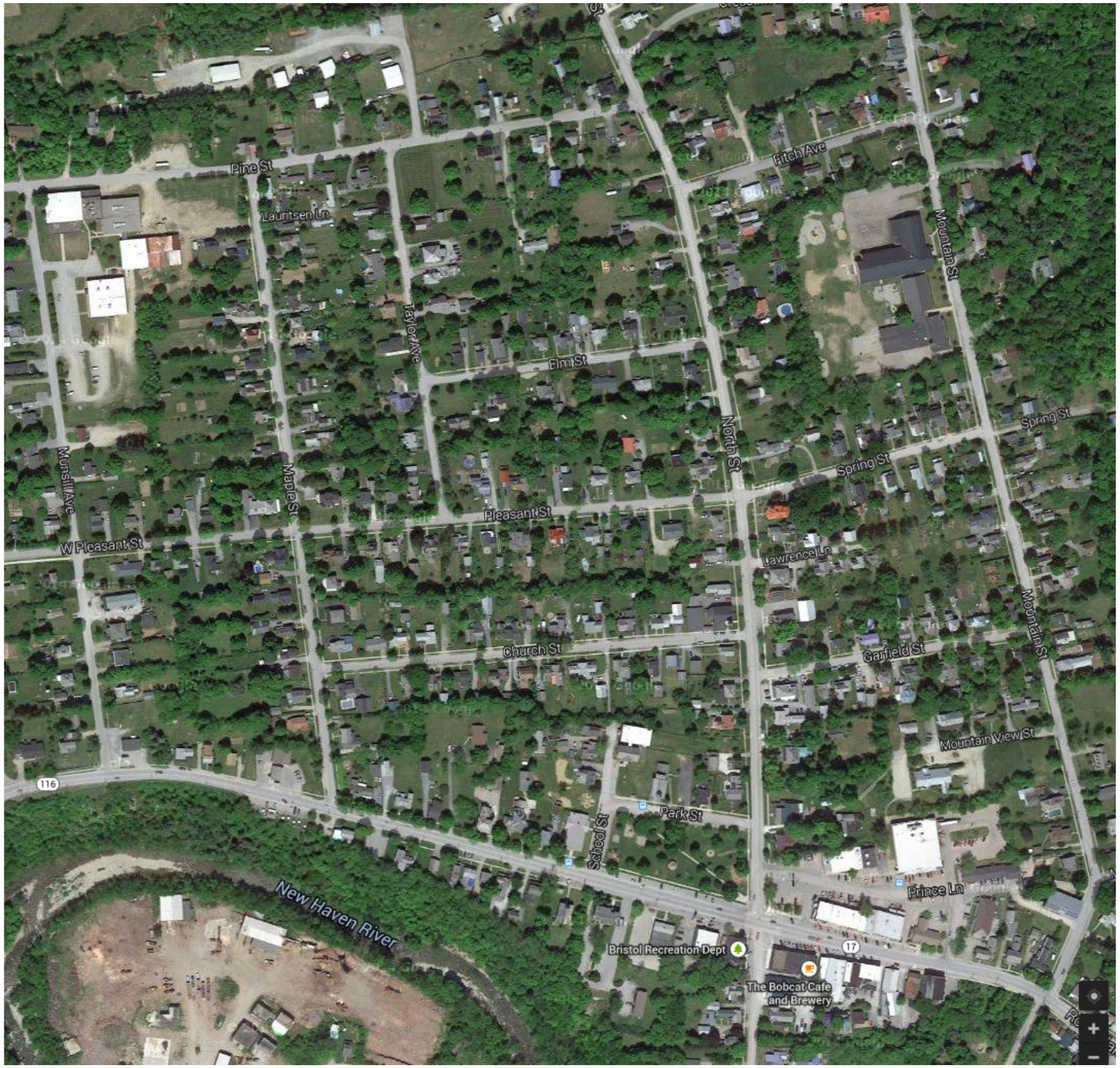
- **Building Materials:**
  - **Carpet vs. vinyl flooring**
  - **Vinyl siding vs. fiber cement**

State Comprehensive Energy Plan

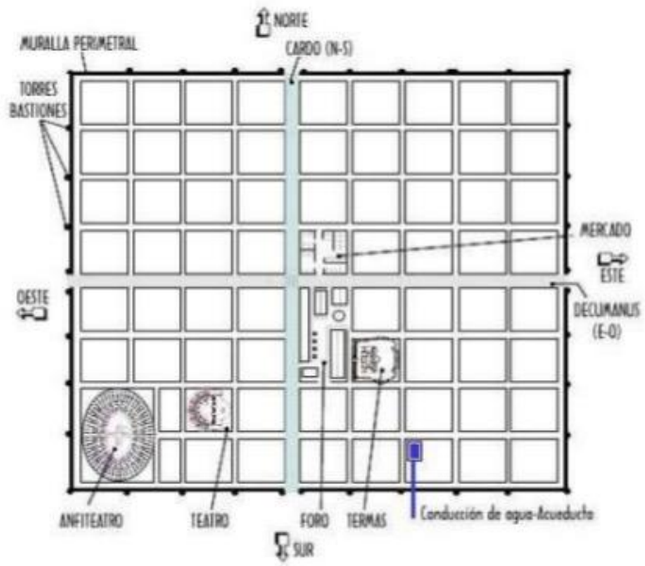
- Goal of 30% new construction units meeting net zero by 2020
- Should this goal be modified for affordable multifamily housing?

NEIGHBORHOOD DESIGN





Basic Plan of a Roman City



- Roman civil engineers used a plan like this
- Two main streets at right
- Intersection right in the middle of the town.
- Both streets extend outside the town through four fortified gates.
- Aqueducts provided water to fill the city's cisterns

ROME, ITALY & BRISTOL, VT

NEIGHBORHOOD DESIGN - SHELBURNE

FOREST PARK

RUTLAND . VERMONT

EXISTING SITE PLAN

HICKORY STREET - Phase III

RUTLAND, VERMONT

SCHEMATIC DESIGN

Duncan Wisniewski ARCHITECTURE
255 SOUTH CHAMPLAIN STREET
BURLINGTON, VERMONT 05401
T: 802.864.6693

DATE: 1.21.2015

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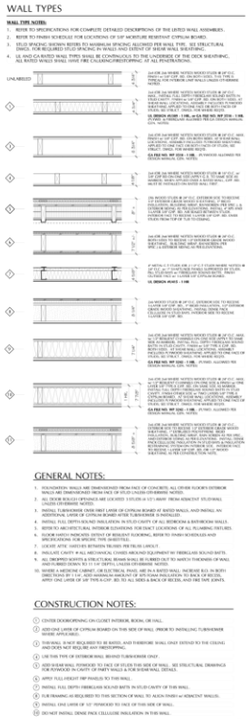
NEIGHBORHOOD DESIGN - RUTLAND

AS-BUILT & NET ZERO

THIRD FLOOR PLAN
Scale: 1/4" = 1'-0"



WALL TYPES

GENERAL NOTES:

CONSTRUCTION NOTES:

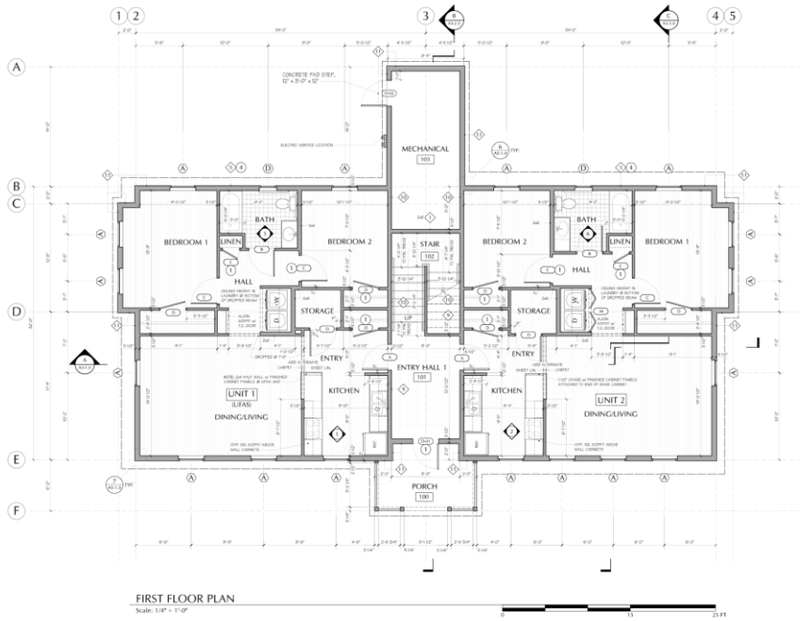
D

HARRINGTON VILLAGE - 6plex D
SHELBURNE, VERMONT

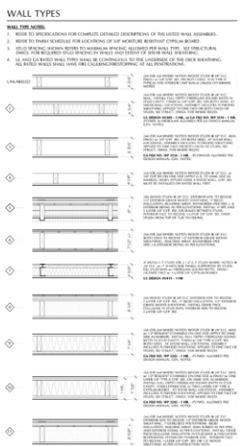
CONSTRUCTION SET

Duncan Wisniewski ARCHITECTURE
255 SOUTH CHAMPLAIN STREET
BURLINGTON, VERMONT 05401
T: 802.864.6993 F: 802.864.6932

DATE: 04.09.2013
A1-3.0



FIRST FLOOR PLAN
Scale: 1/4" = 1'-0"



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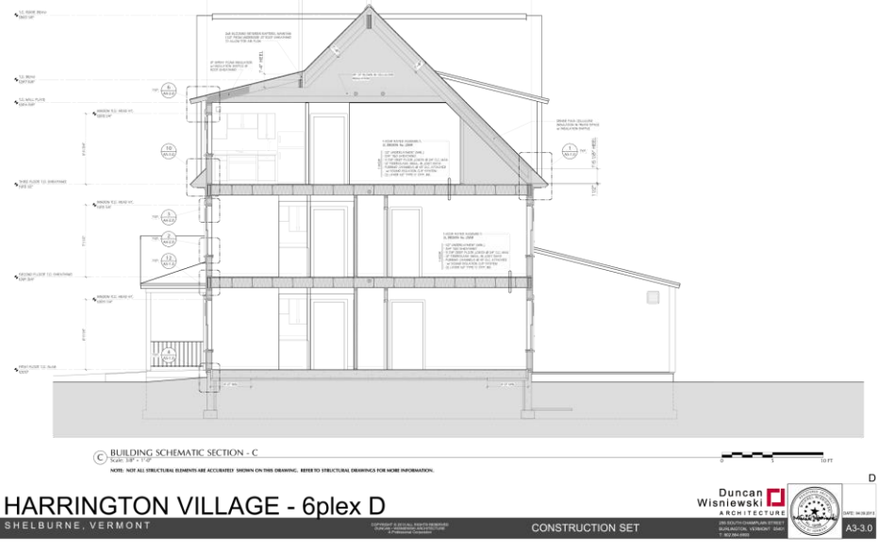

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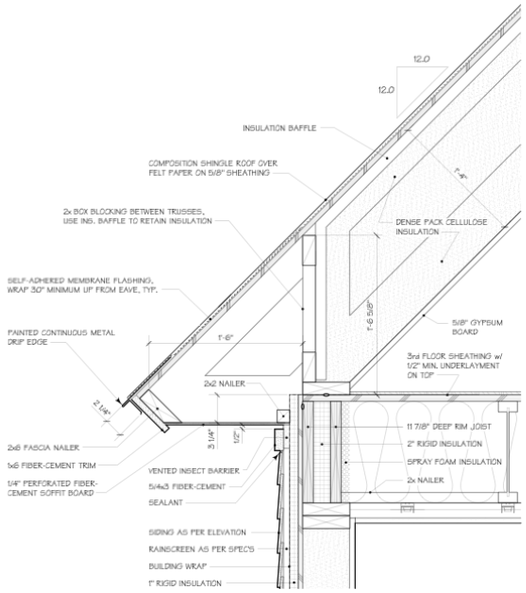
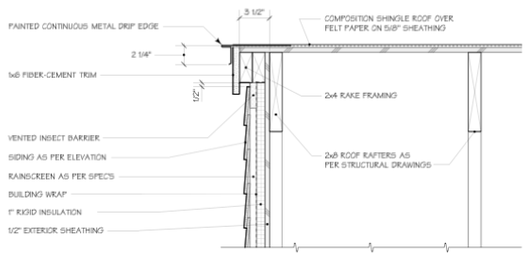
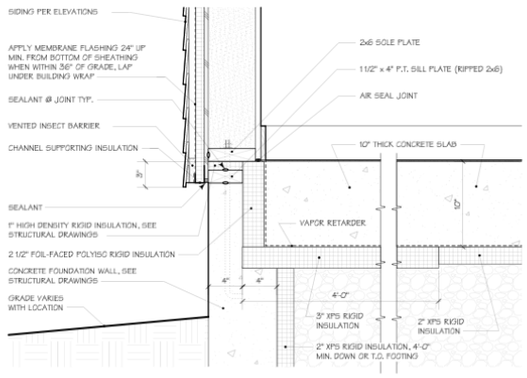
6PLEX AS BUILT
Energy Code ++



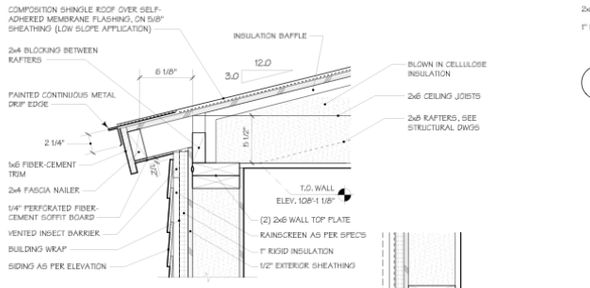
1 MAIN ROOF EAVE DETAIL
1 1/2"=1'-0" D



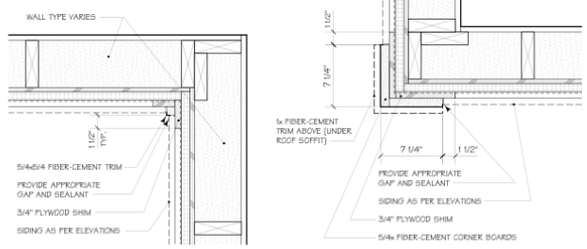
3 SECONDARY ROOF RAKE DETAIL
1 1/2"=1'-0" D



4 SLAB @ FOUNDATION WALL
1 1/2"=1'-0" D

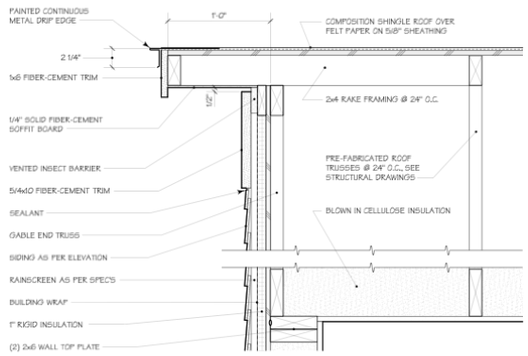


5 ROOF EAVE DETAIL @ MECH. ROOM
1 1/2"=1'-0" D

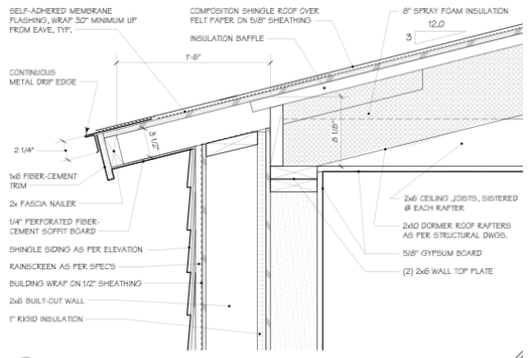


6 INSIDE CORNER TRIM DETAIL
1 1/2"=1'-0" D

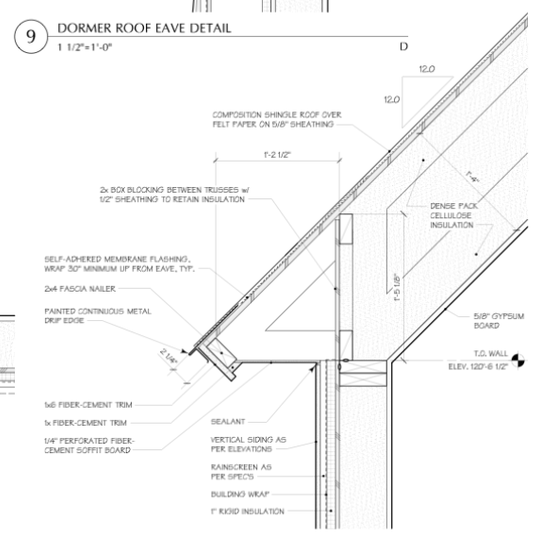
7 CORNER TRIM
1 1/2"=1'-0" D



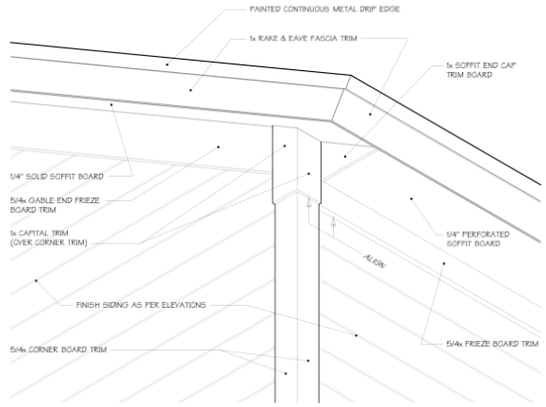
8 MAIN ROOF RAKE DETAIL
1 1/2"=1'-0" D



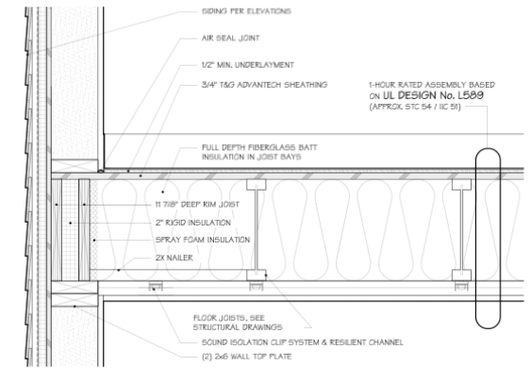
9 DORMER ROOF EAVE DETAIL
1 1/2"=1'-0" D



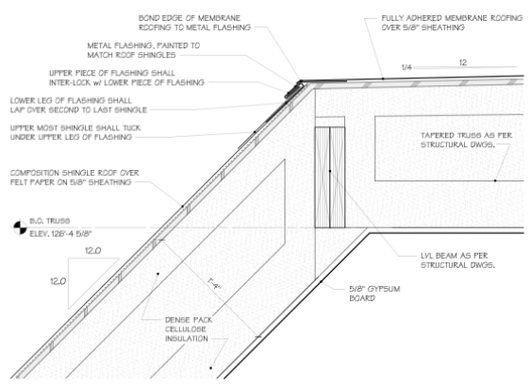
10 ROOF EAVE DETAIL
1 1/2"=1'-0" D



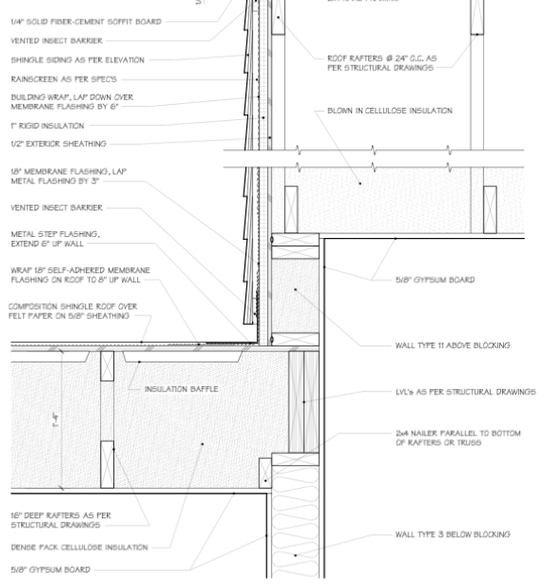
11 ROOF EAVE & RAKE DETAIL @ CORNER
NOT TO SCALE D



12 FLOOR @ EXTERIOR WALL PARALLEL TO JOISTS DETAIL
1 1/2"=1'-0" **NOTE:** EXTERIOR WALL PERPENDICULAR TO JOISTS IS SIMILAR. D



13 ROOF EAVE DETAIL
1 1/2"=1'-0" D



5 DORMER ROOF RAKE AND ROOF TO WALL DETAIL
1 1/2"=1'-0" D

NOTE: SEE PLANS FOR ACCURATE WALL TYPES & STRUCTURAL DRAWINGS FOR LOCATIONS w/ ADDED SHEAR WALL PLYWOOD.

HARRINGTON VILLAGE - 6plex D

SHELBURNE, VERMONT

CONSTRUCTION SET

Duncan Wisniewski ARCHITECTURE
255 SOUTH CHAMPLAIN STREET
BURLINGTON, VERMONT 05401
T: 802.864.6693 F: 802.864.6932

REGISTERED ARCHITECT MICHAEL WISNIEWSKI No. 1203 STATE OF VERMONT

DATE: 04.09.2013

A5-1.0

AS BUILT - HERS RATING 45

- Slab/Frost Wall R10 Continuous, R15 perimeter.
- Walls R 27.5 - - R20 dense pack + R7.5 continuous, rain screen.
- Roof R 60 dense pack or foam.
- Windows R3.3 low e argon.
- Air Sealing 2.15 ACH50 1672 CFM50 (tested)
- Heating Gas (propane or natural gas) hydronic OR pellet boiler.
- DHW Storage tank off boiler.
- Ventilation Exhaust (CD) only with passive vents OR Lunos/HRV.
- Lighting Energy Star Fluorescent.
- Appliances Energy Star.

NET ZERO - HERS RATING 0

- Slab/Frost Wall R20 Continuous, R15 perimeter.
- Walls R46 Dense pack in 12" double stud wall (or corson wall)
- Roof R90 dense pack or foam.
- Windows R6.3 low e argon - Alpen Series 925 Casement.
- Air Sealing 1200 cfm/50
- Heating ASHP
- DHW 98% Efficient gas (propane or natural). Preheat from ASHP.
- Ventilation 85% Efficient HRV - Lunos or central unit.
- Lighting LED.
- Appliances ES Tier 3 refrigerator; induction range.
- Solar 30kw PV

ENERGY MODELING

REM Rate Modeling Results

2011 RBES Compliant Construction

Component Load - Heating Season		mmbtu/yr
Ceilings/Roofs	R-49 Flat, R-32 Slope cellulose	9
Rim/Band Joists	R-20 XPS	4.7
Above Grade Walls	R-21 cavity FG Batt	50.9
Doors	standard	1.5
Windows	U=0.32 SHGC 0.30	28.8
Slab Edge and Floor	R-15	11.5
Infiltration	5.0 ACH50	45.7
Mechanical Ventilation	Exhaust only, 24 hrs/day	24.4
Internal Gains		-53.8
	Total	**122.7**

Annual Consumption		mmbtu/yr
Heating	80% AFUE LP Boiler	154
Domestic Hot Water	Indirect Fired Tank	73.4
Lights/Appliances	50% CFL, Baseline Appliances	76.2
	Total	**303.6**

Annual Operating Costs		$
Heating		4200
Domestic Hot Water		2000
Lights/Appliances		3350
	Total	**$ 9,550**

Annual Operating Cost per Apartment **$ 1,590**

RBES CODE

REM Rate Modeling Results

As-Built, Code ++ 2013 Construction

Component Load - Heating Season		mmbtu/yr
Ceilings/Roofs	R-67 Flat, R-32 Slope cellulose	7.5
Rim/Band Joists	R-23 HDSF	4.4
Above Grade Walls	R-19 cellulose, R-5 exterior	32.6
Doors	standard	1.4
Windows	U=0.30 SHGC 0.32	26.6
Slab Edge and Floor	R-15	11.5
Infiltration	1631 cfm50 (2.0 ACH50)	11.2
Mechanical Ventilation	Exhaust only, 24 hrs/day	24.4
Internal Gains		-46.7
	Total	**72.9**

Annual Consumption		mmbtu/yr
Heating	94% AFUE LP Boiler	78
Domestic Hot Water	Indirect Fired Tank	64.9
Lights/Appliances	CFL, LED, Energy Star	71.7
	Total	**214.6**

Annual Operating Costs	$
Heating	2130
Domestic Hot Water	1770
Lights/Appliances	3150
Total	**$ 7,050**

Annual Operating Cost per Apartment **$ 1,180**

CODE ++

REM Rate Modeling Results

Proposed Net Zero

Component Load - Heating Season		mmbtu/yr
Ceilings/Roofs	R-90 Flat, R-67 Slope cellulose	5
Rim/Band Joists	R-36 HDSF	3.5
Above Grade Walls	R-46 Cellulose, Dbl Wall	16.7
Doors	standard	1.5
Windows	U=0.20 SHGC 0.32	16.3
Slab Edge and Floor	R-20	9.7
Infiltration	1,000 cfm50 (1.25 ACH50)	15.9
Mechanical Ventilation	Lunos ERV 85% eff	3.7
Internal Gains		-41.4
	Total	**30.9**

Annual Consumption		mmbtu/yr
Heating	ASHP 11.6 HSPF	14.8
Domestic Hot Water	ASHP (80%) LP backup (20%)	40.7
Lights/Appliances	LED, Induction Range, CEE Tier 3	68.4
	Total	**123.9**

Annual Operating Costs		$
Heating		650
Domestic Hot Water		1650
Lights/Appliances		3010
	Total	**$ 5,310**

Annual Operating Cost per Apartment **$ 890**

NET ZERO

REM Rate Modeling Results Summary

Heating Component Load	2011 RBES Compliant	mmbtu/yr	As-Built, Code ++	mmbtu/yr	Proposed Net Zero	mmbtu/yr
Ceilings/Roofs	R-49 flat, R-32 slope: cellulose	9	R-67 flat, R-32 slope: cellulose	7.5	R-90 flat, R-67 slope: cellulose	5
Rim/Band Joists	R-20 XPS	4.7	R-23 HDSF	4.4	R-36 HDSF	3.5
Above Grade Walls	R-21 cavity: fiberglass batt	50.9	R-5 XPS cont, R-19 cavity: cellulose	32.6	R-46 double wall: cellulose	16.7
Doors	standard	1.5	standard	1.4	standard	1.5
Windows	U=0.32 SHGC 0.30	28.8	U=0.30 SHGC 0.32	26.6	U=0.20 SHGC 0.32	16.3
Slab Edge and Floor	R-15	11.5	R-15	11.5	R-20	9.7
Infiltration	5.0 ACH50	45.7	1631 cfm50 (2.0 ACH50)	11.2	1,000 cfm50 (1.25 ACH50)	15.9
Mechanical Ventilation	exhaust only, 24 hrs/day	24.4	exhaust only, 24 hrs/day	24.4	Lunos ERV 85% eff	3.7
Internal Gains		-53.8		-46.7		-41.4
	Total mmbtu/yr	**122.7**	**Total mmbtu/yr**	**72.9**	**Total mmbtu/yr**	**30.9**

Annual Consumption		mmbtu/yr		mmbtu/yr		mmbtu/yr
Heating	80% AFUE LP Boiler	154	94% AFUE LP Boiler	78	ASHP 11.6 HSPF	14.8
Domestic Hot Water	Indirect Fired Tank	73.4	Indirect Fired Tank	64.9	ASHP (80%) LP backup (20%)	40.7
Lights/Appliances	50% CFL, Baseline Appliances	76.2	CFL, LED, Energy Star	71.7	LED, Induction Range, CEE Tier 3	68.4
	Total mmbtu/yr	**303.6**	**Total mmbtu/yr**	**214.6**	**Total mmbtu/yr**	**123.9**

Annual Operating Costs	Dollars	Dollars	Dollars
Heating	$ 4,200	$ 2,130	$ 650
Domestic Hot Water	$ 2,000	$ 1,770	$ 1,650
Lights/Appliances	$ 3,350	$ 3,150	$ 3,010
	Annual Operating Cost $ 9,550	**Annual Operating Cost $ 7,050**	**Annual Operating Cost $ 5,310**
	Per Apartment $ 1,590	**Per Apartment $ 1,180**	**Per Apartment $ 890**

COMPARISON

ENERGY USE

Management & Allocation

RESIDENT AIR CONDITIONING

Developer pays for exterior and common lighting as well as all heat and hot water.

Resident pays for their own electrical use including window AC.

Developer has hard data on what they pay for but little on total electrical use for residents.

With ASHP developer pays for AC; resident has no incentive not to use. Odd situation of investing more money to bring down energy use which then increases energy costs in one area.

NZ scenario covers plug loads. Does resident still pay for own electric and developer gets surplus or do residents get free electric in which case they have no incentive to conserve?

ALLOCATION OF ENERGY USE

ON SITE PV - GETTING TO NZ

GETTING TO NET ZERO - SHELBURNE

GETTING TO NET ZERO - RUTLAND

Options.

1. Larger buildings maximize thermal and economic efficiency and reduce PV.
2. Maximize roof size and orientation for PV.
3. More land/Same number of units - negative cost/neighborhood implications.
4. Provide PV off site.

NET ZERO COSTS

	Harrington Village	Actual	Inflation	Net	Incremental
	Shelburne, Vermont	SOV	Estimate	Zero	Add
	6-Plex	Spring of	Fall	Fall	For Net
		2013	2014	2014	Zero
1.0	General Conditions	$ -	$ -	$ -	$ -
2.1	Site work	$ 22,000	$ 23,823	$ 24,108	$ 285
2.2	Demolition	$ -	$ -	$ -	$ -
3.0	Concrete	$ 29,500	$ 31,520	$ 32,109	$ 590
4.0	Masonry	$ -	$ -	$ -	$ -
5.0	Metals	$ -	$ -	$ -	$ -
6.0	Carpentry	$ 219,940	$ 239,023	$ 261,715	$ 22,692
7.0	Thermal & Moisture Protection	$ 51,300	$ 55,891	$ 80,664	$ 24,773
8.0	Doors & Windows	$ 34,400	$ 53,383	$ 71,995	$ 18,613
9.0	Finishes	$ 100,700	$ 106,897	$ 107,048	$ 151
10.0	Specialties	$ 4,670	$ 4,880	$ 4,880	$ -
11.0	Equipment	$ 1,275	$ 840	$ 840	$ -
12.0	Furnishings	$ -	$ -	$ -	$ -
13.0	Special Construction	$ -	$ -	$ -	$ -
14.0	Conveying Systems	$ -	$ -	$ -	$ -
15.1	Mechanical	$ 111,146	$ 115,495	$ 111,600	$ (3,895)
15.2	Sprinkler	$ 15,519	$ 16,372	$ 16,372	$ -
16.0	Electrical	$ 52,285	$ 65,739	$ 150,798	$ 85,059
	Total	$ 642,735	$ 713,862	$ 862,128	$ 148,267
	Note- Excludes infrastructure sitework				

AS-BUILT TO NET ZERO COST ESTIMATE

PAYBACK ANALYSIS:						
(with full cost of PV)						
	Energy Code ++		**Net Zero**			
Annual Operating Cost per unit	$1,180		$890			
Annual savings:					$290	
Estimated Construction Cost:	$713,862		$862,128			
Incremental Cost to NZ:					$148,266	
(includes $90k for PV)						
Percent increase:					20.77%	
Per unit increase:					$24,711	
Payback					85.2	yrs

PAYBACK ANALYSIS						
(net of PV incentive)						
	Energy Code ++		**Net Zero**			
Incremental Cost to NZ for PV:			$90,000			
Other incremental costs to NZ)			$58,266			
					$148,266	
Estimated PV cost, 30kw:			$90,000			
Less PV incentive from SSREIP			-$30,000			
Net PV Cost:			$60,000			
Incremental Cost to NZ						
(net of PV incentive)			$118,266			
Percent increase:					16.57%	
Per unit increase:					$19,711	
Payback					68.0	yrs

Many people report smaller upcharges and these could come down (this was sche

1. Required Public Bid Process makes it difficult for a team to include a contractor f
2. Funding/Permitting Schedules. The process is long but once everything is in pla
3. Fees. As costs rise there is increasing pressure to reduce design fees which lim

Assume we could get it to 10%. That does not sound like too bad a penalty to pay

CONCLUSIONS & STRATEGY

- NZ adds 20% cost to an affordable housing budget with a 60 - 80 yr year payback.

- Even assuming 10% extra stresses the present funding/project delivery system and payback still long.

- Heating loads drastically reduced but not plug loads with little control on them so PV still large.

- ASHP adds AC loads and resident has no incentive to conserve.

- Multi-Family PV cannot be accommodated on the roof therefore additional land is necessary.

- Sheer size of neighborhood PV not compatible with urban design. Offsite PV may be necessary.

- Large scale, off site PV may be financially better.

- NZ discussion needs to occur within a larger framework concerning goals and policies for limited funds.

OR