

Putting the Pieces Together

Better Buildings by Design 2015

Chuck Reiss

Reiss Building and Renovation

Hinesburg, Vermont

www.reissbuilding.com

Vermont's Comprehensive Energy Plan

Improve the energy efficiency of 25%
of the state's housing stock by 2020
(approximately 80,000 housing units)

New homes net zero by 2030

90 % renewable by 2050

New Construction

South Farm and Burlington House



South Farm











ELECTRIC POWER DISTRIBUTION FOR PV/GEOTHERMAL HOME

DF

JANUARY - DECEMBER 2008

1160 kwh from PV to house

24% of total PV output

5164 kwh total house use

4796 kwh TOTAL PV

PV

To house

HOUSE

22.5% came directly from PV

92.9% of total house use

70% from PV via GMP grid

To house

7% non PV from GMP grid

3636 kwh from PV to GMP

To GMP

4004 kwh thru/from GMP to house

76% of total PV output

GMP grid

3636kwh from PV + 368kwh from GMP

70%

7%

JANUARY - DECEMBER 2009

3/29/2010

1071 kwh from PV to house

23% of total PV output

4945 kwh total house use

4669 kwh TOTAL PV

PV

To house

HOUSE

22% directly from PV

94% of total house use

73% from PV thru GMP

To house

5% non PV from GMP grid

3628 kwh from PV to GMP

To GMP

3874 kwh thru/from GMP to house

77% of total PV output

GMP grid

3628 kwh from PV + 246 kwh from GMP

73% (of house use) 5%

South Farm Lot 4 Energy Use (KWH)

	<u>Generated</u>	<u>Used</u>
2008	4,796 (93%)	5,164
2009	4,669 (94%)	4,954

Brandon House

























Burlington House REM Report

- HERS Index 16
- Ft2 2,291
- Blower door 253
- ACH50 0.64
- Under slab R-20
- Walls R-40
- Ceiling flat R-89

Burlington House Initial Energy Data

	KWH Used	KWH Generated
Sept 14- Oct 14	295	545
Oct 15 – Nov 14	409	280
Nov 15 – Dec 14	727	234
Dec 15 – Jan 14	<u>1,019</u>	<u>176</u>
	2,450	1,235

Used 1,215 more than generated fall of 2014





Richmond House

House built in 1907

Three Bedrooms

1,248 sq. ft. of conditioned space

Stone foundation

Full attic

**How to get there from
here**



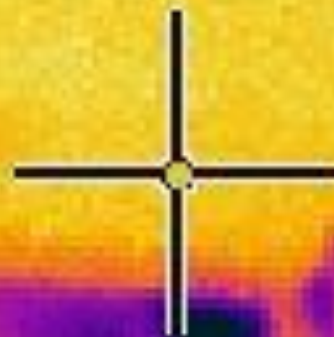
Spot ~ 14.6 °C

FLIR

16



7



3/16/12 Energy Audit Results

cfm50	3,396
ACH50	14.20
gals oil/ yr	650 (\$2,385.00/ yr)
BTU/ Sq. ft.	53,524
Electric Use '11- '12	1952 kwh/yr
CAZ worst case	-1.5

Reiss Building and Renovation

756 Buck Hill Road

Hinesburg, Vermont 05461

Betsy Hardy

05/01/12

341 Jericho Rd.

Richmond, Vt 05477

Recommendations and Estimated Costs for Energy Work

<u>Item</u>	<u>Estimated Cost</u>
1 Energy Audit	\$ 400.00
2 Foam band joists in basement and 4' down basement wall	\$ 3,094.00
4" of closed cell foam in all exposed joist bays and 3" on wall	
Foam 4' down for east, south and north walls	
Foam entire west wall (under deck)	
Ignition paint on all exposed surfaces	
Limited masonry work on wall	
3 Insulate attic storage main house after foaming penetrations w/ foam	\$ 2,386.00
Remove fiberglass insulation, foam all penetrations,	
Add 24" of cellulose (R-75)	
Fiberglass will be bagged and left on site	
4 Construct new hatch to attic	\$ 760.00
Weighted door on hinges with foam core	

5	Add storage area in attic					\$ 1,040.00	
		Plywood storage area 8' x 16'					
		Framing using 2 layers of 2x10 joists					
6	Replace sliding door in kitchen					\$ 2,211.00	
		Marvin Integrity sliding door					
		New door foamed in place					
		New exterior and interior trim					
7	Add storm panel to front window					\$ 324.00	
		Marvin custom storm window					
8	Replace exterior door in basement					\$ 926.00	
		ThermaTru Smooth star flush door					
		Door foamed in place					
		New exterior trim					
9	Remove heat lines in basement					\$ 654.00	
10	Foam domestic hot water lines and heat lines in the basement					\$ 192.00	
11	Bath fan					\$ 732.00	
		Panasonic 110 cfm fan					
		ducted to gable end with solid pvc pipe					

12	Air- air domestic hot water				\$ 3,514.00
		Stieble Eletron Accelera 300 heat pump water heater			
		80 gal storage tank			
13	Solar pv				
		24 Solar World panels roof applied			\$ 19,642.00
		SMA 6000 Inverter (located in basement)			
		Each panel 265 watts, total peak wattage 6,360			
		Approximately 7,632 kwh/yr			
		New 100 amp 30 circuit panel in the basement			
		Fed credit estimate	\$ 5,120.00		
		State incentive estimate	<u>\$ 2,312.00</u>		
			\$ 7,432.00		
		Adjusted solar pv estimate	\$ 12,210.00		
	Total				\$ 23,156.00
	Total adjusted after incentives and credits				\$ 15,724.00

14		Add two 18,000 btu mini split air to air heat pumps			\$ 9,000.00
		Mitsubishi MSZ (MUZ)-FE 12 NA			
		Cost per unit \$4,500.00			
		For info see: www.mitsubishicomfort.com			

Phase I

June – July 2012

Air seal and insulate Attic and Basement
Install new sliding door











Air seal and insulate

- Attic 24" of cellulose R-75
- Basement walls 3" closed cell foam R- 20
- Basement joist bays 4" closed cell R- 25
- Existing walls 2- 3" of cellulose R- 11

Test Out Results

cfm50	3,396	1,943
ACH50	14.2	8.12
gals oil/ yr*	650	391
Kwh/yr	1,952	1,108
CAZ worst case	-1.5	-1.9

* Reduced by 259 gals (-40%)

Cost of Energy Work Phase I

Insulate and seal Basement	\$5,110.00
Insulate and Seal Attic	\$4,554.00
Replace 6' sliding door	<u>\$3,795.00</u>
	\$13,459.00
State Incentive (HP)	<u>\$2,259.00</u>
Total Adjusted Cost	\$11,120.00

Next Phase?

12	Air- air domestic hot water				\$ 3,514.00
		Stieble Eletron Accelera 300 heat pump water heater			
		80 gal storage tank			
13	Solar pv				
		24 Solar World panels roof applied			\$ 19,642.00
		SMA 6000 Inverter (located in basement)			
		Each panel 265 watts, total peak wattage 6,360			
		Approximately 7,632 kwh/yr			
		New 100 amp 30 circuit panel in the basement			
		Fed credit estimate	\$ 5,120.00		
		State incentive estimate	<u>\$ 2,312.00</u>		
			\$ 7,432.00		
		Adjusted solar pv estimate	\$ 12,210.00		
	Total				\$ 23,156.00
	Total adjusted after incentives and credits				\$ 15,724.00

Phase II

October – November 2013

PV and Domestic Hot water



Sizing the system?

- PV
- Heat pumps

Richmond House Heat Take Off

Btu Load at -10 Degree C

	<u>Ft2</u>	<u>R</u>	<u>U</u>	<u>Ft2 x U</u>	<u>Delta T</u>	<u>Btu/ hr</u>
Ceiling	624	80	0.01	8.1	78	632.7
Slab	575	5	0.2	115.0	28	3220.0
Walls; 1st & 2nd	1,349	11	0.09	121.4	78	9470.0
Walls; basemt	200	16	0.06	12.0	78	936.0
Walls; basemt	200	16	0.06	12.0	50	600.0
Walls; basemt	287	2	0.5	143.5	28	4018.0
Windows; new	35		0.3	10.5	78	819.0
Windows; old	136		0.4	54.4	78	4243.2
Doors; new	42		0.3	12.6	78	982.8
Doors; old	38		0.25	9.5	78	<u>741.0</u>
						25,662.7

Total Volume (V) 14,352 Blower Door cfm50 1,943

Air exchange ACH N= $\frac{\text{cfm50} \times 60}{V \times N}$ $\frac{1,943 \times .97 \times 60}{14,352 \times 13.8}$
 ACH N = .57

Btu/ hr air Vol x HC Air x Delta T
 (14,352 x .57) x .018 x 78 11,485.0

Total Btu/hr 37,147.7

Projected KWH Annual Usage

• Two Heat Pumps (2,200 each)	4,400
• DHW Heat Pump	1,000
• Plug Load	<u>1,200</u>
	6,600
Project annual solar production	7,632
Available for Electric Car	1,032

KWH/Yr Based on Oil Use

$391 \text{ gals/ yr} = 54.036 \text{ Mbtu/ yr}$

$54.036 \text{ Mbtu/yr} \times .80 = 43.228 \text{ Mbtu/yr}$

$43.228 \text{ Mbtu/yr} / 2.6 \text{ (COP)} = 16.63 \text{ Mbtu/yr}$

$16,626,523 / 3412 \text{ (KWH / btu)} = 4,873 \text{ KWH/yr}$

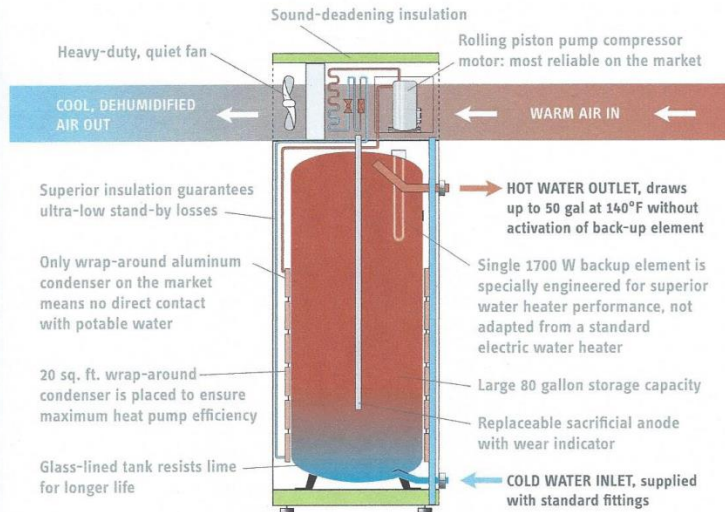
Heat Load	4,873
Plug Load	<u>1,200</u>
Total	6,073





Capture the Energy

STIEBEL ELTRON



Simple innovation from Germany.

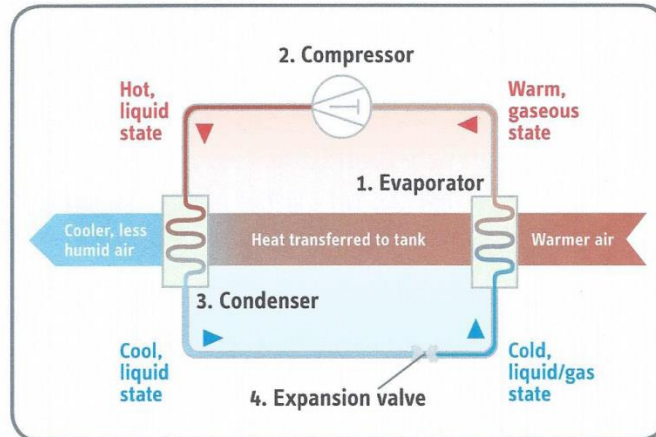
Heat pumps have been around for decades, but a heat pump water heater is a new concept. The Accelera® 300 works like an air conditioner but instead of dumping the heat outdoors, it puts it into the water.

The heat pump system contains a fan that forces air through an evaporator (1). The evaporator contains a liquid refrigerant. When this refrigerant evaporates, it extracts heat from the ambient air.

The now warm gaseous refrigerant passes through the compressor (2) which increases its pressure. As the pressure increases, the temperature of the refrigerant rises. The refrigerant turns back into a liquid which is now hot.

The hot refrigerant then passes through the condenser (3), which is wrapped around the water tank, transferring its heat to the water.

The refrigerant which is now cool then passes through an expansion valve (4), where it goes back into a gaseous state and the process begins anew.



State and Local Rebates / Incentives | Regional incentives for the Accelera® 300 may be available. The US Department of Energy's Database of State Incentives for Renewables & Efficiency website, DSIRE, has up-to-date details at: <http://www.dsireusa.org/>

ISO 9001
CERTIFIED







Cost of Energy Work Phase II

PV array;	\$13,528.00
24 265 watt Solar World panels	
6360 peak wattage, estimated	
7,632 kwh/yr	
(after fed credit of \$5,798.00)	
Stiebel Eltron air- air DHW	<u>\$2,477.00</u>
heat pump	
	\$16,005.00

Phase III

Air-Air Heat Pumps for Space Heating, four replacement windows

14		Add two 18,000 btu mini split air to air heat pumps	\$ 9,000.00
		Mitsubishi MSZ (MUZ)-FE 12 NA	
		Cost per unit \$4,500.00	
		For info see: www.mitsubishicomfort.com	

Projected KWH Annual Usage

• Two Heat Pumps (2,200 each)	4,400
• DHW Heat Pump	1,000
• Plug Load	<u>1,200</u>
	6,600
Project annual solar production	7,632
Available for Electric Car	1,032













Cost of Energy Work Phase III

Mitsubishi Mini splits FH 15 and FH 12	\$8,244.00
Four replacement windows	<u>\$2,849.00</u>
	\$11,093.00

Richmond House KWH Usage

	<u>KWH Used</u>	<u>Generated</u>	<u>+/-</u>
Sept '13	65	0	
Oct '13	86	0	
(PV and DHW heat pump installed)			
Nov '13	136	30	-86
Dec '13	160	159	-1

Richmond House KWH Usage

	<u>KWH Used</u>	<u>Generated</u>	<u>+/-</u>
Jan '14	309	131	-178
Feb '14	254	348	+94
Mar '14	208	393	+185
Apr '14	164	159	+185
May '14	103	641	+538
June '14	85	761	+676

Richmond House KWH Usage

	<u>KWH Used</u>	<u>Generated</u>	<u>+/-</u>
July '14	72	740	+668
Aug '14	81	710	+629
Sept '14	132	641	+509
Oct '14	225	466	+241

Richmond House KWH Usage

	KWH Used	Generated	+/-
Mitsubishi heat pumps installed			
Nov '14	529	197	-332
Dec '14	<u>920</u>	<u>79</u>	<u>-841</u>
Total '14	3,082	5,729	+,2647
Jan '15	1,339	120	-1,219

Adjusted Richmond House KWH Usage

	<u>KWH Used</u>	<u>Generated</u>	<u>+/-</u>
Jan '14	1,339	131	-1,208
Feb '14	1,119	348	-771
Mar '14	980	393	-587
Apr '14	627	622	-5
May '14	350	641	+291
June '14	167	761	+594

Adjusted Richmond House KWH Usage

	<u>KWH Used</u>	<u>Generated</u>	<u>+/-</u>
July '14	72	740	+668
Aug '14	81	710	+629
Sept '14	463	641	+178
Oct '14	637	466	-171
Nov '14	529	197	-332
Dec '14	<u>920</u>	<u>79</u>	<u>-841</u>
Total	7,284	5,729	-1,555

Finance Options

Total cost of Energy Retrofit	\$38,218.00
10% down	<u>\$ 3,822.00</u>
Principle amount	\$34,396.00
VSECU VGreen 10 yr at 3.75%	\$344.00/month
Pace 20 yr at 2.9%	\$189.00/month

Annual Utility Expenses 2011- 2012

650 gals/ yr oil at \$3.67/ gal	\$2,834.00
Annual maintenance	\$300.00
Monthly oil expenses	\$261.00
Monthly Electric bill (162 kwh)	<u>\$24.00</u>
Monthly utility expenses	\$285.00

Energy Cost Analysis

Monthly payment w/ VGreen	\$344.00
Monthly Oil bill (40 gals/ yr back up)	<u>\$ 12.00</u>
	\$356.00
Utility Bill before energy work	<u>-\$285.00</u>
Additional each month	\$ 71.00
Total interest to be paid	\$ 6,904.00
Total cost after 10 yrs.	\$45,122.00
(cost of energy work + interest)	

Energy Cost Analysis

Project/ finance cost after 10 yrs. (cost of energy work + interest)	\$45,122.00
25 yr Electric cost 1,555 kwh/ yr	\$ 5,442.00
25 yr Oil back up 40 gals/ yr	\$ 3,670.00
25 yr Maintenance \$100.00/ yr	<u>\$ 2,500.00</u>
	\$56,734.00
System life 25 yrs.	
25 yrs. x 12 months x \$285.00	\$85,500.00
Savings over life of the installed system	\$28,766.00

Vermont's Energy Future?

Conservation

250 gals oil/ house yr x 80,000 homes

20 M gals oil/ yr

30.2 M gals propane/yr

27.1 M ccf nat gas/ yr

Vermont's Energy Future?

Conservation + Renewables

650 gals oil/ house yr x 80,000 homes

52 M gals oil/ yr

78.4 M gals propane/yr

70.5 M ccf nat gas/ yr

Net Zero Energy Fund

- 20 year term
- 2.3% financing
- No down payment

Project cost of	\$ 35,000.00
Monthly payment	\$ 182.00
Monthly savings	\$ 103.00

Vermont's Energy Future

80,000 homes is $\frac{1}{4}$ of the total
housing stock

90 % renewable by 2050

New homes net zero by 2030

Can we get there?

“Optimists underestimate difficult it will be to succeed. But that self-deception is precisely what makes them willing to take more risks and invest in a better future, while pessimist slouch towards self fulfilling failure.

So do your kids (Vermont) a favor in the coming year, be of good cheer. Don't condemn the next generation to penury through the tyranny of miserable expectations.”

Charles Kenny