ZERO NET ENERGY MODEL

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Date 2-Dec-12

Project Name Hobart NZE house

Project Address 39 Sengekontacket Rd. OB

Energy Modeler David R Hobart

Existing House

House is two attached rectangles offset by 9 feet from each other, in Oak Bluffs Ma. Original rectangle (ranch) section is 27x43.5 floor area (28x44.5 exterior), with a 9x3.5 entry; Addition is 19x19 (20x20 exterior), with a 9x7.5 entry. Walls are 8 ft. There are 1206 ft2 over a poured concrete cellar (7.5 ft deep), 428.5 ft2 over pilings. R-0 in cellar; Ranch has R-11 in walls and R-19 in ceiling. Addition has R-19 in walls, R-33 in floor, and R-40 in ceiling.Addition exterior wall length (19,19, 13,7, 9, 11.5) is 78.5. Ranch exterior wall length is (43.5, 27, 27, 28) is 125.5. There are 107.75 ft2 glazed area S window, (21 ft2 shaded 80%), E has 25.5 ft2; N, 56.5 ft2; W, 58.5 ft2. 12 Ft2 of skylights on W roof. All glass R-3.

Proposed house

Ranch section of the house will have a second floor added; addition to remain the same size. Second floor to be same length (43.5) but shorter by 3 ft in width (24). Glazed S windows: 180.875 ft2; W 109.125; N 106.25; E 69.31. Assume Windows R-5.9. 12 ft2 skylights. Assumr R-5.9 for all glass. Assume SHGC of 0.5. Cellar floor to be R-16.5; cellar walls R-23.75. Ranch second floor ceiling to be R-60 SIP; walls R-41.43. Addition floor to be R-40.93, walls R-39.77, ceiling R-63.87. Addition exterior remains the same at 78.5. Ranch 1st floor remains the same at 125.5. Height will be 9 ft. Second story ranch perimeter (43.5, 43.5, 24, 24) is 135. Height will be 8 ft. The PV system will be facing directly south, set at 45 degrees. Target leakage will be 0.05 at CFM50/ssf, 75 cfm, 80% effective. Estimate 275 kWh/month internal, 25 kWh external. Water use is 50 gpd, 5-130F HPWH COP 2. Minisplit COP 2.3. 21 ft2 of south glazing is 80% shaded year round. Estimate cooling load is 300 kWh/year.

annual energy model in Boston, MA. Assume 100 ft2 S window, and 1/3 of the rest on E, N, W. SHGC = 0.5. Size the PV system, unshaded 45 degree roof facing south. R-20 slab, R-40 wall, R-60 ceiling, R-5 windows and doors, 0.05 CFM50/ssf, 50 CFM, 70% effectiveness. 275 kWh/month internal electricity, 25 kWh external electricity. 50 gpd, 50-130F, HPWH COP 2. Minisplit COP 2.3 Net glazed area is 72% of window area. South glazing is 20% shaded Nov. - Feb. Cooling is 450 kWh/year

MARC'S BUILDING LOAD COEFFICIENT CALCULATOR

Input cells are yellow Mouse over cells with a red mark in the upper right hand corner to read inserted comments

		Design Temperature Difference	62	Building Area, ft2	2674.00

R VALUES, ft2-hr-˚F / BTU

Wall R Value	37.00	Flat Ceiling R Value	45.00	Slab on grade R Value	19.00
Floor over outdoors R Value	65.00	Skylight R Value	0.00	Foundation(heated) R Value	25.00
Window R Value	8.50	Opaque Door R Value	5.50		
Sloped Ceiling R Value	65.00	Glass Door R Value	8.50		

ELEMENT	AREA, ft2	UA, BTU /	hr-˚F	5.55555556
Walls	2221	60	total wall area - windows+doors	
Floor over outdoors	467	7	Addition plus part of entry	
Windows	610	72		
Sloped Ceiling	460	7	sloped ceiling over addition	
Skylight	0	0	None	
Flat Ceiling	1232	27	Flat over ranch	
Opaque Door	0	0	None	
Glass Door	159	19		
	PERIMETER			
Slab on grade	141	24	slab is underground	
Foundation Wall (heated	141	46		
Foundation wall height	8.0			
Slab area	1174			
Shell area	7451			
CFM50/ssf	0.04		Target CFM50	298.04
Infiltration		19	NB: This is a different value than used to calculate design heat loss!	
Ventilation effectiveness	0.92			
Ventilation, CFM	100	9		
Total UA - Building load coefficient		***290***		

MONTHLY AVERAGE SOLAR INSOLATION CALCULATOR USING PVWATTS OUTPUT

BTU/ft2/day per kWh/m2/day 317

Enter the square feet of NET GLAZING (not gross window area) in E7, E25, E43, and E61
Enter the Glazing Solar Heat Gain Coefficient (SHGC) in cells G7, G25, G43, and G61
NOTE: these are NOT the NFRC Whole Window Values!
The dirt/off axis factor is a constant which accounts for dirt and the fact that the glazing has lower SHGC at acute angles of insolation

Copy the input azimuth results from PVWatts into the yellow shaded cells in Column C

Azimuth	180	ft2 of glazing	210	SHGC	0.44	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/month	BTU/ft2/month	Fraction	BTU/month	
Jan	2.96	938	31	29,088	0.95	2,170,337	
Feb	3.72	1,179	28	33,019	0.90	2,333,961	
Mar	4.64	1,471	31	45,597	0.75	2,685,908	
Apr	4.58	1,452	30	43,556	0.55	1,881,480	
May	4.89	1,550	31	48,054	0.25	943,541	
Jun	5.04	1,598	30	47,930	0.13	489,379	
Jul	4.85	1,537	31	47,661	0.25	935,823	
Aug	5.05	1,601	31	49,626	0.60	2,338,592	
Sep	4.59	1,455	30	43,651	0.75	2,571,256	
Oct	4.26	1,350	31	41,863	0.90	2,959,129	
Nov	3.04	964	30	28,910	0.95	2,157,092	
Dec	2.76	875	31	27,123	1.00	2,130,203	
						23,596,701	

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	2.96	292	61.32
2	3.72	333	69.93
3	4.64	446	93.66
4	4.58	416	87.36
5	4.89	442	92.82
6	5.04	426	89.46
7	4.85	417	87.57
8	5.05	436	91.56
9	4.59	389	81.69
10	4.26	390	81.9
11	3.04	277	58.17
12	2.76	267	56.07
Year	4.2	4531	951.51

Copy the input azimuth results from PVWatts into the yellow shaded cells in Column C

Azimuth	270	ft2 of glazing	85	SHGC	0.44	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/month	BTU/ft2/month	Fraction	BTU/month	
Jan	1.53	485	31	15,035	1.0	477,973	
Feb	2.29	726	28	20,326	1.0	646,165	
Mar	3.17	1,005	31	31,152	1.0	990,309	
Apr	3.74	1,186	30	35,567	1.0	1,130,688	
May	4.38	1,388	31	43,042	1.0	1,368,313	
Jun	4.70	1,490	30	44,697	1.0	1,420,918	
Jul	4.57	1,449	31	44,909	1.0	1,427,670	
Aug	4.36	1,382	31	42,846	1.0	1,362,065	
Sep	3.53	1,119	30	33,570	1.0	1,067,200	
Oct	2.62	831	31	25,747	1.0	818,489	
Nov	1.73	548	30	16,452	1.0	523,019	
Dec	1.40	444	31	13,758	1.0	437,360	

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	1.53	132	27.72
2	2.29	193	40.53
3	3.17	294	61.74
4	3.74	333	69.93
5	4.38	392	82.32
6	4.7	395	82.95
7	4.57	392	82.32
8	4.36	373	78.33
9	3.53	293	61.53
10	2.62	225	47.25
11	1.73	142	29.82
12	1.4	117	24.57

Copy the input azimuth results from PVWatts into the yellow shaded cells in Column C

Azimuth	0	ft2 of glazing	123	SHGC	0.44	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/month	BTU/ft2/month	Fraction	BTU/month	
Jan	0.63	200	31	6,191	1.0	284,799	
Feb	0.83	263	28	7,367	1.0	338,900	
Mar	1.46	463	31	14,347	1.0	660,010	
Apr	2.59	821	30	24,631	1.0	1,133,071	
May	3.64	1,154	31	35,770	1.0	1,645,504	
Jun	4.15	1,316	30	39,467	1.0	1,815,538	
Jul	3.83	1,214	31	37,637	1.0	1,731,396	
Aug	3.01	954	31	29,579	1.0	1,360,706	
Sep	1.82	577	30	17,308	1.0	796,212	
Oct	0.90	285	31	8,844	1.0	406,855	
Nov	0.72	228	30	6,847	1.0	314,985	
Dec	0.57	181	31	5,601	1.0	257,675	

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	0.63	32	6.72
2	0.83	46	9.66
3	1.46	101	21.21
4	2.59	209	43.89
5	3.64	320	67.2
6	4.15	350	73.5
7	3.83	325	68.25
8	3.01	239	50.19
9	1.82	122	25.62
10	0.9	46	9.66
11	0.72	30	6.3
12	0.57	26	5.46

Copy the input azimuth results from PVWatts into the yellow shaded cells in Column C

Azimuth	90	ft2 of glazing	70.79	SHGC	0.44	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/month	BTU/ft2/month	Fraction	BTU/month	
Jan	1.62	514	31	15,920	1.0	421,482	
Feb	2.24	710	28	19,882	1.0	526,391	
Mar	3.44	1,090	31	33,805	1.0	895,000	
Apr	3.90	1,236	30	37,089	1.0	981,948	
May	4.62	1,465	31	45,401	1.0	1,202,005	
Jun	4.89	1,550	30	46,504	1.0	1,231,212	
Jul	4.55	1,442	31	44,713	1.0	1,183,793	
Aug	4.20	1,331	31	41,273	1.0	1,092,732	
Sep	3.42	1,084	30	32,524	1.0	861,093	
Oct	2.69	853	31	26,435	1.0	699,869	
Nov	1.71	542	30	16,262	1.0	430,547	
Dec	1.42	450	31	13,954	1.0	369,448	

Month	Solar Radiation (kWh/m²/day)	AC Energy (kWh)	Energy Value ($)
1	1.62	144	30.24
2	2.24	190	39.9
3	3.44	324	68.04
4	3.9	351	73.71
5	4.62	416	87.36
6	4.89	412	86.52
7	4.55	390	81.9
8	4.2	359	75.39
9	3.42	284	59.64
10	2.69	235	49.35
11	1.71	139	29.19
12	1.42	119	24.99

ANNUAL NET HEATING LOAD

Monthly interior electrical usage, kWh: 275

Heating Degree Days Base 70F from degreedays.net

Month	HDD65	Gross heat loss, BTU/month	Gains, BTU/month	Solar Gains, BTU/month	Utilization factor	Net heat loss, BTU/month	BTU loss /hr w/o solar	BTU loss /hr w/ solar	BTUgain/hr Solar
Jan	1015	7,059,528	938,300	3,354,591	0.97	2,913,981	9489	3917	5572
Feb	871	6,057,979	938,300	3,845,418	0.91	1,682,087	9015	2503	6512
Mar	763	5,306,817	938,300	5,231,227	0.76	587,310	7133	789	6343
Apr	485	3,373,272	938,300	5,127,187	0.54	82,086	4685	114	4571
May	263	1,829,218	938,300	5,159,364	0.30	3,113	2459	4	2454
Jun	89	619,013	938,300	4,957,047	0.10	7	860	0	860
Jul	19	132,149	938,300	5,278,682	0.02	0	178	0	178
Aug	32	222,566	938,300	6,154,095	0.03	0	299	0	299
Sep	99	688,565	938,300	5,295,761	0.11	10	956	0	956
Oct	313	2,176,978	938,300	4,884,343	0.37	9,985	2926	13	2913
Nov	550	3,825,360	938,300	3,425,642	0.77	447,274	5142	601	4540
Dec	825	5,738,040	938,300	3,194,686	0.94	1,865,555	8539	2776	5763
		Annual Net Heating Load, BTU/year				***7,591,409***			
		Annual Net Heating Load, kWh/year				***2,225***			
						$ 533.98			

Heating Degree Days Base 70F

	Oak Bluffs	Boston	NYC	Concord, NY	Albany, NY	Burlington, V	Hartford, CT
Jan	1015	1152	1494	1418	1531	1280	
Feb	871	1020	1287	1256	1353	1116	
Mar	763	833	1117	1060	1178	932	
Apr	485	504	713	624	702	558	
May	263	264	417	349	406	308	
Jun	89	77	210	134	175	106	
Jul	19	17	112	68	94	34	
Aug	32	29	146	92	118	55	
Sep	99	106	297	230	271	161	
Oct	313	394	661	586	654	482	
Nov	550	650	925	866	914	760	
Dec	825	1010	1324	1266	1356	1128	
	5324						

MARC'S DHW CALCULATOR

Input cells are yellow
Green cells are also inputs, with defaults entered to begin

Number of occupants	2
Gallons DHW/person/day	12
Days/year	365
Incoming water temperature, ˚F	50
Hot water setpoint, ˚F	125
BTU/gallon before system efficiency	**625**
DHW system efficiency (includes standby losses)	80%
BTU/gallon including system efficiency	**781**
Gross DHW energy, BTU/year	**6,841,013**
Solar water heating? Y or N	n
Solar DHW annual fraction	70%
Net DHW energy, BTU/year	
Heat pump water heating? Y or N	Y
Heat pump water heater COP	2.3
Net DHW energy, BTU/year	***2,974,353***
Solar water heating, heat pump back-up?	no entry needed
Net DHW energy, BTU/year	
Net Annual DHW Energy, BTU/year	***2,974,353***
Net Annual DHW Energy, kWh/year	***872***

ANNUAL ENERGY USAGE AND PV ARRAY SIZING

Heating COP	3.51
Monthly electrical usage applied to heat offset	275
onthly electrical usage not applied to heat offset	25
PV Annual Production, kWh/kW	1,220

End Use	kWh/year
Heating	634
DHW	872
Electricity	3,600
Cooling	350
Total	***5,456***

Solar Electric System Size, kW	***4.47***

22,359.07

Cooling	kWh/ft2/year
Used sparingly	0.1
Used continuously	1.0

14.95 $ 1,309.35 Total elec/yr
6.23

13,415.44 10.24590164
3