Heat Spring | Zero Net Energy Homes

Capstone Project | March 9 – May 15, 2015

John F. Slater

June 11, 2015

Project Name: Slater-Deep Energy retrofit

Project Address : 15 Forrence Dr., Hollis, NH 03049

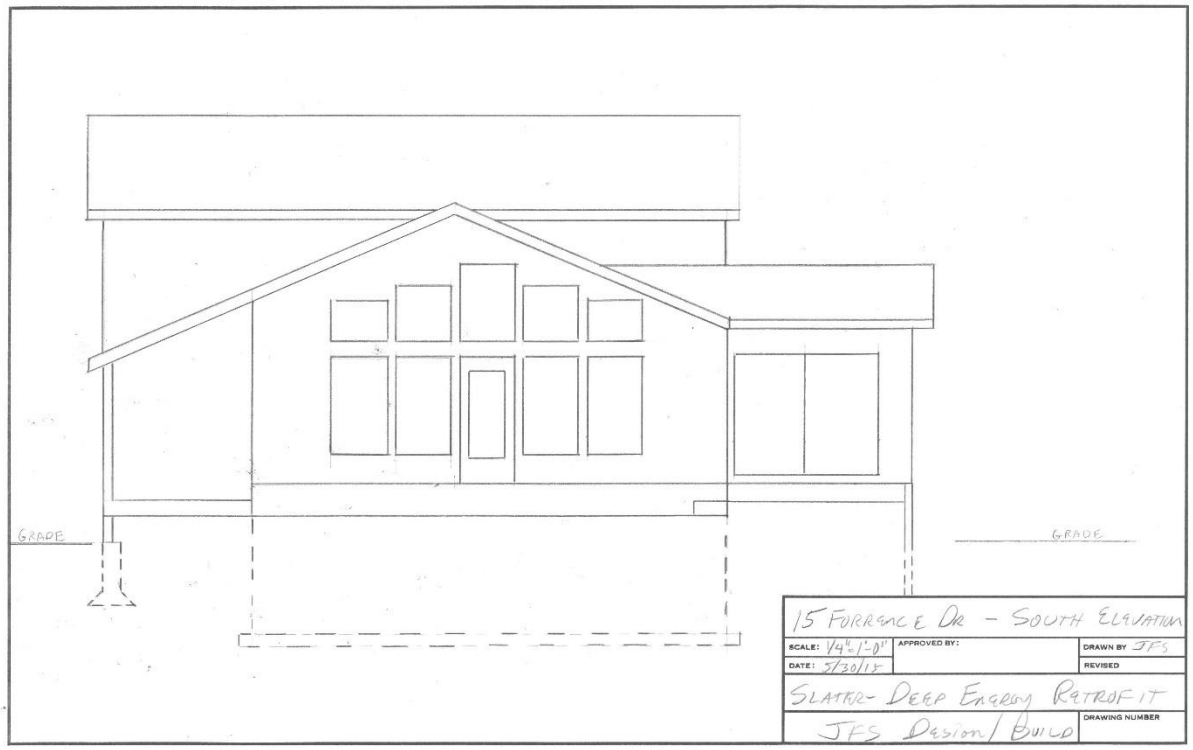
Energy Model Used: Marc's Zero Net Energy Model ©Marc Rosenbaum, 2012

Energy Modeler : John Slater

Notes:

House built in very well drained soils, has a very good poured foundation, 70's framing (2x4 exterior walls, ½ CDX wall and roof sheathing; 2 x 10 joists; 2 x 12 beams; 2 x 6 rafters and ceiling joists 16" O.C.), 200 amp service; drilled bedrock well

Modelled Heating Load = 5.54 kBTU/ ft^2/ yr which is comparable to Passive House standard (4.75 kBTU/ ft^2/ yr). RESNET testing (Blower door, etc.) may prove load to be less (or more!).



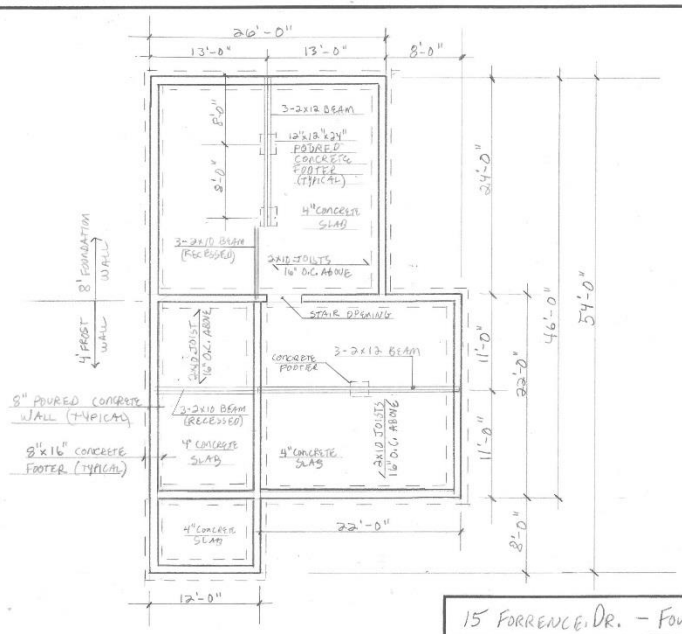
15 Furrance Dr - South Elevation

SCALE: 1/4"=1'-0"	APPROVED BY:	DRAWN BY JFS
DATE: 5/30/12		REVISED

Slater- Deep Energy Retrofit

JFS Design/Build

DRAWING NUMBER



Foundation Plan (Existing)

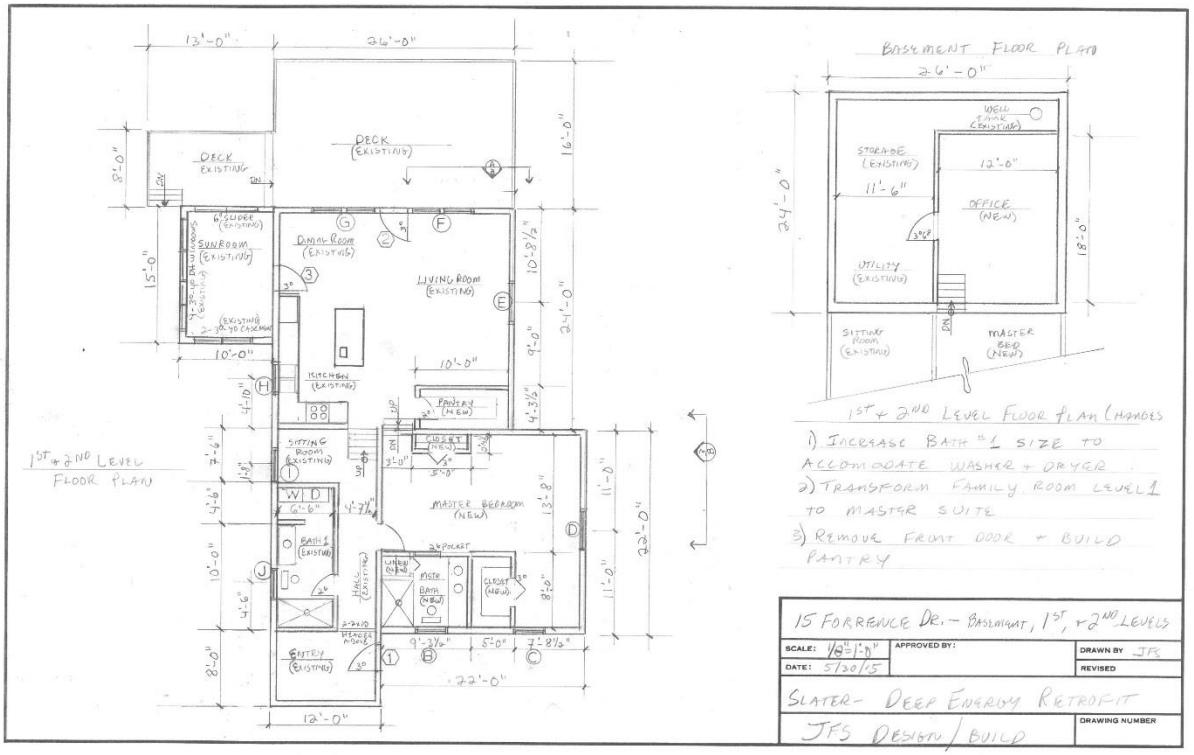
15 Forrence Dr. – Foundation Plan

SCALE: 1/8" = 1'-0"	APPROVED BY:	DRAWN BY JFS
DATE: 5/30/18		REVISED

Slater – Deep Energy Retrofit

JFS Design/Build

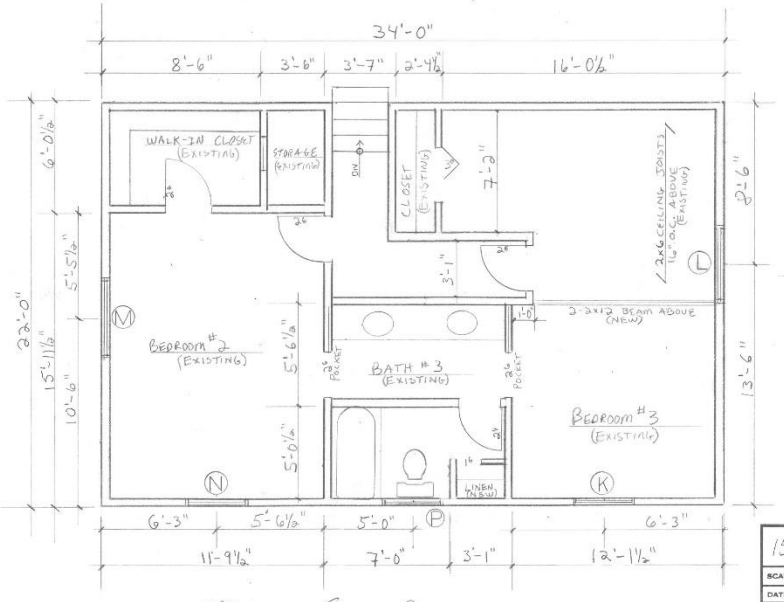
DRAWING NUMBER



1ST + 2ND LEVEL FLOOR PLAN CHANGES

1) INCREASE BATH #1 SIZE TO ACCOMODATE WASHER + DRYER
2) TRANSFORM FAMILY ROOM LEVEL 1 TO MASTER SUITE
3) REMOVE FRONT DOOR + BUILD PANTRY

15 FORRENCE DR. – BASEMENT, 1ST, + 2ND LEVELS	
SCALE: 1/8" = 1'-0"	APPROVED BY:
DATE: 5/30/15	DRAWN BY JFS
	REVISED
SLATER – DEEP ENERGY RETROFIT	
JFS DESIGN / BUILD	DRAWING NUMBER



3RD LEVEL FLOOR PLAN

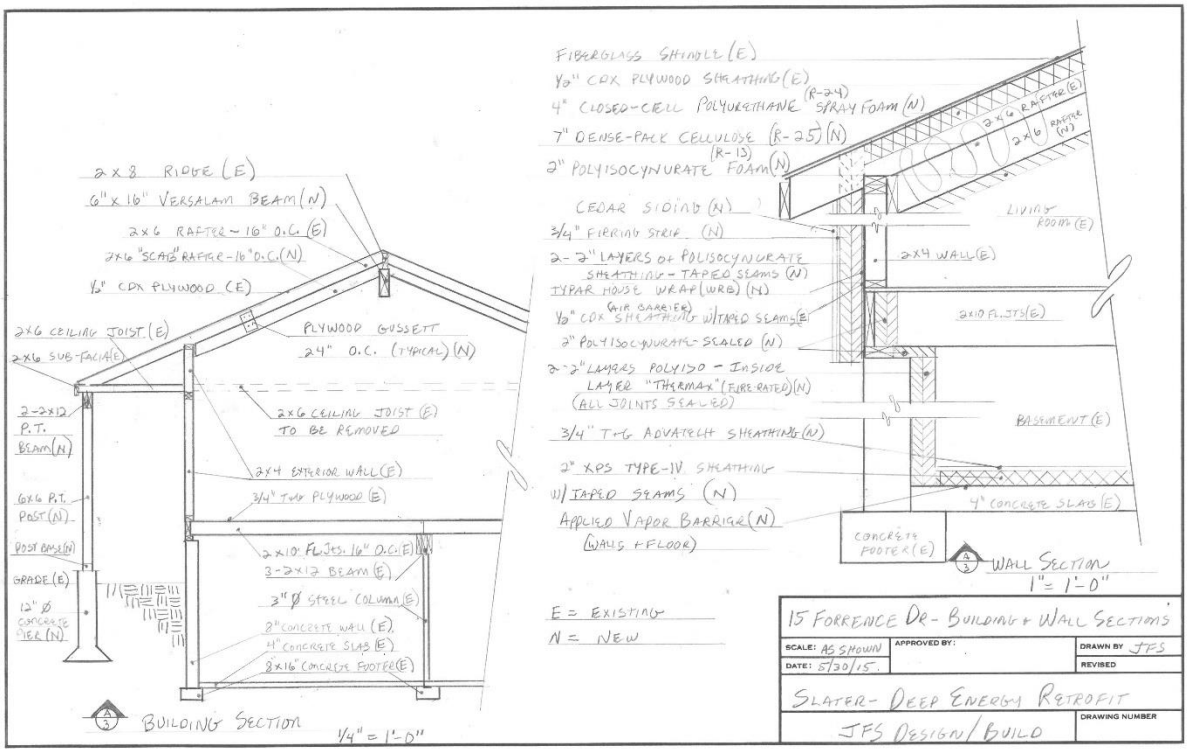
DOOR SCHEDULE

	SIZE	ROUGH OPENING	REMARKS
1	3'0" 8"	3'-2" × 6'-10½"	FIBERGLASS INSULATED W/ HALF-LITE
2	3'0" 8"	3'-2" × 6'-10½"	FIBERGLASS INSULATED W/ FULL-LITE
3	3'0" 8"	3'-2" × 6'-10½"	FIBERGLASS INSULATED W/ FULL-LITE
4	2'8" 8"	2'-10 × 6'-10½"	FIBERGLASS INSULATED W/ HALF-LITE

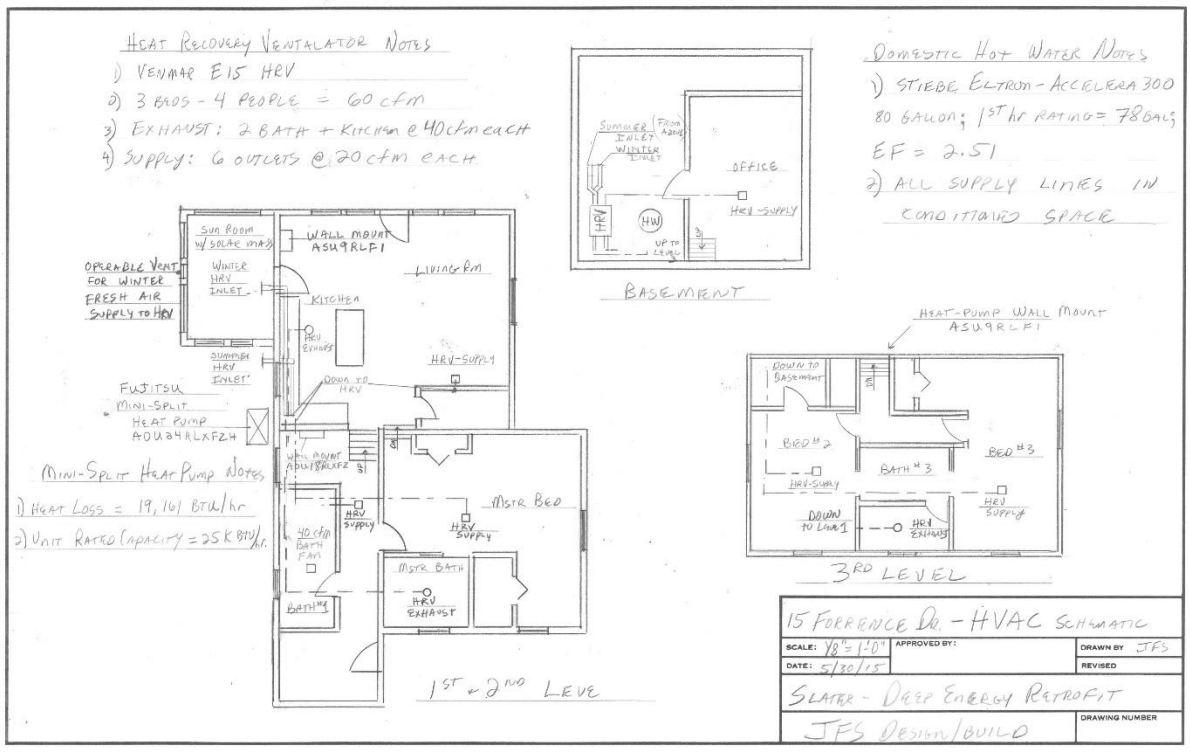
3RD LEVEL FLOOR PLAN CHANGES

1) THREE BEDROOMS → TWO BEDROOMS
2) ENLARGE BATHROOM
3) MOVE ENTRY DOOR TO BED #3
4) REMOVE WALL IN BED #3 – REPLACE W/ 2-2x12 BEAM

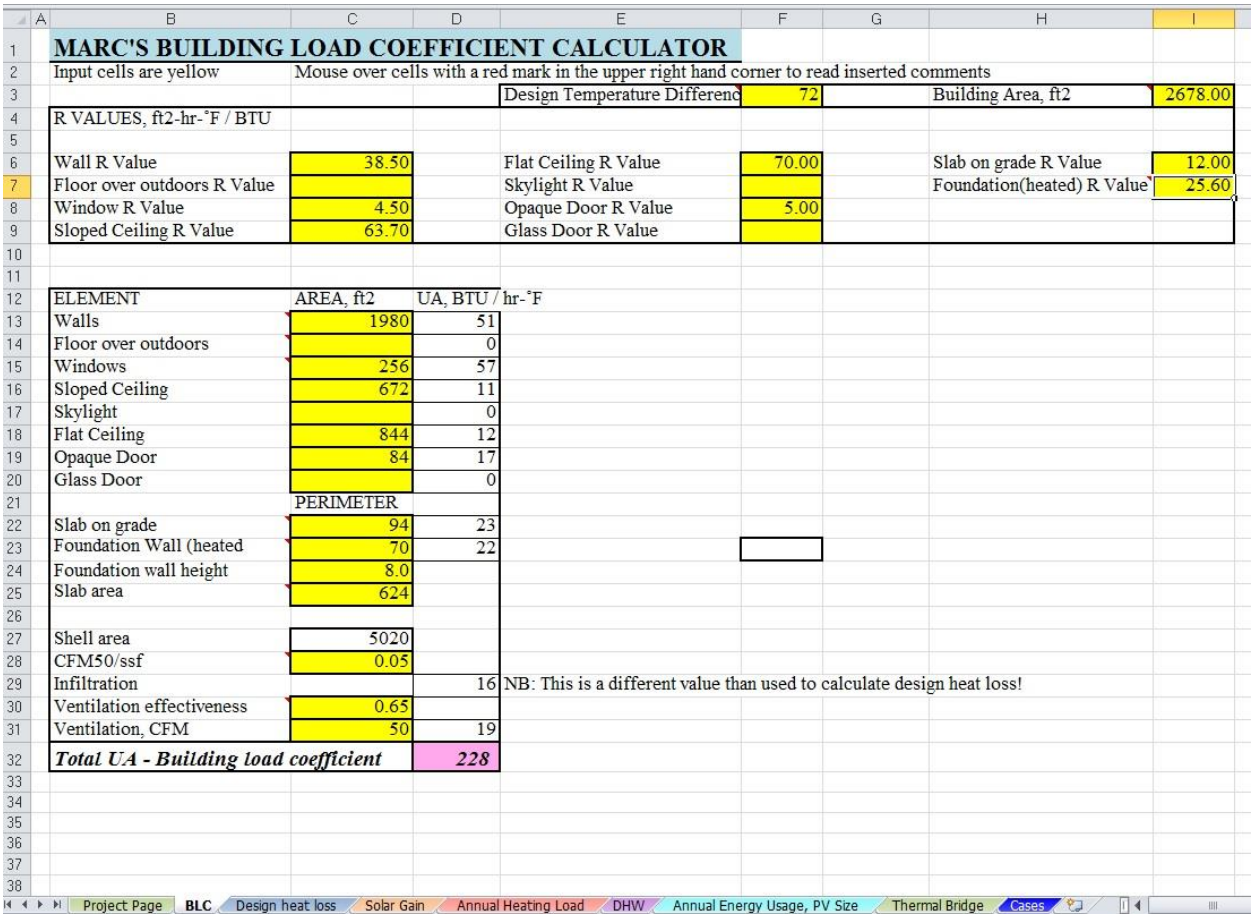
15 FORRENCE DR – 3RD LEVEL PLAN + WINDOW SCHEDULE	
SCALE: 1/4" = 1'-0"	APPROVED BY:
DATE: 5/30/15	DRAWN BY JFS
	REVISED
SLATER – DEEP ENERGY RETROFIT	
JFS DESIGN / BUILD	DRAWING NUMBER



15 FORRENCE DR - BUILDING + WALL SECTIONS		
SCALE: AS SHOWN	APPROVED BY:	DRAWN BY JFS
DATE: 5/30/15		REVISED
SLATER - DEEP ENERGY RETROFIT		
JFS DESIGN/BUILD		DRAWING NUMBER



15 FORRENCE DR. - HVAC SCHEMATIC		
SCALE: 1/8" = 1'-0"	APPROVED BY:	DRAWN BY JFS
DATE: 5/30/15		REVISED
SLATER - DEEP ENERGY RETROFIT		
JFS DESIGN/BUILD		DRAWING NUMBER



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 Differenc	72		Building Area, ft2	2678.00
R VALUES, ft2-hr-°F / BTU							
Wall R Value	38.50		Flat Ceiling R Value	70.00		Slab on grade R Value	12.00
Floor over outdoors R Value			Skylight R Value			Foundation(heated) R Value	25.60
Window R Value	4.50		Opaque Door R Value	5.00			
Sloped Ceiling R Value	63.70		Glass Door R Value				

ELEMENT	AREA, ft2	UA, BTU / hr-°F
Walls	1980	51
Floor over outdoors		0
Windows	256	57
Sloped Ceiling	672	11
Skylight		0
Flat Ceiling	844	12
Opaque Door	84	17
Glass Door		0
	PERIMETER	
Slab on grade	94	23
Foundation Wall (heated	70	22
Foundation wall height	8.0	
Slab area	624	
Shell area	5020	
CFM50/ssf	0.05	
Infiltration		16
Ventilation effectiveness	0.65	
Ventilation, CFM	50	19
Total UA - Building load coefficient		***228***

NB: This is a different value than used to calculate design heat loss!

Project Page | BLC | Design heat loss | Solar Gain | Annual Heating Load | DHW | Annual Energy Usage, PV Size | Thermal Bridge | Cases

MARC'S HEAT LOSS CALCULATOR

Inputs come from BLC sheet Mouse over cells with a red mark in the upper right hand corner to read inserted comments

		Design Temperature Difference, °F	72	Building Area, ft2	2678
R VALUES, ft2-hr-°F / BTU					
Wall R Value	39	Flat Ceiling R Value	70	Slab on grade R Value	12
Floor over outdoors R Value	0	Skylight R Value	0	Foundation(heated) R Value	26
Window R Value	5	Opaque Door R Value	5		
Sloped Ceiling R Value	64	Glass Door R Value	0		

ELEMENT	AREA, ft2	UA, BTU / hr-°F
Walls	1980	51
Floor over outdoors	0	0
Windows	256	57
Sloped Ceiling	672	11
Skylight	0	0
Flat Ceiling	844	12
Opaque Door	84	17
Glass Door	0	0
	PERIMETER	
Slab on grade	94	23
Foundation Wall (heated space)	70	22
Foundation Wall height	8	
Slab area	624	
Shell area	5020	
CFM50/ssf	0.05	
Infiltration		54
Ventilation effectiveness	0.65	
Ventilation, CFM	50.00	19
Total UA - Building load coefficient		266
Heat loss, BTU/hr		*19,161*

	Heat loss, BTU/hr
Walls	3,703
Floor over outdoors	-
Windows	4,096
Sloped Ceiling	760
Flat Ceiling	868
Skylight	-
Opaque Door	1,210
Glass Door	-
Slab on grade	1,660
Foundation Wall (heated space)	1,601
Infiltration	3,904
Ventilation	1,361
Total heat loss, BTU/hr	*19,161*
BTU/hr-ft2	*7*

Project Page | BLC | **Design heat loss** | Solar Gain | Annual Heating Load | DHW | Annual Energy Usage, PV Size | Thermal Bridge | Cases

MONTHLY AVERAGE SOLAR INSOLATION CALCULATOR USING PVWATTS OUTPUT

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

Enter the square foot of NET GLAZING (not gross window area) in E10, E28, E46, and E64
Enter the Glazing Solar Heat Gain Coefficient (SHGC) in cells G10, G28, G46, and G64
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	92	SHGC	0.8	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/mon	BTU/ft2/mon	Fraction	BTU/month	
Jan	3.57	1,131	31	35,075	0.8	1,316,591	
Feb	2.88	888	28	24,877	0.8	933,802	
Mar	5.28	1,672	31	51,844	1.0	2,432,501	
Apr	4.38	1,363	30	40,895	1.0	1,918,779	
May	4.45	1,412	31	43,760	1.0	2,053,206	
Jun	4.82	1,529	30	45,857	1.0	2,151,627	
Jul	5.24	1,653	31	51,242	1.0	2,404,273	
Aug	4.93	1,562	31	48,433	1.0	2,272,497	
Sep	4.25	1,346	30	40,372	1.0	1,894,265	
Oct	3.71	1,177	31	36,501	1.0	1,712,617	
Nov	2.64	838	30	25,125	0.8	943,103	
Dec	2.69	852	31	26,419	0.8	991,659	

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

Azimuth	90	ft2 of glazing	52	SHGC	0.8	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/mon	BTU/ft2/mon	Fraction	BTU/month	
Jan	2.82	640	31	19,855	1.0	526,545	
Feb	2.88	636	28	17,795	1.0	471,915	
Mar	4.14	1,312	31	40,674	1.0	1,078,680	
Apr	3.83	1,214	30	36,432	1.0	966,180	
May	4.38	1,362	31	42,218	1.0	1,119,627	
Jun	4.72	1,495	30	44,840	1.0	1,189,162	
Jul	4.38	1,580	31	48,969	1.0	1,298,666	
Aug	4.44	1,408	31	43,639	1.0	1,157,298	
Sep	3.47	1,100	30	33,002	1.0	875,222	
Oct	2.76	874	31	27,105	1.0	718,824	
Nov	1.69	536	30	16,079	1.0	426,403	
Dec	1.54	489	31	15,148	1.0	401,736	

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

Azimuth	0	ft2 of glazing	42.5	SHGC	0.8	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/mon	BTU/ft2/mon	Fraction	BTU/month	
Jan	0.65	207	31	6,414	1.0	139,026	
Feb	1.88	342	28	9,569	1.0	207,400	
Mar	2.62	832	31	25,782	1.0	558,824	
Apr	3.14	997	30	29,905	1.0	648,197	
May	3.86	1,223	31	37,902	1.0	821,522	
Jun	4.44	1,407	30	42,200	1.0	914,685	
Jul	4.53	1,455	31	45,109	1.0	977,743	
Aug	3.73	1,201	31	37,231	1.0	806,986	
Sep	2.61	829	30	24,859	1.0	538,811	
Oct	1.56	493	31	15,294	1.0	331,490	
Nov	0.88	254	30	7,634	1.0	165,462	
Dec	0.55	169	31	5,233	1.0	113,436	

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

Azimuth	270	ft2 of glazing	53	SHGC	0.8	dirt/off axis	0.85
Month	Insolation,	BTU/ft2/day	Days/mon	BTU/ft2/mon	Fraction	BTU/month	
Jan	2.18	692	31	21,461	1.0	580,086	
Feb	1.96	622	28	17,405	1.0	470,447	
Mar	3.98	1,261	31	39,082	1.0	1,056,375	
Apr	3.73	1,181	30	35,441	1.0	957,965	
May	4.15	1,309	31	40,574	1.0	1,096,716	
Jun	4.64	1,471	30	44,144	1.0	1,193,223	
Jul	4.85	1,569	31	48,645	1.0	1,314,869	
Aug	4.41	1,397	31	43,310	1.0	1,170,677	
Sep	3.54	1,121	30	33,633	1.0	909,097	
Oct	2.66	845	31	26,186	1.0	707,820	
Nov	1.75	567	30	17,019	1.0	460,014	
Dec	1.58	500	31	15,507	1.0	419,160	

ANNUAL NET HEATING LOAD

Monthly interior electrical usage, kWh: 350

Heating Degree Days Base 70F from degreedays.net

Month	HDD70	Gross heat loss, BTU/month	Electric Gains,	Solar Gains, BTU/month	Utilization factor	Net heat loss, BTU/month
Jan	1461	7,989,569	1,194,200	2,562,248	0.99	4,279,349
Feb	1297	7,092,725	1,194,200	2,083,564	0.99	3,852,487
Mar	1245	6,808,360	1,194,200	5,126,380	0.86	1,355,536
Apr	699	3,822,525	1,194,200	4,491,120	0.64	189,598
May	376	2,056,179	1,194,200	5,091,071	0.33	5,190
Jun	149	814,816	1,194,200	5,448,696	0.12	20
Jul	63	344,519	1,194,200	5,995,551	0.05	0
Aug	130	710,913	1,194,200	5,407,458	0.11	9
Sep	281	1,536,666	1,194,200	4,217,395	0.28	2,032
Oct	512	2,799,904	1,194,200	3,470,751	0.58	91,466
Nov	936	5,118,574	1,194,200	1,994,982	0.96	2,049,282
Dec	1111	6,075,572	1,194,200	1,925,991	0.98	3,010,617
				Annual Net Heating Load, BTU/year		***14,835,586***
				Annual Net Heating Load, kWh/year		***4,348***

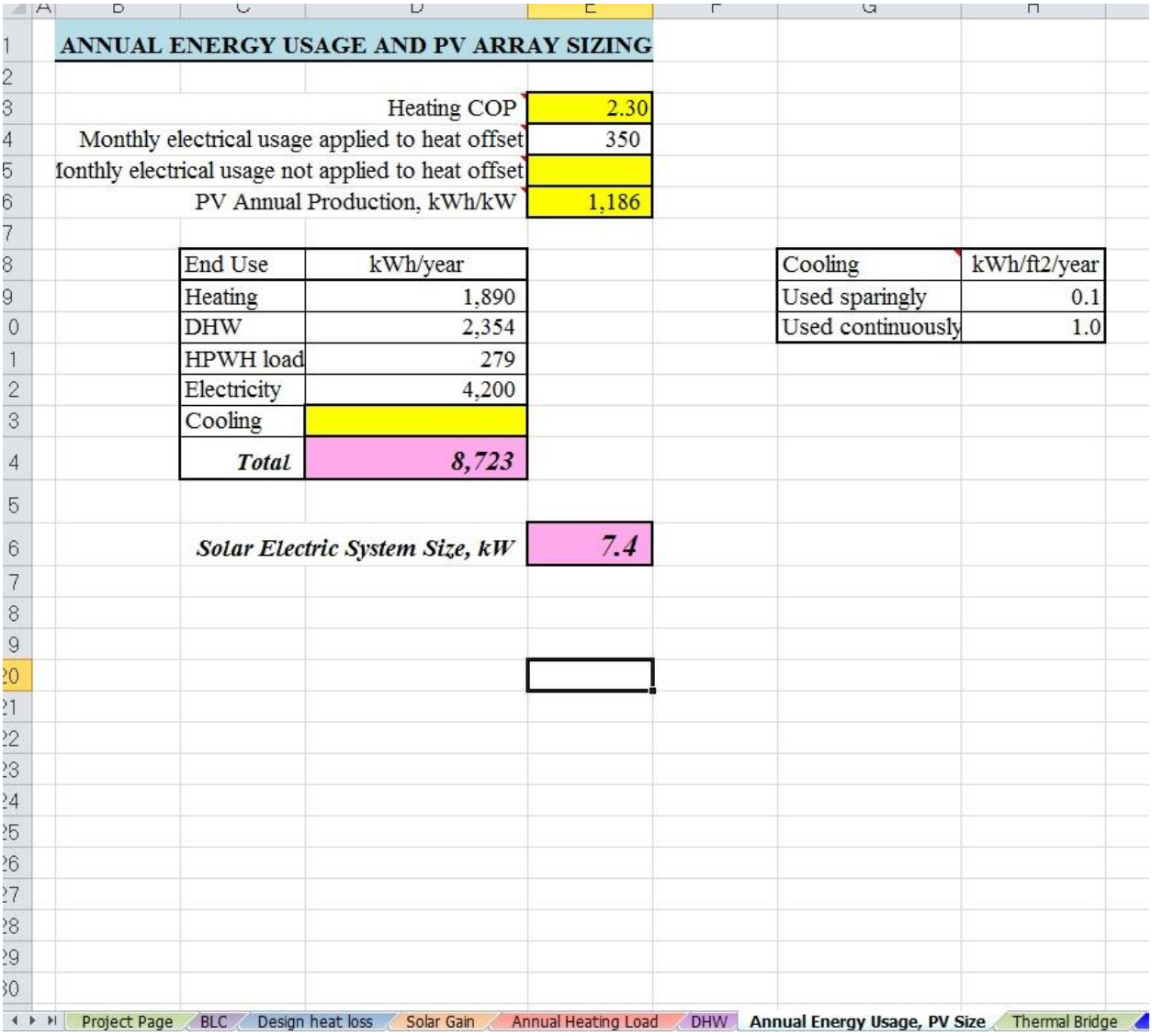
MARC'S DHW CALCULATOR

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

Number of occupants	4
Gallons DHW/person/day	16
Days/year	365
Incoming water temperature, ˚F	52
Hot water setpoint, ˚F	130
BTU/gallon	**650**
Standby losses, kWh/day	2
Gross DHW energy, BTU/year, including standby losses	**17,668,686**
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	2.2
Net DHW energy, BTU/year	***8,031,221***
Solar water heating, heat pump back-up?	no entry needed
Net DHW energy, BTU/year	
Net Annual DHW Energy, BTU/year	***8,031,221***
Net Annual DHW Energy, kWh/year	***2,354***

Additional heating load from HPWH

HPWH COP	2.2
Heating season, months	6
Additional heating load, kWh (before heating system COP)	642



ANNUAL ENERGY USAGE AND PV ARRAY SIZING

Heating COP	2.30
Monthly electrical usage applied to heat offset	350
Monthly electrical usage not applied to heat offset	
PV Annual Production, kWh/kW	1,186

End Use	kWh/year
Heating	1,890
DHW	2,354
HPWH load	279
Electricity	4,200
Cooling	
Total	***8,723***

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

Solar Electric System Size, kW ***7.4***

Project Page | BLC | Design heat loss | Solar Gain | Annual Heating Load | DHW | **Annual Energy Usage, PV Size** | Thermal Bridge