Jones Family PV Battery Upgrade Project
February 20, 2023

Current System

1.8 kW net PV system installed in 2003

12 180W Sharp PV Panels

Keep

Inverter location

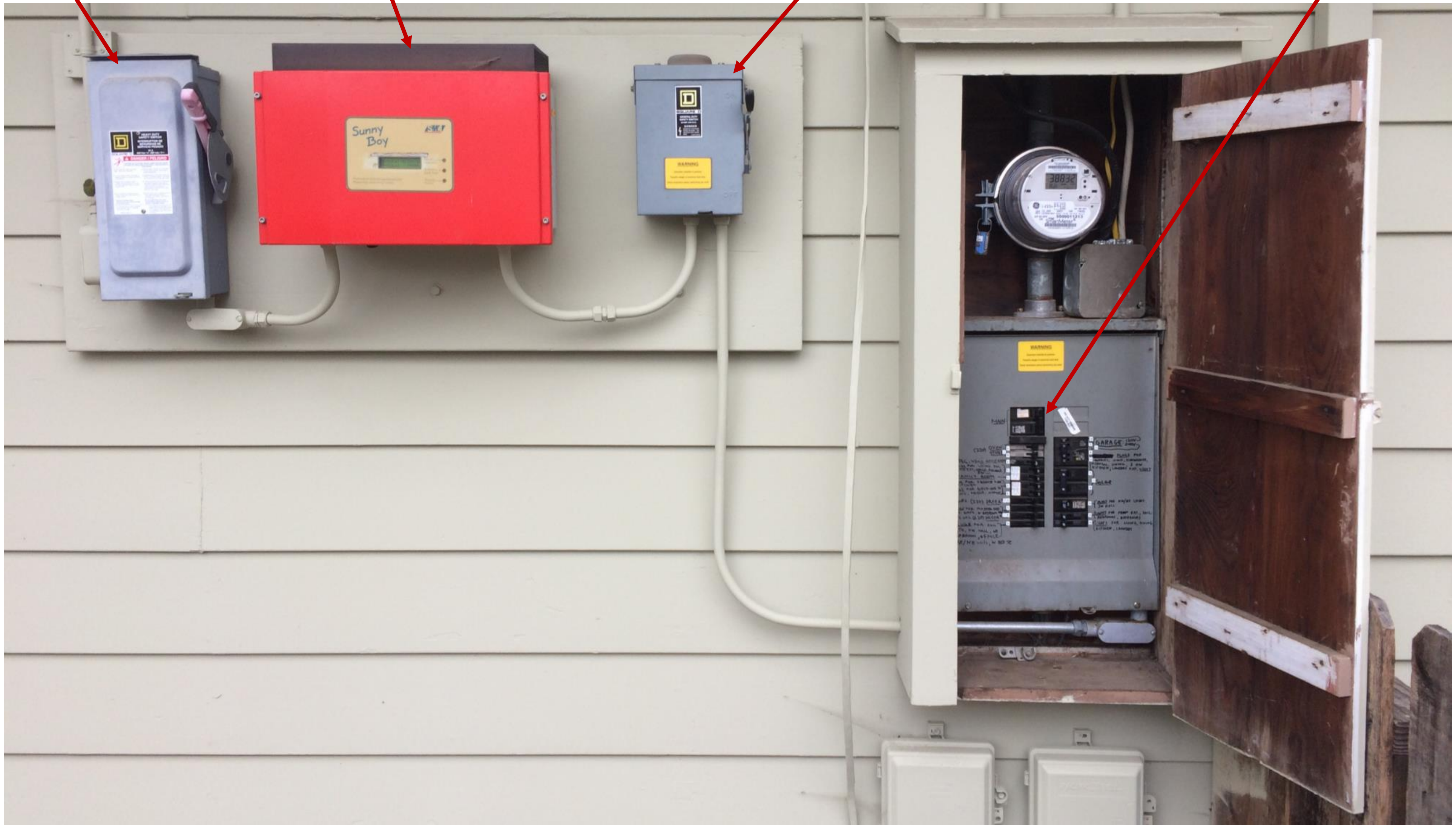
Current System

DC shutoff

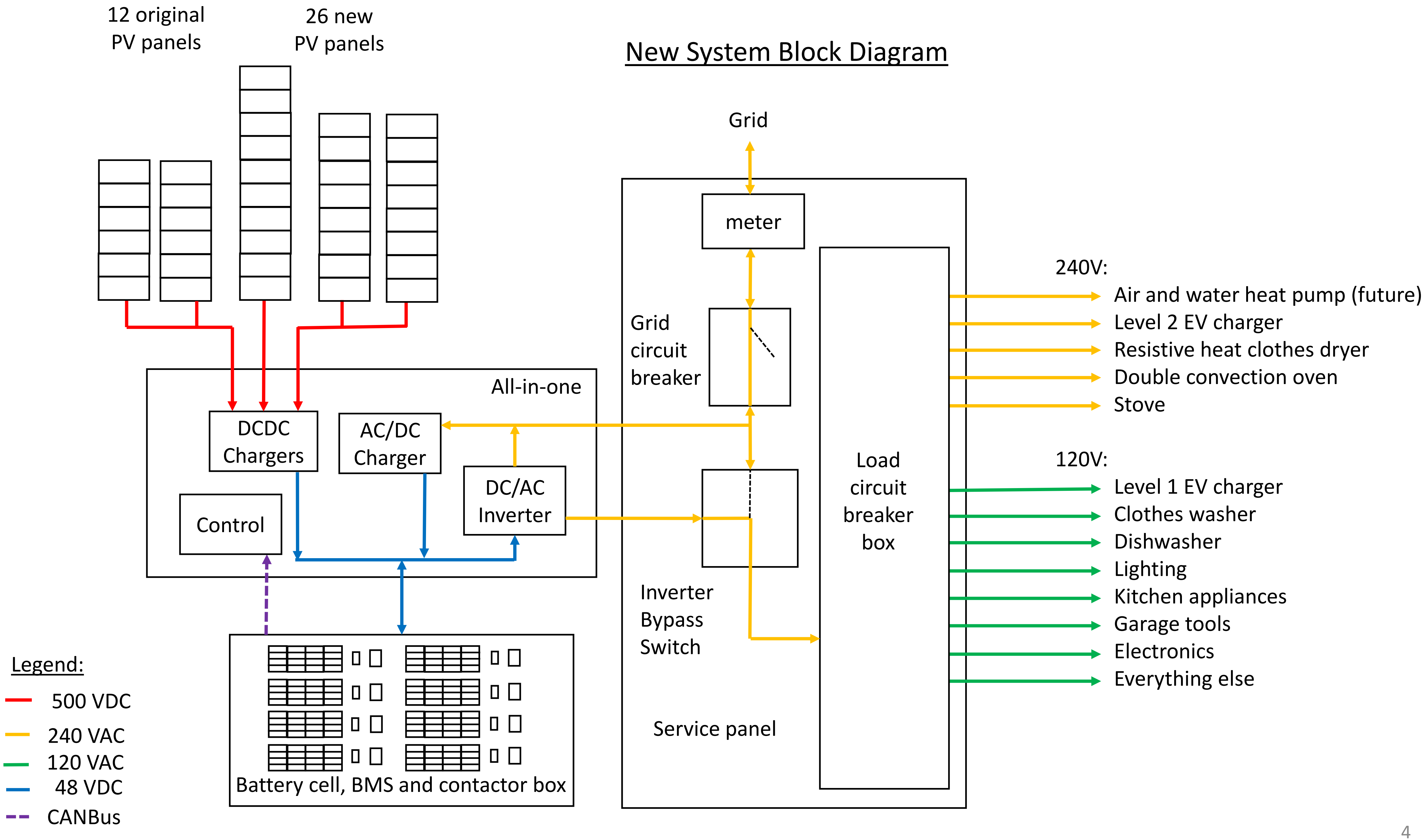
Upgrade
SMA Sunny Boy
2500W inverter

AC shutoff

Upgrade
90 amp
service panel



New System Block Diagram



Inverter Upgrade

Sol-Ark 15K-2P-N All-in-one: https://www.sol-ark.com/sol-ark-15k-all-in-one/

Lithium battery manager CANBus interface

Battery power interface:
- 48V nominal
- 275 amp max
- 50 to 9900 amp-hours

3 PV MPPT inputs:
- 500V open circuit max
- 26 amps max per MPPT
- 2 strings max per MPPT

31.8” high
18.3” wide
10.9” deep
135 lbs
Outdoor rated
Wall mount
WiFi connection
Designed and assembled in Texas

Grid interface

Load interface:
- 12 kW max continuous from batteries only
- 15 kW max continuous using grid

$8,295 through EcoDirect in Carlsbad, CA: more local distributor?
https://www.altestore.com/store/inverters/hybrid-inverters/sol-ark-hybrid-inverter-pre-wired-systems-p41381/#SOLARK15K

Additional PV Panels

Mission Solar MSE345SX5T 345 Watt Panels: https://www.missionsolar.com/wp-content/uploads/2022/03/C-SA2-MKTG-0025-Data-Sheet-for-SX5T.pdf

41V open circuit
11A short circuit current
69” high
42” wide
1.6” deep
45 lbs
25 year warranty to 84% capacity
Designed and assembled in Texas

$318 each from EcoDirect in Carlsbad, CA: more local distributor?
https://www.ecodirect.com/Mission-Solar-345-Watt-All-Black-Mono-Solar-Panel-p/mission-solar-mse345sx5t.htm

<u>Additional PV Panels</u>

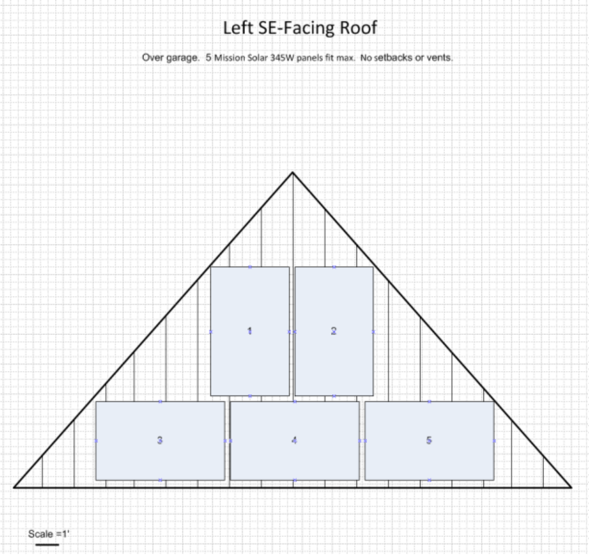
SE family room roof (not shown)

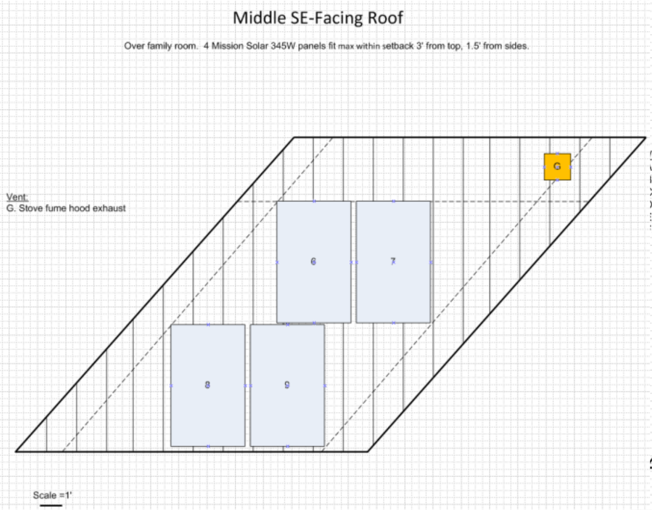
SE roof above bedrooms

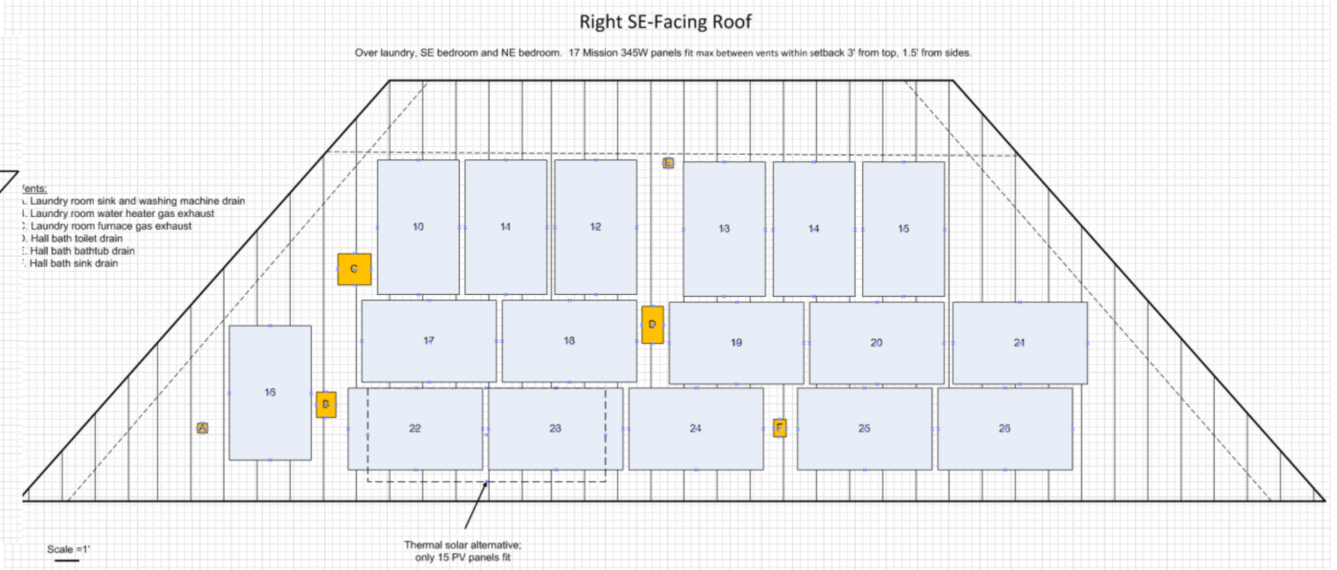
SE garage roof

Additional PV Panels

Up to 26 fit in mixed orientations x 345W = 8970W in to DC/DC battery charger.

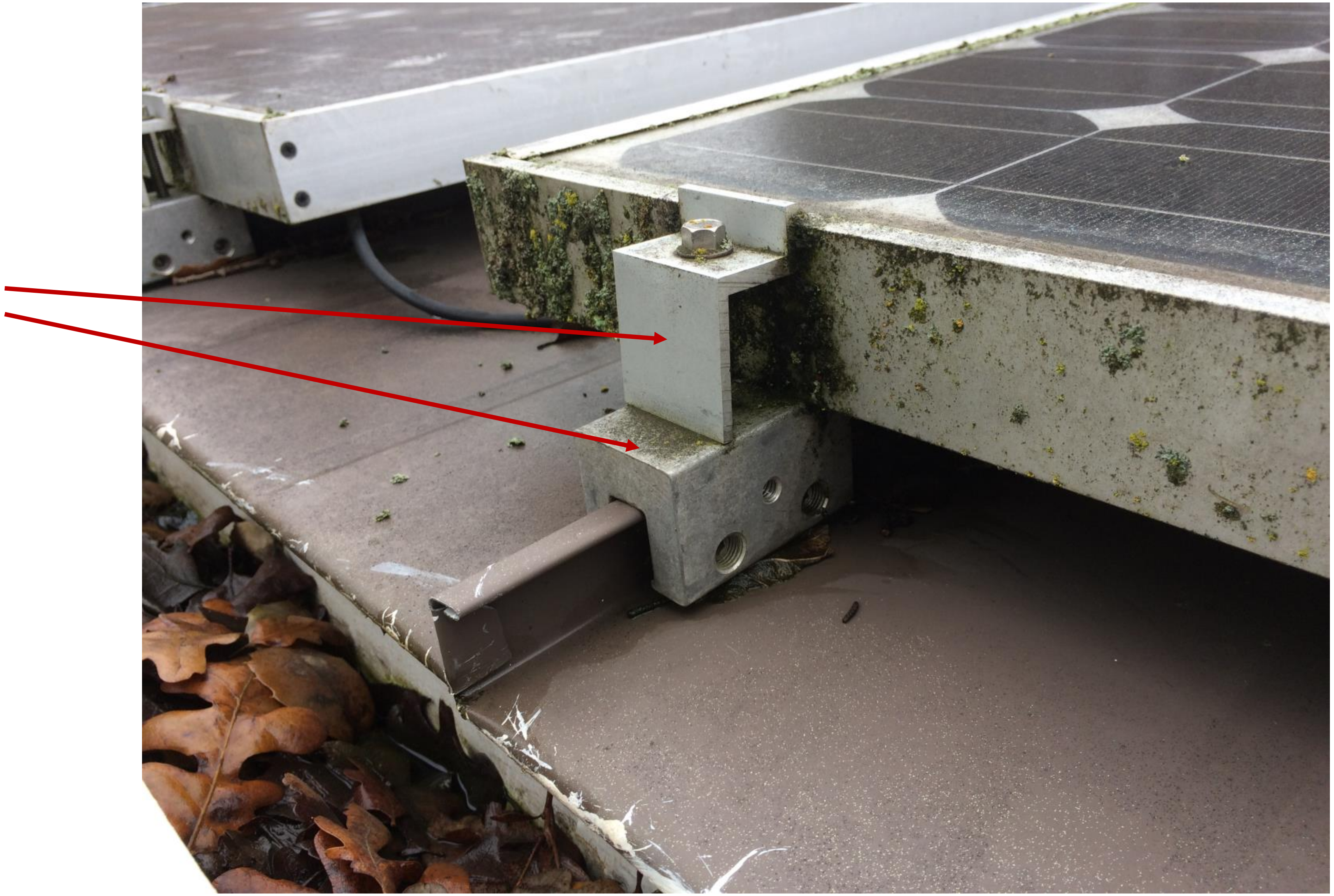






PV Roof Mount System

Standing seam metal roof installed ~2007, 1” high x ½” wide seam, 17.25” center-to-center
Current array on SW overhang with 2.5/12 pitch; SE side is 5/12
S5! S-5-S mounting system, 1” spacing on ends and between panels



New Battery Backup System

Up to 8 used 48V 100 amp hour LiFePO4 electric vehicle battery packs in parallel

4 Valence Ucharge XP Modules

16 HiPower Cells

New Battery Backup System

Insert Trevor's BMS info and connection to All-in-one here

Add battery box details:

- Foundation
- Underground conduit
- Shell
- Rack system

<u>New Battery Backup System</u>

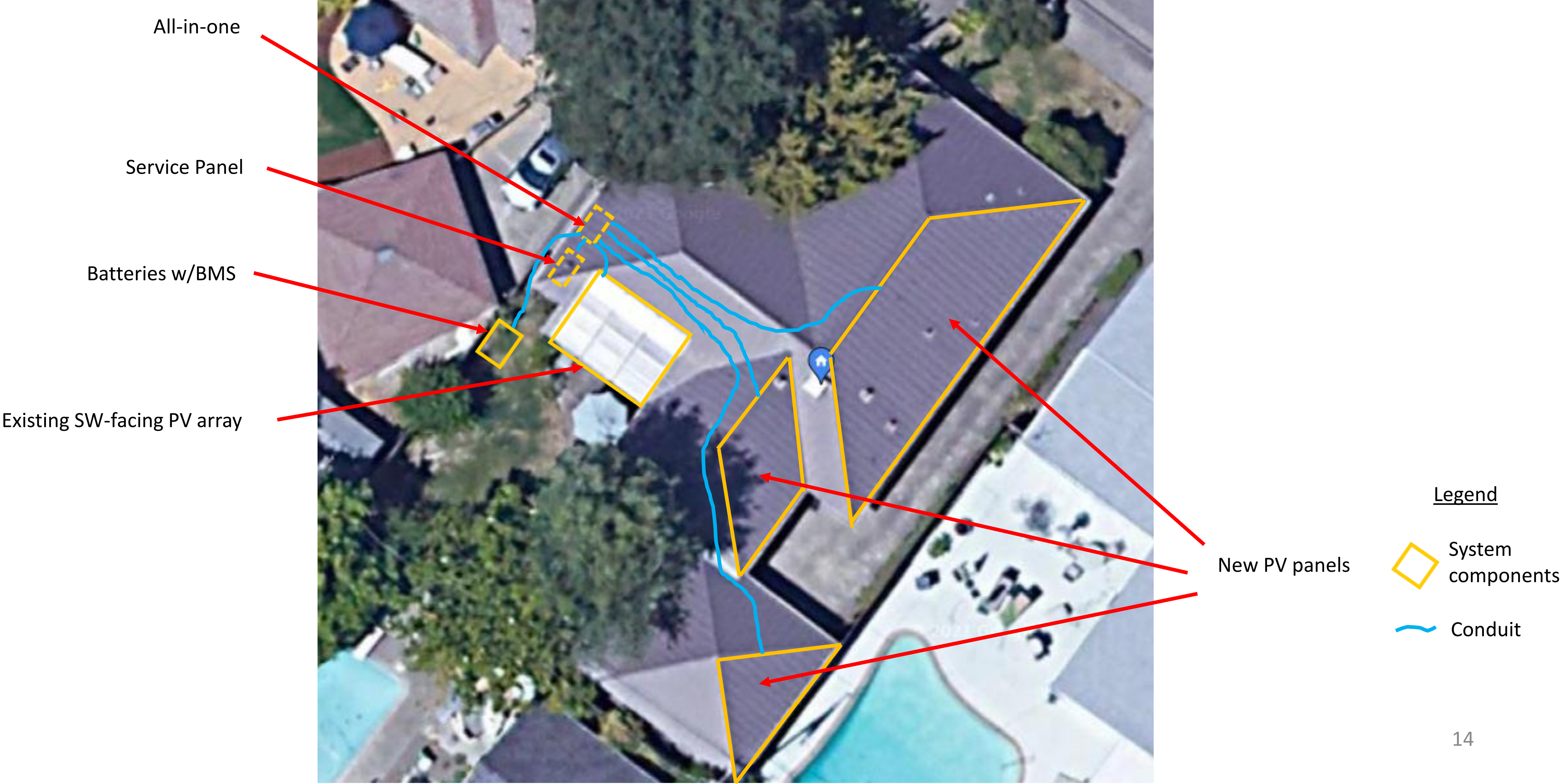
Service panel

Battery box location (rose bushes to be transplanted)

<u>New Battery Backup System</u>

Battery box mockup

Conduit


All-in-one
Service Panel
Batteries w/BMS
Existing SW-facing PV array
New PV panels
Legend
System components
Conduit

Conduit

TBD
- Which wires go in which conduit
- Junction boxes
- Layout

Service Panel Upgrade

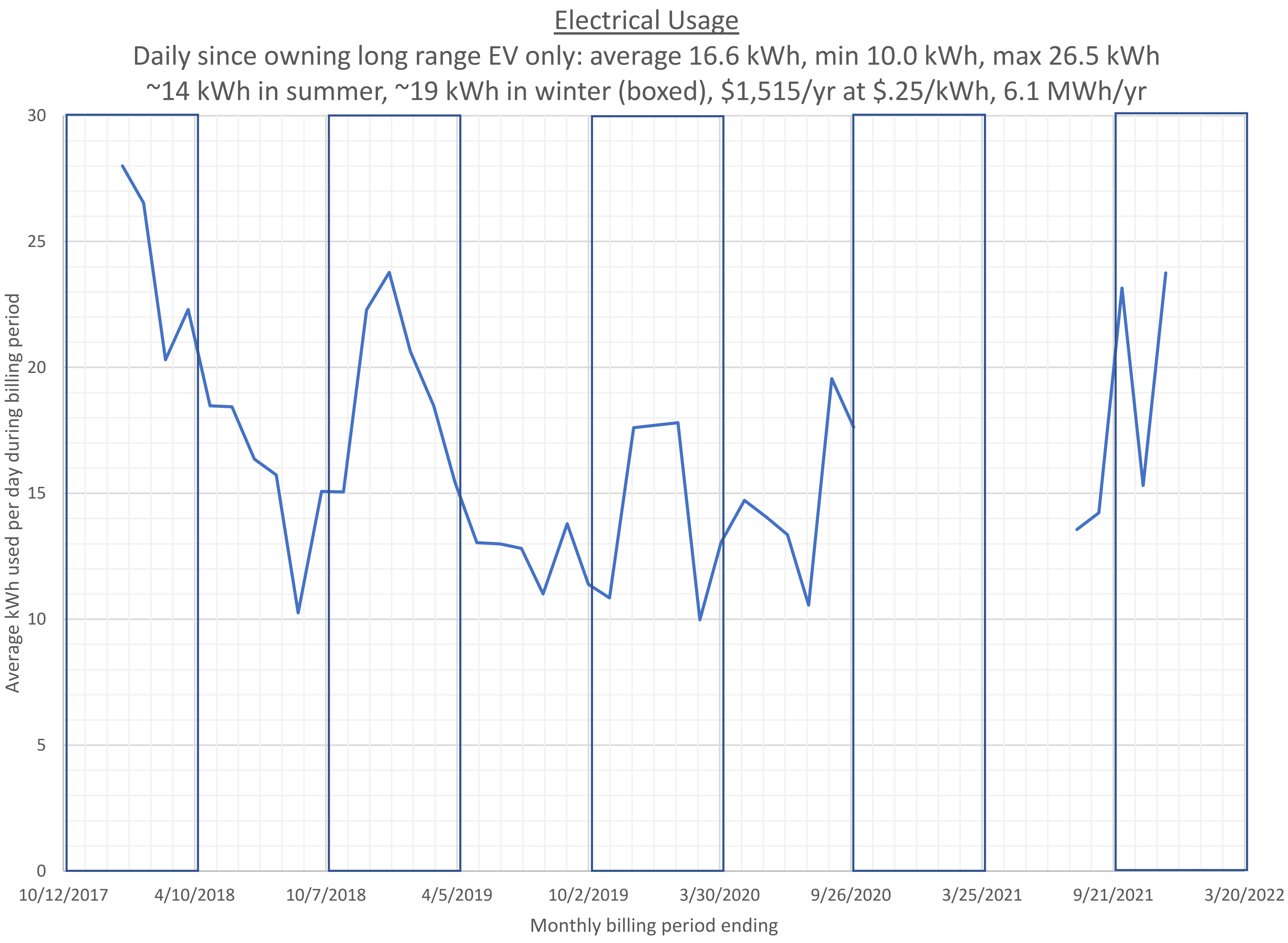
TBD
- Grid circuit breaker
- Bypass switch
- Load circuit breakers

Part List fill out

Item No.	Item	Make	Model	Supplier	Unit cost	Qty	Tax	Shipping	Subtotal
1	All-in-one	Sol-Ark	15K-2P-N	EcoDirect	$8,295	1			$8,295++
2	PV panels	Mission Solar	MSE345SX5T	EcoDirect	$318	26			$8,268++
3	Roof panel attachments	S5!	S-5-S						
4	Battery cells	Will start with 2 5 kWh packs I already own							$0
5	Battery management boards	THJ Media	BMS-1						
6	Battery box foundation, shell and underground conduit								
7	Battery box rack	Home made							
8	Power wiring								
9	Control wiring								
10	Above ground conduit								
11	Conduit junction boxes								
12	Grid circuit breaker, inverter bypass switch and load circuit breaker box								
Total									$16,563++

Appendix A – System Analysis

System Analysis



System Analysis

Local irradiation

According to NREL, our GHI (Global Horizontal Irradiation) = full sun hours equivalent per year = 1694, in Jan it is 65/31=2.1 hours per day and in May-July it is 225/31=7.3 hours per day. Annual average is 1694/365=4.6 hours per day. Multiply by net PV output to calculate energy produced in kWh per day.

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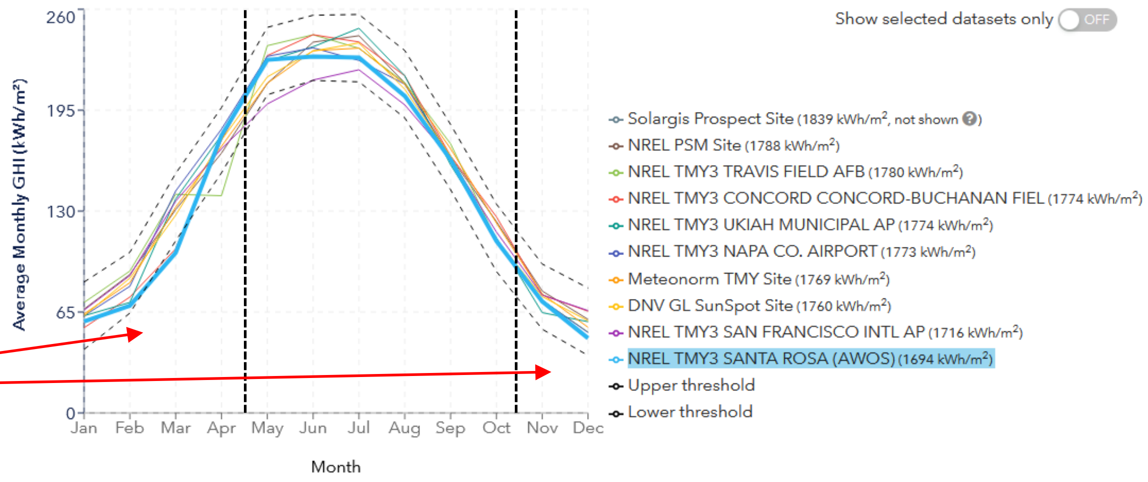
Solar Resource Compass | Credits: 29 Exp: 18 Jan 2022 CJ

Weather Analysis Irradiance **Soiling/Snow** Albedo Save Print

GHI Comparison

This chart provides a visual comparison of the reported long-term average GHI for each month from each source. DNV adds the threshold lines as one indication of monthly and seasonal consistency. You can roll over each month to review the individual values. You can also click on a dataset in the legend to highlight that result in the chart.



Furnace needed Nov-Apr;
April good for solar, Nov bad

Considering on-site solar data measurements? DNV's Measurements Team can quickly generate a proposal for turnkey installation, maintenance, cleaning and data monitoring.

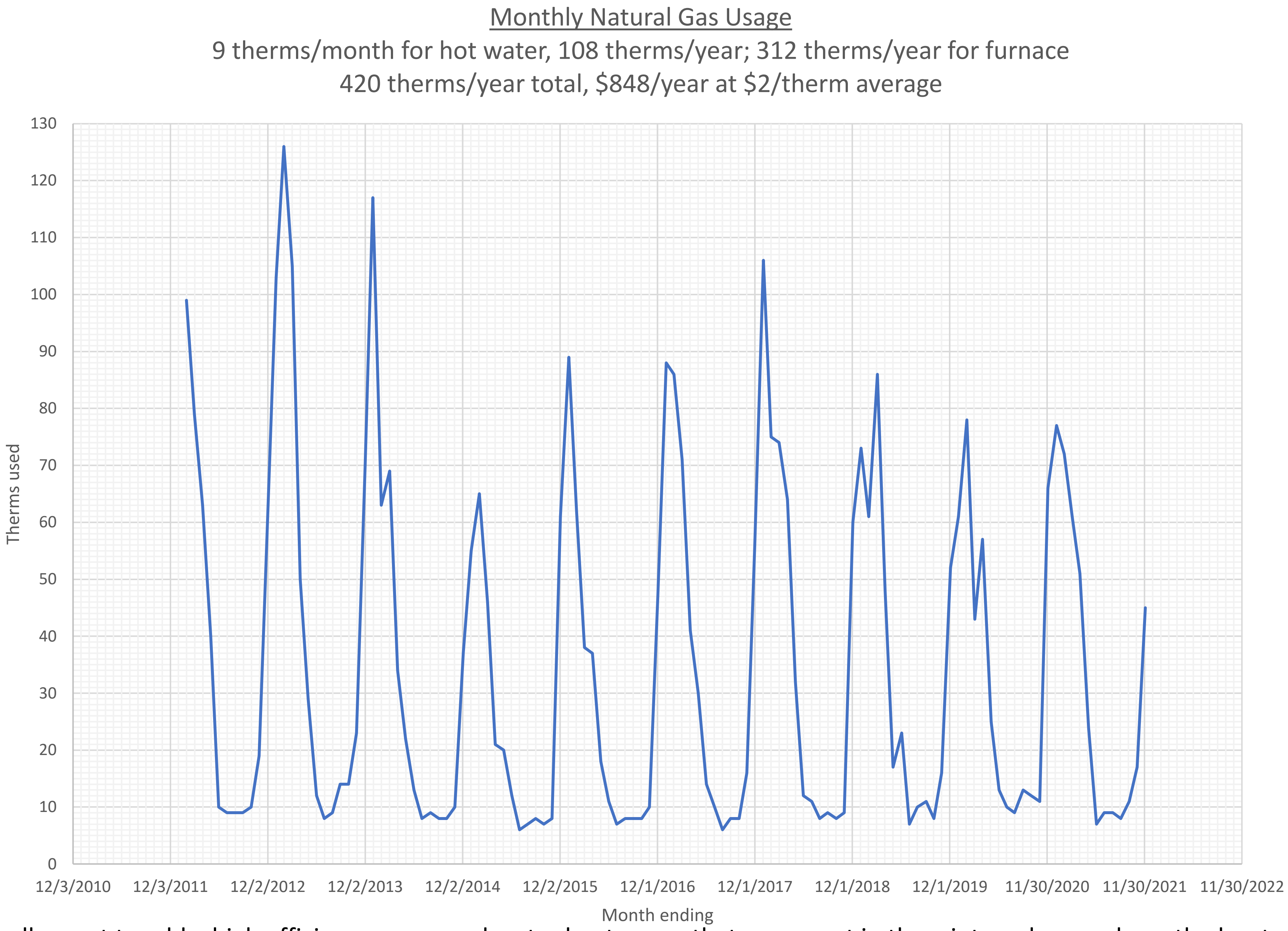
Summary Table

This table provides the monthly values for the currently selected dataset. You can select a new dataset by clicking the column headers above.

	NREL TMY3 SANTA ROSA (AWOS)			
	DHI (kWh/m²)	GHI (kWh/m²)	Temperature (°C)	Wind speed (m/s)
January	33.7	58.9	8.4	1.5
February	36.2	69.1	10.7	1.9
March	48.5	103.2	10.9	2.7
April	61.4	178.7	13.2	2.5
May	69.4	227.4	16.1	2.6
June	68.8	229.6	18.2	2.9
July	69.1	228.8	17.1	2.5
August	62.6	204.1	18.6	2.2
September	50.1	163.2	18.3	1.9
October	42.3	110.8	13.7	2.1
November	29.7	71.8	10.3	1.8
December	26.3	48.1	8.9	1.9
Annual	598.0	1693.7	13.7	2.2

8 kW PVs x 4.6 average full sun hours per day should generate 37 kWh/day average. With enough battery backup to store it for overnight use we would have >2x our current average need.

System Analysis



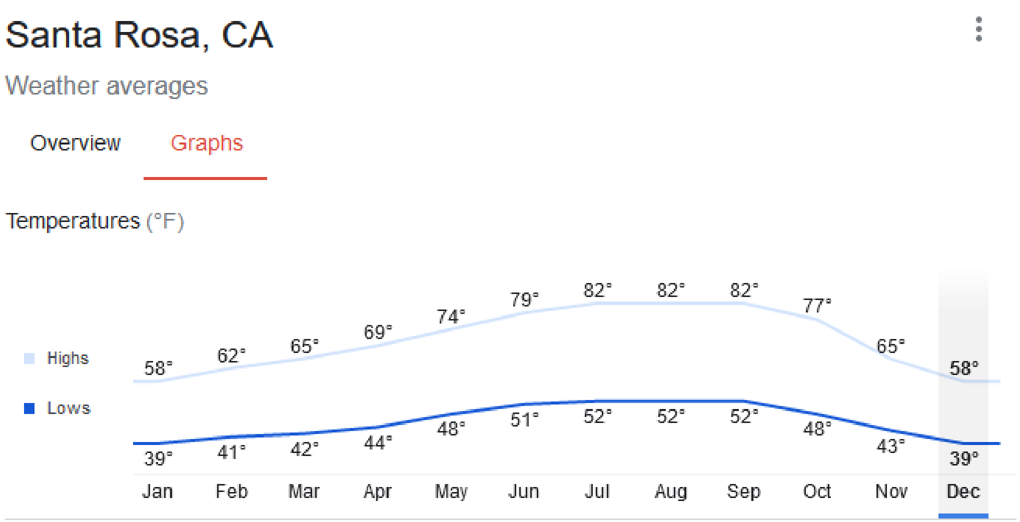
But we eventually want to add a high efficiency space and water heat pump that uses most in the winter when we have the least sun, so we need to know the added load and upsize accordingly, possibly curtailing any solar we can't sell back to the grid in the summer.

System Analysis

Added heat pump load estimate

We consume an average of 420 therms or 12,306 kWh/year of natural gas for space and water heat. We generally run our heater Nov-Apr where the lows are 39 to 44 F on average, vs. 48 to 52F for the rest of the year. Based on Chiltrix data it looks like COP will be around 2.6 for 122 degree domestic hot water which is assumed to be what will be used for the furnace, so we will need about 4,733 kWh per year, and our energy bills without solar would be about $346 more per year or about $1 per day, not a high price to pay to enable renewably powered heating, only ~1/4 of a Venti latte at Starbucks.

Average temps according to Google:



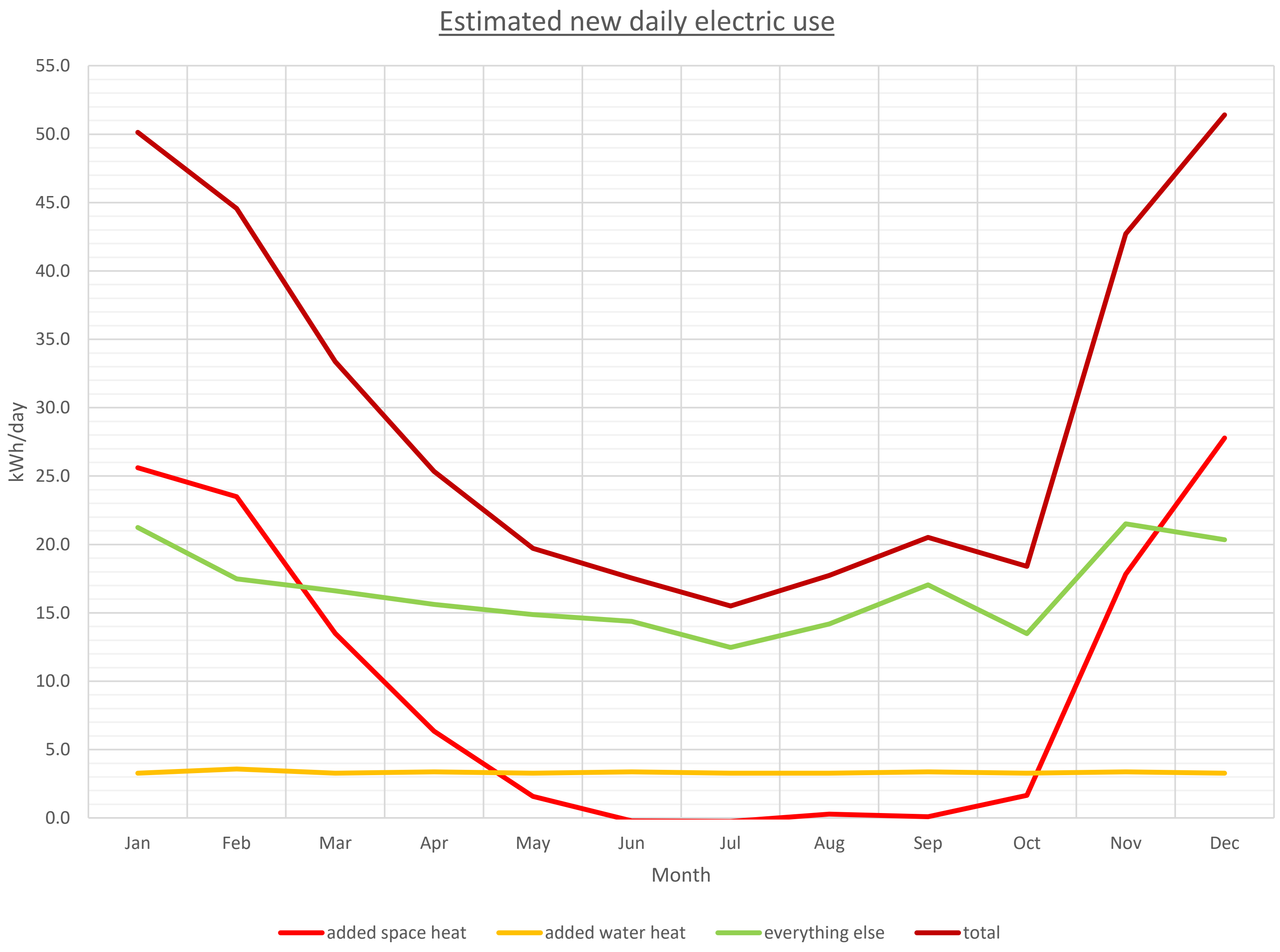
Heat pump COP according to manufacturer:

CX34 Fluid Outlet		Outdoor Air Temperature dB °F (wB)								
LWT °F		-4	5	17(15)	23	32	47(43)	59	68	77
86	Capacity (BTU)	15,968	18,561	22,371	25,556	29,719	35,178	43,332	48,689	53,568
	Power Input (kW)	2.03	2.10	2.22	2.29	2.37	2.50	2.60	2.73	2.86
	COP	2.31	2.59	2.95	3.27	3.67	4.12	4.89	5.23	5.49
95	Capacity (BTU)	14,365	16,992	20,575	24,396	28,660	33,813	41,661	46,779	51,456
	Power Input (kW)	2.14	2.19	2.27	2.37	2.45	2.53	2.63	2.75	2.89
	COP	1.97	2.27	2.66	3.02	3.43	3.92	4.65	4.98	5.22
104	Capacity (BTU)	13,375	15,559	18,891	22,622	26,818	31,868	39,272	44,151	48,553
	Power Input (kW)	2.14	2.17	2.26	2.40	2.53	2.65	2.74	2.88	3.01
	COP	1.83	2.12	2.45	2.76	3.11	3.53	4.20	4.49	4.72
113	Capacity (BTU)	12,147	14,126	17,178	20,847	24,942	29,889	36,815	41,388	45,516
	Power Input (kW)	2.14	2.17	2.25	2.45	2.63	2.80	2.90	3.05	3.19
	COP	1.66	1.91	2.23	2.49	2.78	3.13	3.72	3.98	4.18
122	Capacity (BTU)		12,727	15,494	19,073	23,099	27,944	34,427	38,692	42,548
	Power Input (kW)		2.14	2.23	2.51	2.75	2.99	3.10	3.25	3.41
	COP		1.74	2.03	2.23	2.46	2.74	3.26	3.49	3.66
131	Capacity (BTU)			14,091	17,367	21,018	25,419	31,322	35,178	38,692
	Power Input (kW)			2.26	2.53	2.79	3.82	3.13	3.28	3.44
	COP			1.82	2.01	2.21	2.47	2.93	3.14	3.30

Ratings per AHRI 550/590. All values assume (sea level) 0 Ft. altitude. Defrost correction below.

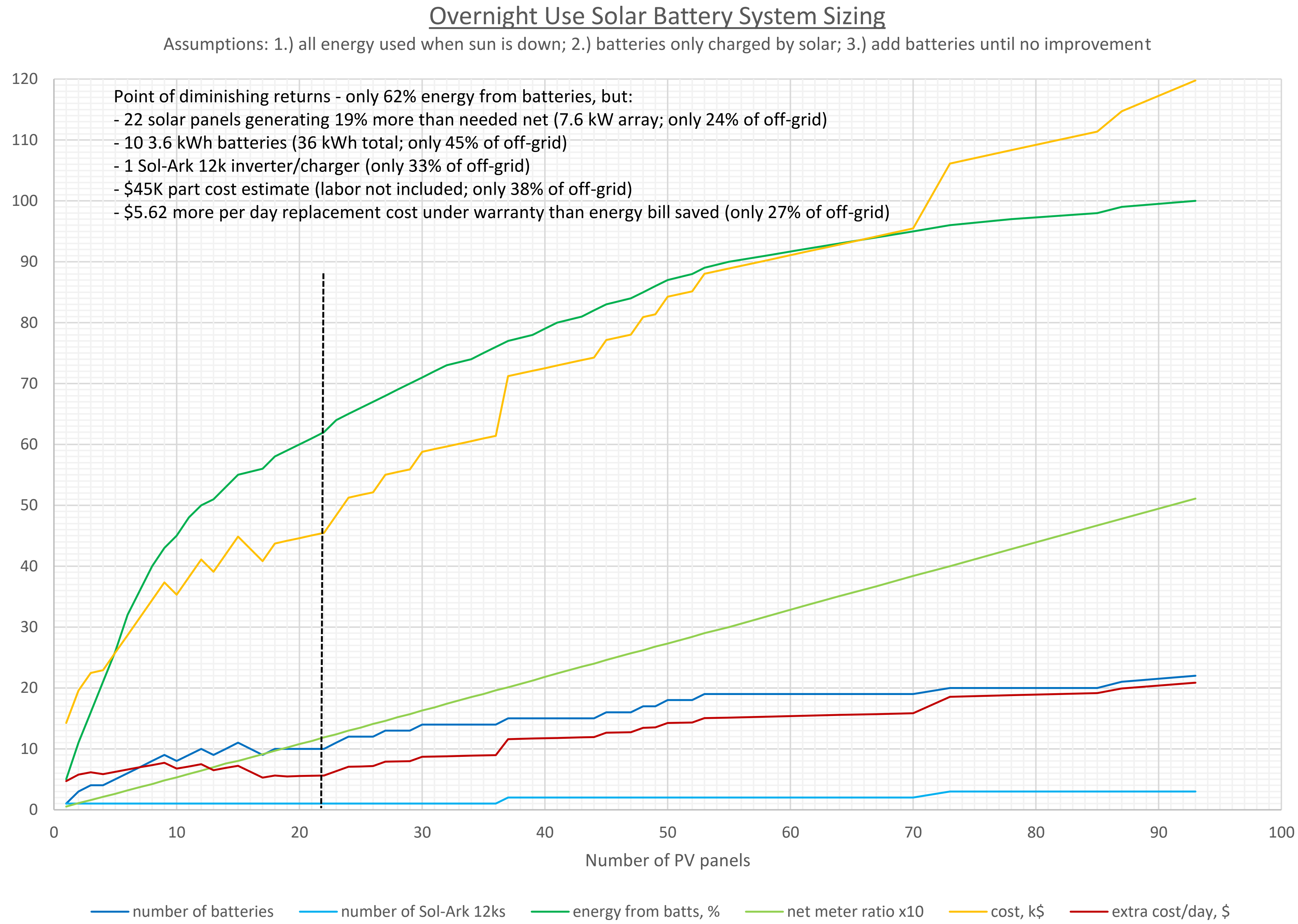
	Outdoor air wet bulb temperature °C									
	-15	-10	-5	0	6	10	15	18	20	25
Correction factor	0.81	0.86	0.9	0.95	1	1	1	1	1	1

System Analysis



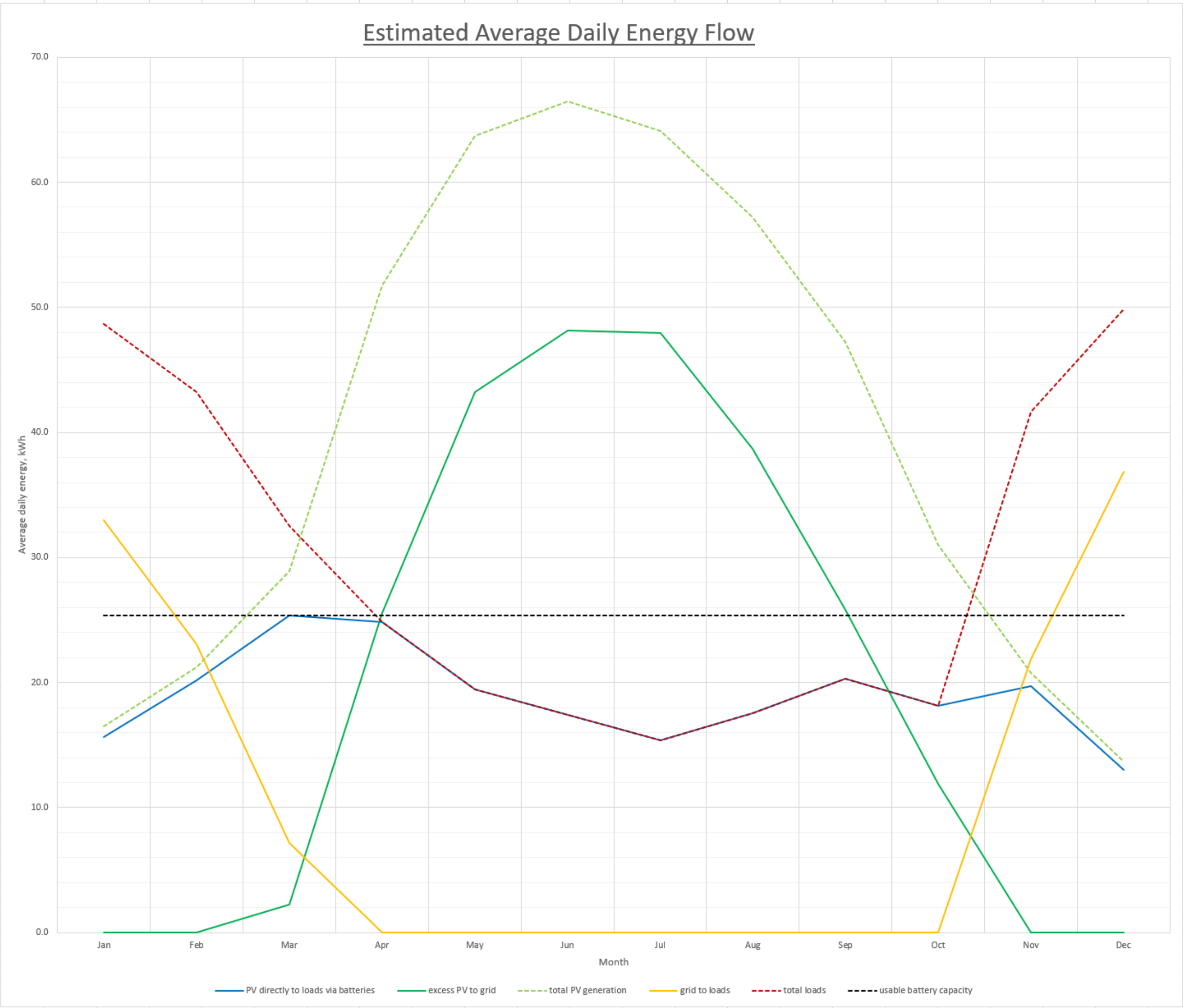
Thus future needs will rise once we add a high efficiency heat pump.

System Analysis



It's hard to go completely off grid. We will target an eventual size of 8 kW generation with 40 kWh production to get about 69% off grid at about ¼ the cost of getting 99% off the grid.

System Analysis



Inputs		
Number of 400W panels	25	
Number of 3.6 kWh batteries	11	
Outputs		
Annual load, kWh	10,599	
PV power, kW	8.7	
Battery pack energy nameplate, kWh	39.6	
Battery pack energy usable, kWh	25.3	64%
Energy from batteries	65%	
Energy from grid	35%	
Net meter	135%	
Part cost	$49,250	
Extra cost per day	$6.44	

Estimated future system performance.