Carl Querfurth 7/14/23

Living Off-Grid with EVs

Balancing loads with priorities

We began with a 2012 Nissan Leaf and 16 FLA batteries.

- For 5 years we had approximately 5kW of PV and 740Ah of house batteries to work with.
- The car had 4 times the energy storage of the house. The propane generator ran often through the winter. We never charged the car at home.

2012 Nissan Leaf
In Japan the 2012 Leaf had an optional bidirectional power system

16 Trojan FLA Batteries (370Ah) 48 volt system

Growth and the unknowns of “new” technology

Aquion aqueous salt water batteries

- In 2017 we built an addition and needed more PV and battery power. We wanted to find a less toxic battery than Lead Acid or Lithium and discovered Aquion, a company founded in 2014 making Salt Water Aquious batteries.
- We added 10 Aquion 48S 2.2kWh batteries along with our original 16 FLA 370Ah batteries. We also added 22 PV panels and maintained two separate power distribution panels with a series of switches to keep the system flexible. When our lead acid batteries began to fail we decided to replace them with more Aquions. We learned that Aquion had gone out of business. At the time we felt the Aquions were performing well but were just suited for the general market, so we searched and found a small stock pile in Canada. We bought 14 more. 24 total, increasing our capacity to about 48kWh. (24 useable)

24 Aquion 2.2kWh batteries (48kWh)
2 separate systems for ease in modification

Add the Tesla Model 3 to the mix

In 2019 we replaced our 2004 Prius with the Tesla

- Our 2004 Prius was dying and we felt we needed an All Wheel Drive vehicle due to NH snow and our 1/2 mile uphill driveway. At that time Tesla Model 3 was the only viable AWD EV on the market. At this point in time there was only one public charging station within 20 miles of us. It was 7kW, i.e. fairly slow. The nearest Supercharger was/is 35 miles away. We spent a lot of time calculating, mapping and driving to charge stations…

Our two EVs charging at a public 7kW charger

2020 we add the Electric Tractor

Solectrac 25G joins the scene

- Using 3 EVs with only PV and 48kWh of batteries created lots of juggling situations. We constantly had to keep an eye on what had power and what needed it. From laundry to travel needs we tried to keep it all ready.
- We had 118kWh of batteries in our vehicles and only 48kWh in the house. We needed a way to share the power.

2012 Nissan Leaf (23kW), Solectrac 25G(23kW), Tesla Model 3 (72kW)

Bring in the new, recycling the old.

Sending the Salt water batteries off to Battery Recyclers of America

- The Aquion batteries began to fail in the winter of 2022. The decline was fast and needed to be addressed. We decided on Fortress eVault Max 18.5kWh LiFePo batteries. We started with 3 and then added 3 more. 6 X 18.5 = 111kWh total. They claim potentially 6,000 cycles (at 80/20 SoC) and a 15 year life expectancy.

- To dispose of the salt water batteries we found Battery Recyclers of America. At first they quoted us a fee of $1/pound ($6,000) to take the batteries away. After a few phone calls, they did some research and changed the offer to paying us 10¢/pound and they covered the shipping. So, we got a check for $600. They base their prices on recyclability and value of materials. They had a hard time figuring out the salt water batteries. The business was established in 2009.

48 Aquion batteries ready for pickup

First three eVaults sharing the load with the Aquions

Finally 6 Fortress eVault Max 18.5kWh batteries (110 kWh) Aquions gone.

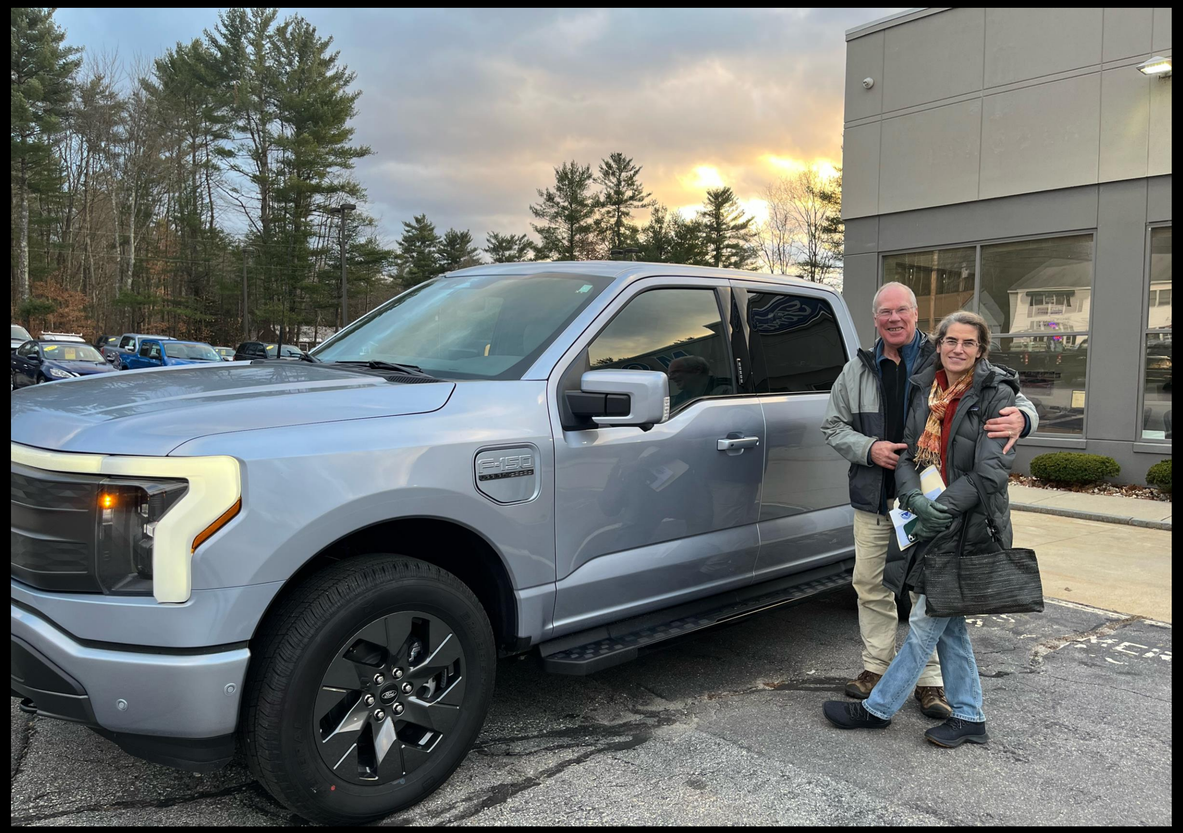
Bi-Directional Thoughts

- It is frustrating when the house batteries are depleting while the car sits in the garage full.
- We had read back in 2012 that Nissan of Japan was installing a bi-directional charging system in the Japanese market but they never introduced it in the US.
- We spoke with the Canadian company dc bel about their bi-directional charging station but they don’t offer an off-grid option.
- We had read the literature on the F150’s potential power sharing. We called SunRun and leaned their set up was not available for off-grid sites.

The F150 Lightning added December 2022

We lucked into an orphaned F150

- The bidirectional power of the F150 made the choice easy for us. It provides a maximum 9.6kW at 240v and/or 2.4kW at 120v (for reference; our house inverters provide 6.8kW each). The main battery pack stores approximately 92kWh. There are currently two ways to use the F150 as backup power.
- 1.) Pay $3-5k for a wall unit from SunRun that will oversee the power of the house and truck and act as transfer switch in the event of power failure. (Not available for off-grid)
- 2.) Use the 240v outlet in the truck bed and connect it to a transfer switch and use it as you would any back up generator. Our option!
- Now we have 110kWh in the house and 185kWh in the vehicles of which we can bi-directionally access the 92kWh of the F150.

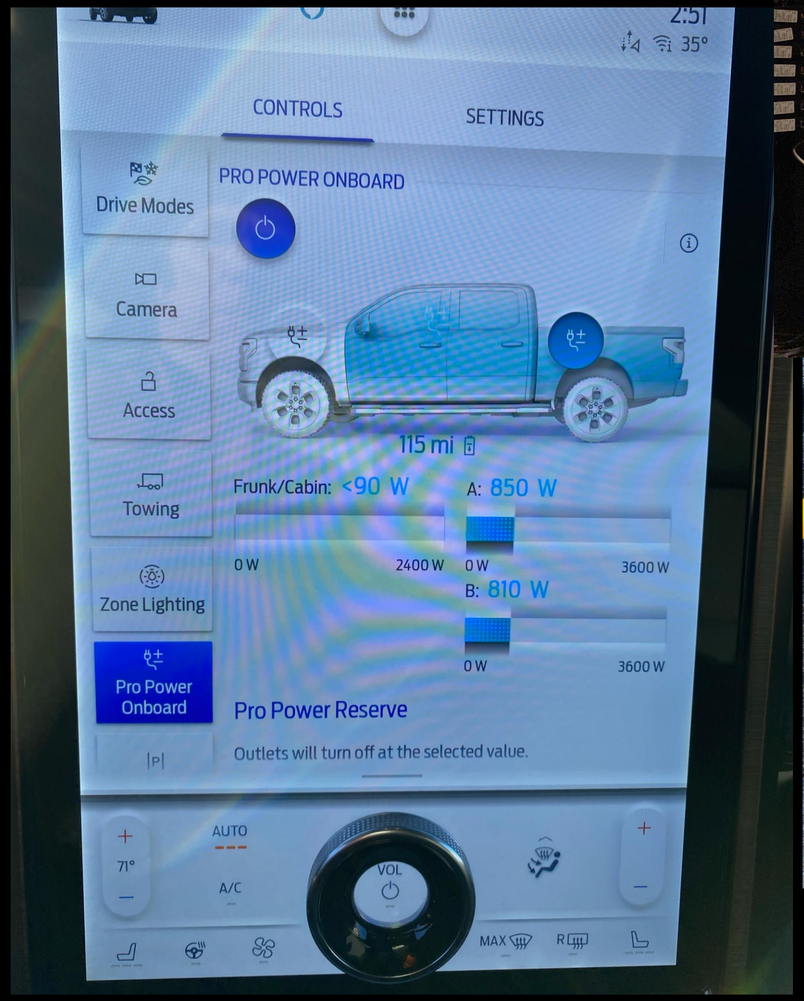


92kWh of battery with potential tp power the house

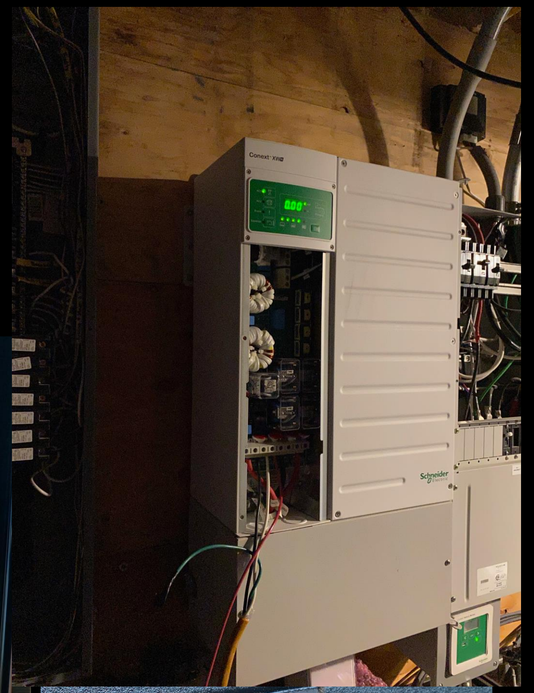
Bidirectional power

Using our F150 to power the house

- Our first step was to test to see if it would work. We ran an extension cord out of the 240v outlet in the truck bed to the AC1 input of our Schneider XW+ inverter, turned it on and bingo, the truck was powering the house. We learned that the AC1 input was intended for grid power which is much more stable than the F150's 240v output.
- This system will ultimately be wired to the AC2 where the generator normally comes in and will be connected to a transfer switch in the garage. We'll be able to choose between the F150 and the generator as back-up power sources. We're scheduled for our electrician to make the connections.



F150 Control Screen



F150 has 9.6kW of power available through the 240v outlet in the bed.

Ford/SunRun integrated charging system

Charging your truck and powering your house

- Ford/Sunrun
- YouTube advertisement

Battery Comparison

FLA v. Salt Water v. LiFePo

Trojan BATTERY COMPANY

L16RE-B DATA SHEET

MODEL: L16RE-B with Bayonet Cap
DIMENSIONS: inches (mm)
BATTERY: Flooded/wet lead-acid battery
COLOR: Maroon (case/cover)
MATERIAL: Polypropylene

RE SERIES

PRODUCT SPECIFICATION WITH T2 TECHNOLOGY™

BCI GROUP SIZE	TYPE	CAPACITY [A] Amp-Hours (AH)			ENERGY (kWh)	TERMINAL Type	DIMENSIONS [B] Inches (mm)			WEIGHT lbs. (kg)
		5-Hr Rate	20-Hr Rate	100-Hr Rate	100-Hr Rate		Length	Width	Height [C]	
6 VOLT DEEP CYCLE BATTERY										
903	L16RE-B*	303	370	410	2.46	5	11-5/8 (295)	7 (178)	17-11/16 (450)	118 (54)

A. The amount of amp-hours (AH) a battery can deliver when discharged at a constant rate at 80°F (27°C) for the 20-Hour and 100-Hour rates and 86°F (30°C) for the 5-Hour rate and maintain a voltage above 1.75 V/cell. Capacities are based on nominal performance.
B. Dimensions are based on nominal size. Dimensions may vary depending on type of handle or terminal.
C. Dimensions taken from bottom of the battery to the highest point on the battery. Heights may vary depending on type of terminal.
Trojan's battery testing procedures adhere to both BCI and IEC test standards.

CHARGING INSTRUCTIONS

CHARGER VOLTAGE SETTINGS (AT 77°F/25°C)

System Voltage	6V	12V	24V	36V	48V
Daily Charge	7.2 – 7.35	14.4 – 14.7	28.8 – 29.4	43.2 – 44.1	57.6 – 58.8
Float	6.60	13.2	26.4	39.6	52.8
Equalize	7.75	15.5	31.0	46.5	62.0

Do not install or charge batteries in a sealed or non-ventilated compartment. Constant under or overcharging will damage the battery and shorten its life as with any battery.

TERMINAL CONFIGURATIONS

S	LT	L-Terminal
		Terminal Height Inches (mm) 1-3/4 (43) *Torque Values Lb-IN (Nm)* 100 – 120 (11 – 14) *Through-hole Diameter (mm)* 3/8 (10)

* Polypro™ Case

CHARGING TEMPERATURE COMPENSATION

.028 VPC for every 10°F (5.55°C) above or below 77°F (25°C) (add .028 VPC for every 10°F (5.55°C) below 77°F and subtract .028 VPC for every 10°C above 77°F).

OPERATIONAL DATA

Operating Temperature	Self-discharge
-4°F to 113°F (-20°C to +45°C). At temperatures below 32°F (0°C) maintain a state of charge greater than 60%.	5 – 15% per month depending on storage temperature conditions.

TSEL-L16RE-B-DS-0111

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Aspen 48S-2.2 Battery

AQUION ENERGY

PRODUCT SPECIFICATION SHEET

Aquion Energy's Aspen 48S-2.2 battery is a modular building block for clean energy storage systems. Based on Aquion's safe, clean, and sustainable Aqueous Hybrid Ion (AHI™) technology, the Aspen 48S-2.2 is engineered to meet Cradle to Cradle certification standards. Designed for years of hassle-free operation in stationary, long-duration applications, AHI batteries are optimized for storing energy for residential, off-grid, and microgrid applications. The Aspen 48S-2.2 delivers an unmatched combination of performance, safety, and environmental sustainability in a cost-effective battery platform.

PRODUCT PERFORMANCE

Testing performed at 30°C

Embodied Energy (Wh)		Charge Current (A)				
		2	4	6	8	10
Discharge Current (A)	2	2,358	2,204	1,963	1,725	1,478
	4	2,209	1,993	1,839	1,617	1,387
	6	2,081	1,879	1,674	1,491	1,294
	8	1,961	1,788	1,600	1,430	1,246
	10	1,858	1,695	1,525	1,368	1,197

Embodied Capacity (Ah)		Charge Current (A)				
		2	4	6	8	10
Discharge Current (A)	2	47.8	44.0	39.4	35.4	31.0
	4	45.8	41.9	37.5	33.7	29.5
	6	44.7	40.7	36.4	32.7	28.6
	8	43.0	39.5	35.3	31.7	27.7
	10	41.3	38.2	34.2	30.6	26.8

OPERATION & PERFORMANCE

Nominal Energy (10-hour charge/20-hour discharge)	2.2 kWh
Nominal Voltage	48 V
Cycle Life	3,000 cycles (to 70% retained capacity)
Ambient Operating Temperature	-5°C to 40°C
Voltage Range	40.0 to 59.5 V
Peak Power	1.0 kW
Continuous Current	20 A
Usable Depth of Discharge	100%

WARRANTY

Limited Warranty	8 years: 5 years full + 3 years prorated

PHYSICAL CHARACTERISTICS

Height	935 mm (36.8")
Width	330 mm (13.0")
Depth	310 mm (12.2")
Weight	118 kg (260 lbs)

CERTIFICATIONS

Sustainability	Cradle to Cradle Certified™ Bronze product
UL	UL recognized
CE	CE marked
Shipping Testing	Modified ISTA 3H
IP Rating	IP22

Performance characteristics based on testing conducted by Aquion Energy. Performance may vary depending on use, conditions, and application. For the most up-to-date specification, visit http://aquionenergy.com.

 AQ-SP-00035_A

FORTRESS *Power*

eVault Max 18.5 Lithium Battery Storage

EVAULT MAX 18.5 LITHIUM BATTERY STORAGE

The newest innovative Lithium Iron Phosphate battery from Fortress Power is the eVault Max 18.5 kWh. An all-in-one solution for your residential and commercial needs. Scalable up to 370kWh with a serviceable top cover access to make installation of this battery simple and worry free. The eVault Max is AC/DC coupled to solar arrays and works for many applications that require solar storage, including Off-Grid, Back Up power, self-supply and Peak Charge Reduction just to name a few.

The eVault Max 18.5 is The Largest Single Residential Battery On The Market!

- **Safe Lithium Iron Phosphate Technology (LiFePO4)**
- **High Durability and Long-Lasting**
- **Closed Loop Communication with Inverters**
- **Scalable from 18.5 kWh - 370 kWh**
- **Intelligent Digital Processor Based BMS**
- **Advanced cell level monitoring and balancing**
- **IP55 Aluminum Industrial Grade Enclosure**
- **Touch screen LCD performance display**

Electrical Specifications	
Nominal Voltage	51.2V
Nominal Capacity	360AH
Rated Capacity @ 0.5C (180A)	18.43 kWh
Resistance	<10 mΩ
Communication Protocol	CAN/RS485
Efficiency (at 0.5C)	98%
Self-Discharge	<1 % / Month
Maximum Allowed Modules in Parallel	20

Mechanical Specifications	
Dimensions: (L*W*H)	20.3" x 20.3" x 42.2" (515 x 515 x 1073mm)
Weight	520 lbs (235.87 kg)
Terminal Type	M10
Ring Terminal Size	1/2" or larger
Terminal Torque	7.0 - 7.7 Nm (5.1 - 5.7 ft - lb)
Case Material	Industrial Grade Aluminum
Enclosure Protection	IP55
Cell Type Chemistry	Prismatic - $LiFePO_4$

Charge Specifications	
Recommended Charge Current	150A
Maximum Charge Current	180A
Recommended Charge Voltage	54.4V
BMS Charge Voltage Disconnect	>56V

Compliance Specifications:	
Certifications	UL1642, UL1973, UL9540
Shipping Classification	UN 38.3. UN 3480, Class 9

Discharge Specifications	
Recommended Continuous Discharge Rate	150A (7.6 KW)
Peak Continuous Discharge Rate	180A (9.2 KW)
Maximum Surge Power Rate	200A (10.2kW 10S)
Recommended Low Voltage Disconnect	48V
Battery Low Voltage Protection	<46V
Battery Recovery Voltage	47V

Basic Charging Profile	
Bulk + Absorb Charge	54.4V
Absorb Time	60 Minutes
Float Charge	54V
Inverter Charging	2 Stage / No Float
Equalization	No equalization (typical) 54.6V for 10 seconds (rare)
Temperature Compensation	None

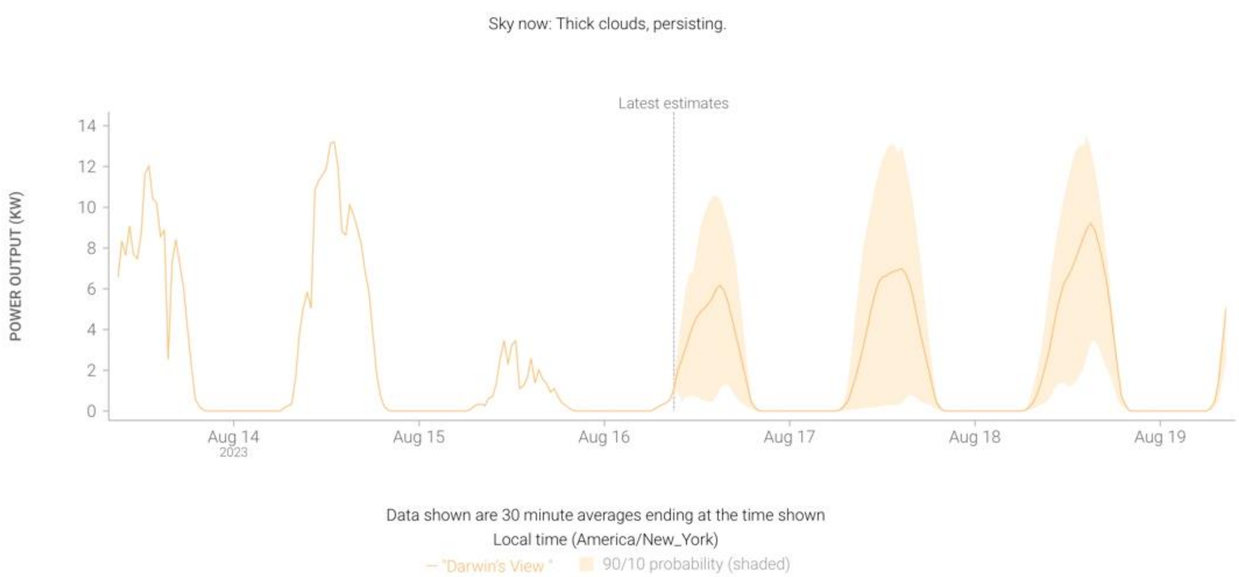
Temperature Specifications		
Discharge Temperature	-4°F~140°F (-20°C ~ 60°C)	
Charge Temperature	32°F ~ 120°F (0°C ~ 49°C)	
Storage Temperature	6 months: 14°F ~ 77°F (-10°C ~ 25°C) 3 months: -4°F ~ 113°F (-20°C ~ 45°C)	

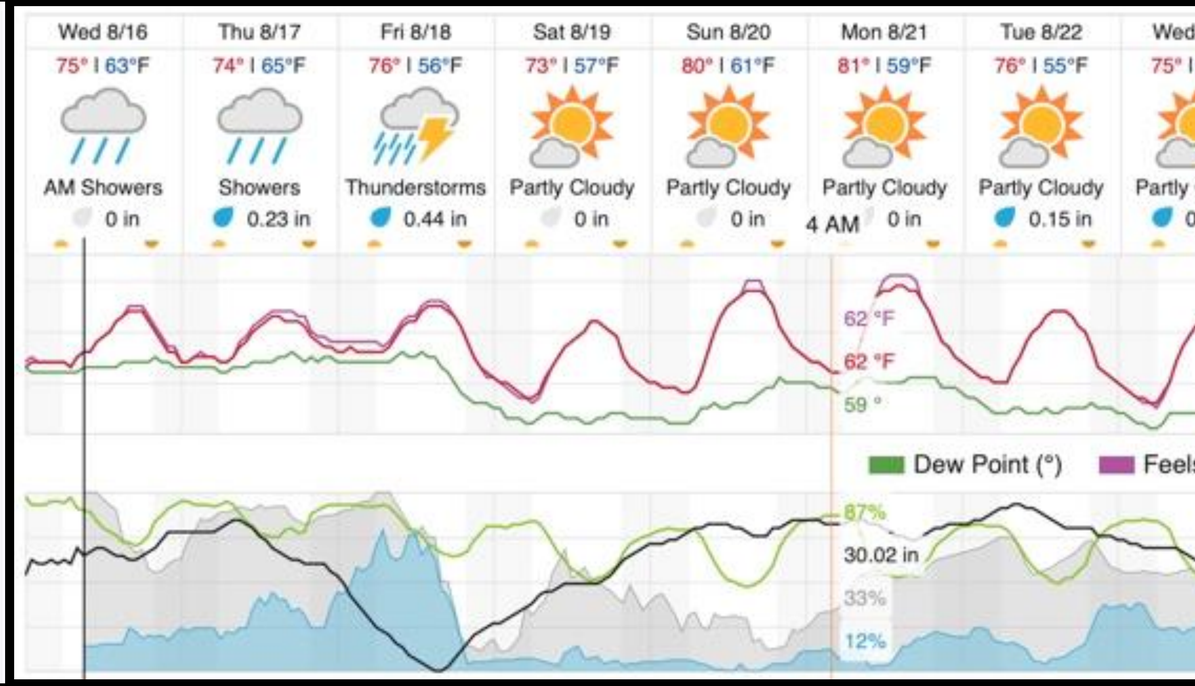
Intertek UL1642, UL1973, UL9540 UN38.3 PASSED

www.FortressPower.com

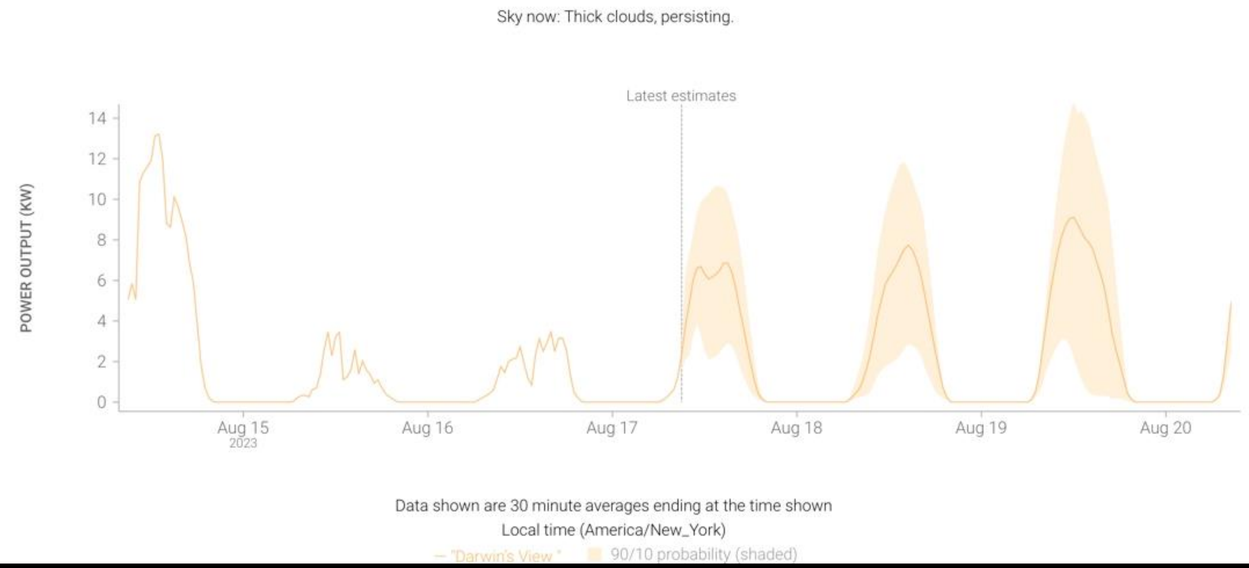
Sales@FortressPower.com · 877-497-6937 · 505 Keystone Road, Southampton, PA 18966, USA

Graph: Live and Forecasts solcast.com.au website for PV forecasting





Graph: Live and Forecasts



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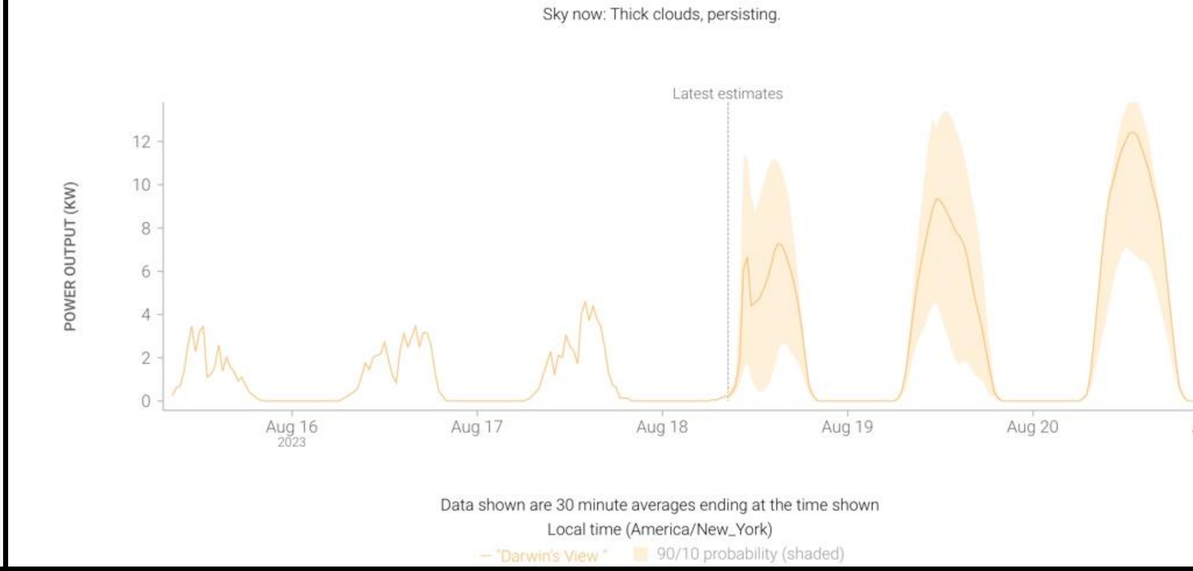
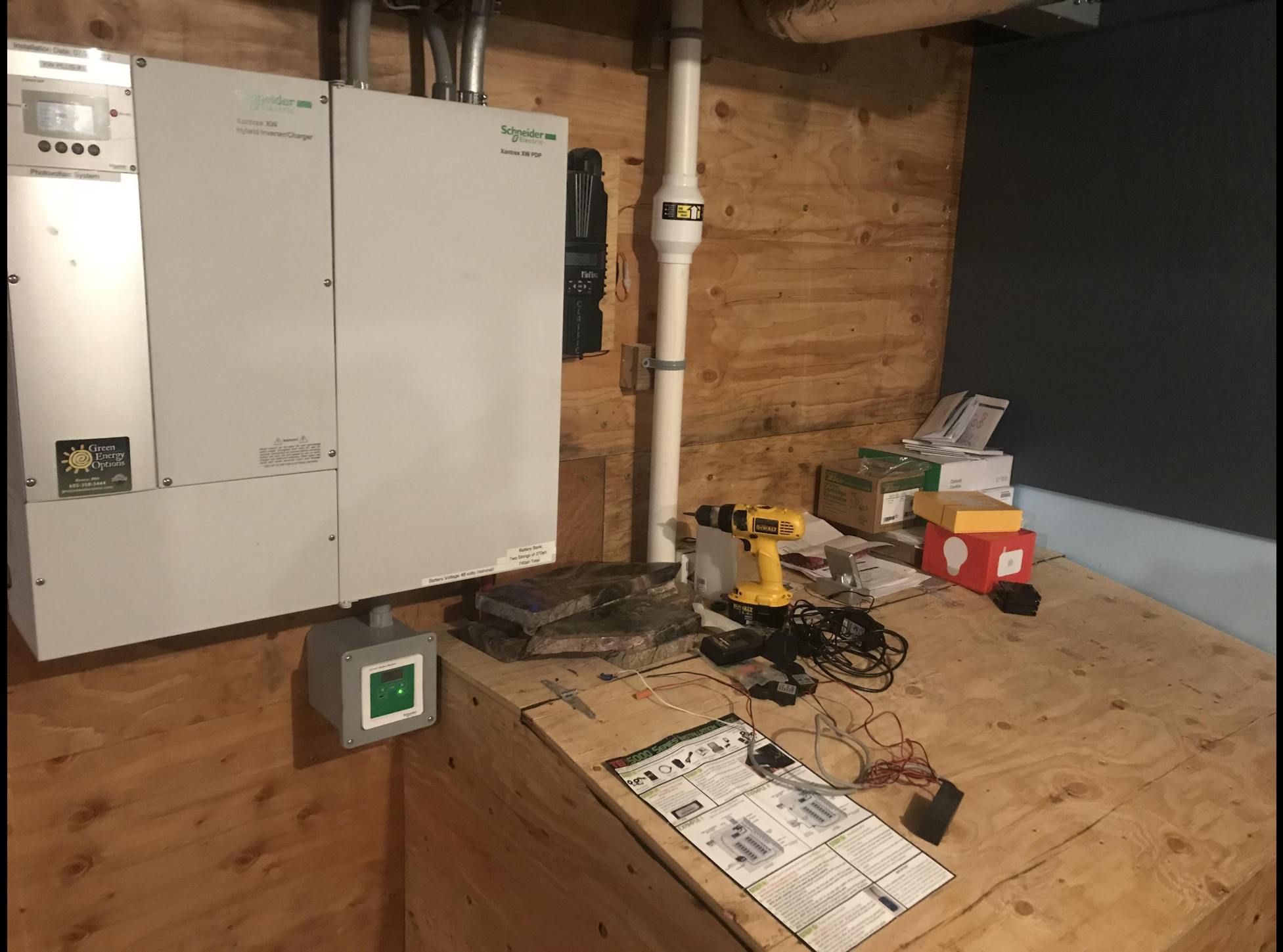
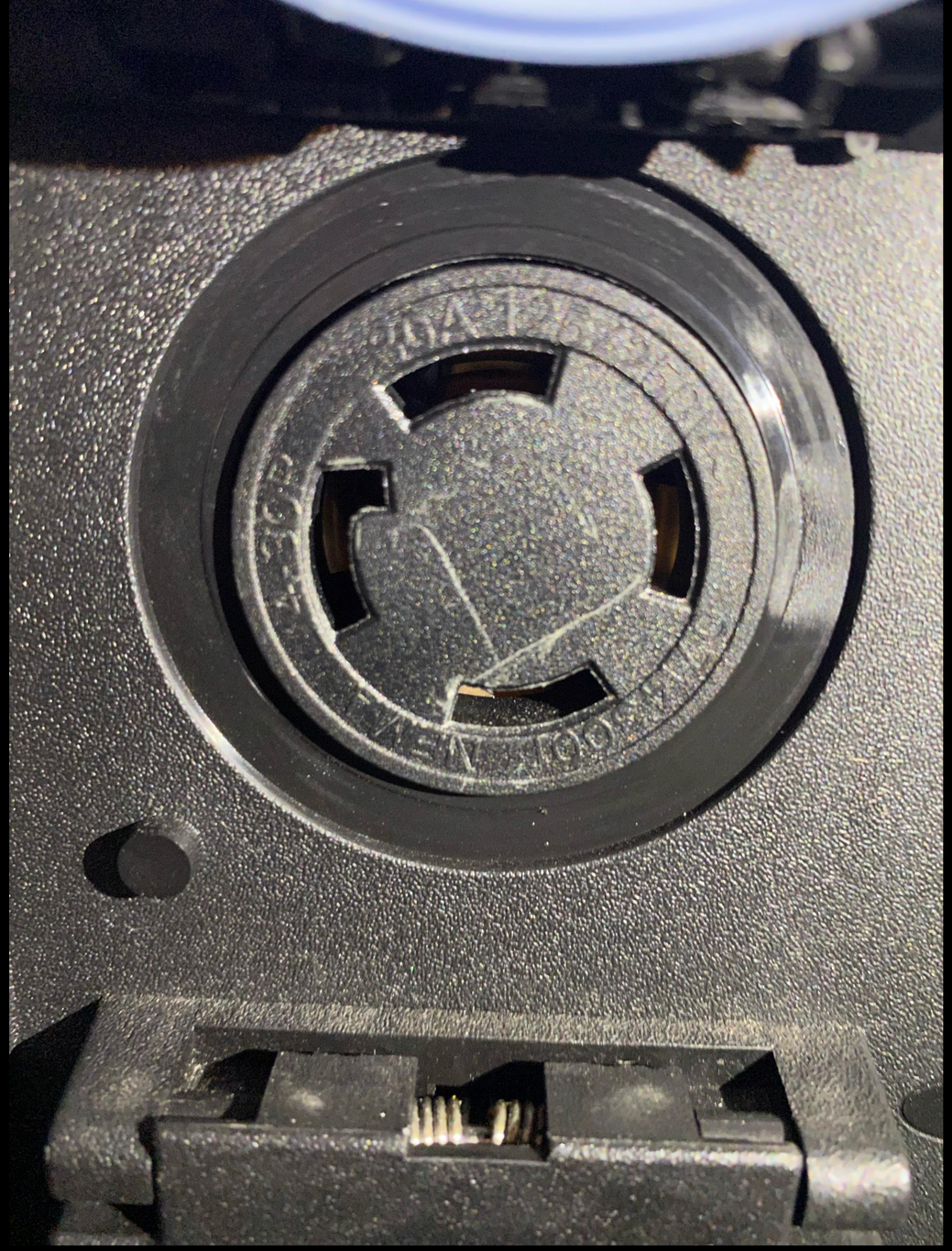



Schneider Electric
Xantrex XW PDP
Green Energy Options
DEWALT




LITHIUM ION BATTERIES
UN3480
2500
FARMTRAC