A Standalone Microgrid Powering a California Organic Farm

Design and Lessons Learned

Bruce Ackerman
Big Mesa Farm
Comptche, California, US

Big Mesa Farm

40 ha valley surrounded by forest
16 km from the Pacific coast
Off-grid – not served by any utilities

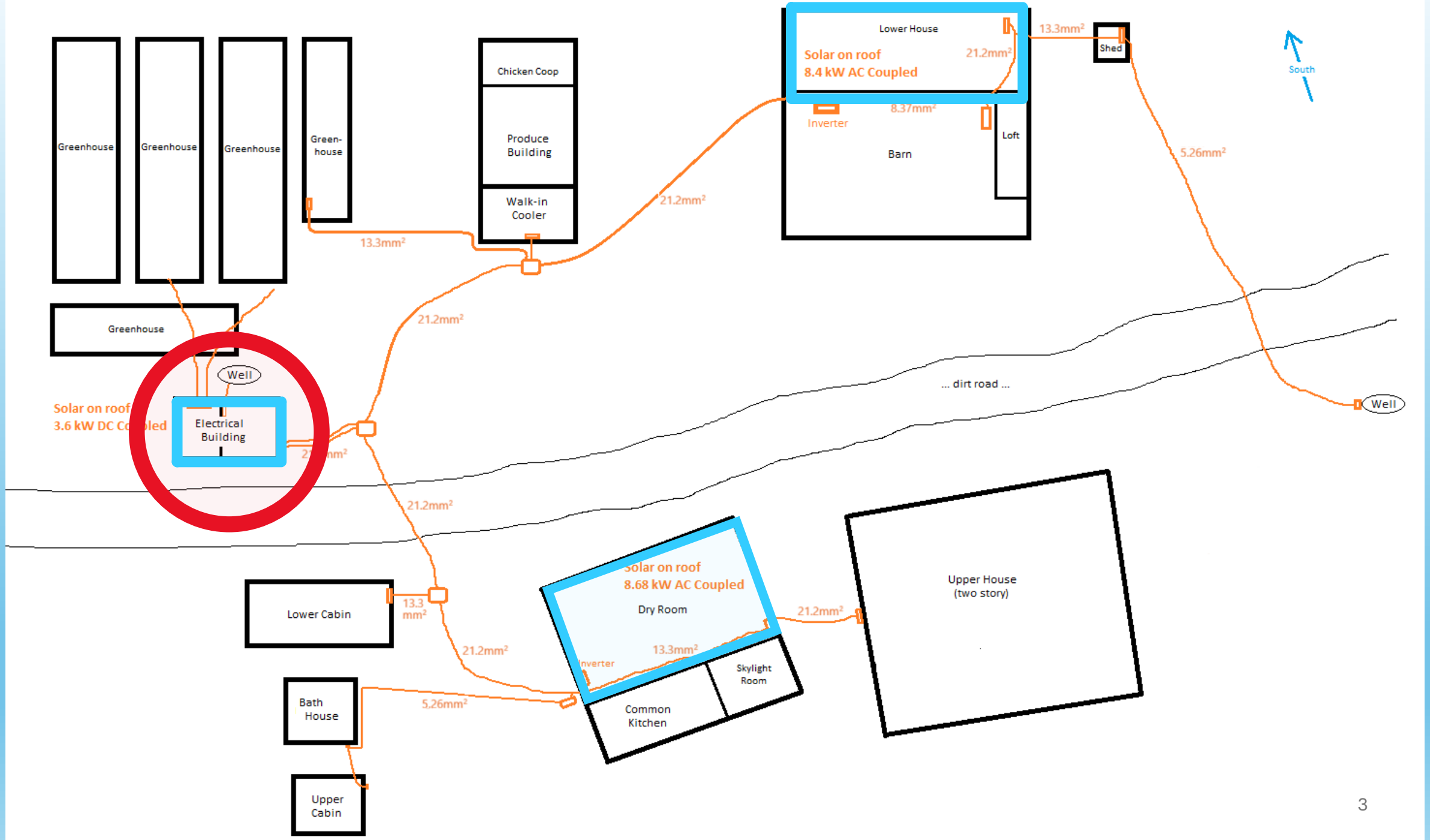
Owner and Farmer: Caymin Ackerman

Growing mixed organic vegetables – delivered to stores, farmer's markets and restaurants in three cities

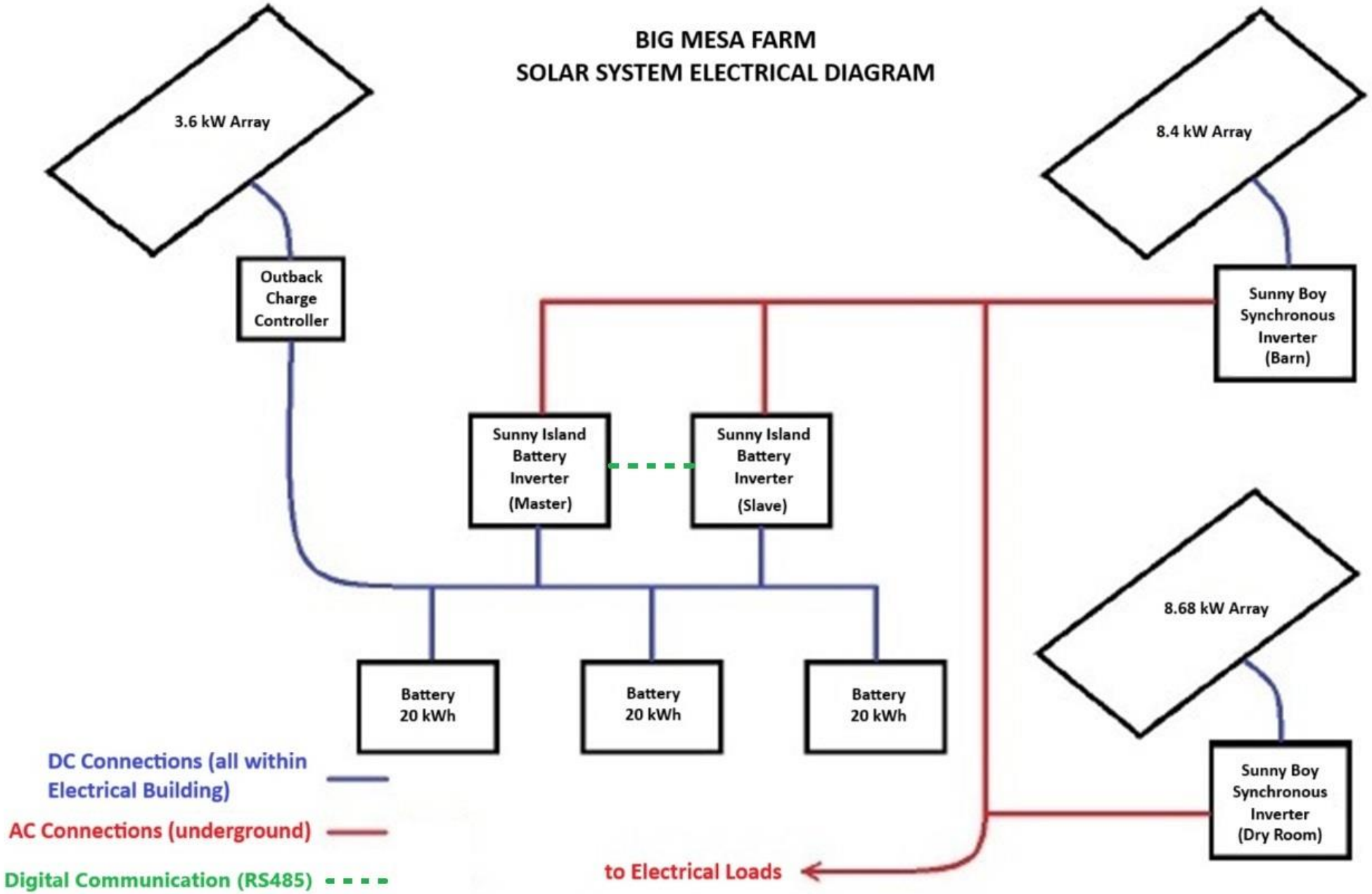
9 buildings and 5 greenhouses
- 2 houses and 4 "cabins"
- 3 kitchens

The first European settlers were the Mattila family, from Finland!




Greenhouse
Greenhouse
Greenhouse
Green-house
Chicken Coop
Produce Building
Walk-in Cooler
Lower House
Solar on roof
8.4 kW AC Coupled
21.2mm²
13.3mm²
Shed
South
Inverter
8.37mm²
Loft
Barn
5.26mm²
21.2mm²
13.3mm²
21.2mm²
Greenhouse
Well
Solar on roof
3.6 kW DC Coupled
Electrical Building
... dirt road ...
Well
21.2mm²
21.2mm²
Lower Cabin
13.3 mm²
Solar on roof
8.68 kW AC Coupled
Dry Room
21.2mm²
Upper House
(two story)
21.2mm²
13.3mm²
Inverter
Skylight Room
Common Kitchen
Bath House
5.26mm²
Upper Cabin

BIG MESA FARM
SOLAR SYSTEM ELECTRICAL DIAGRAM





Began installation one month after moving onto the farm…



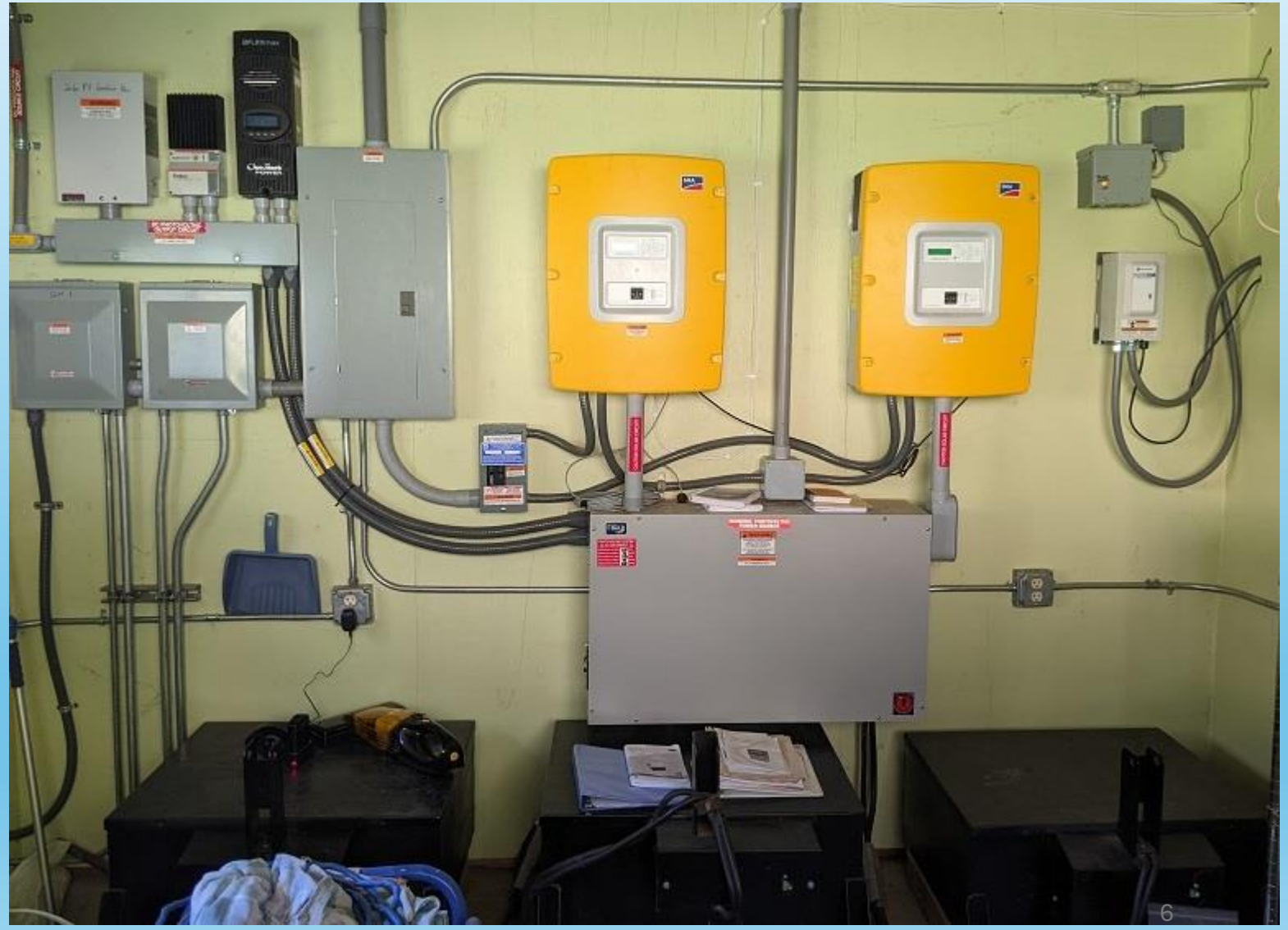
The Electrical Building – Grid Forming, Batteries and AC Distribution

Two SMA Sunny Island 6048-US inverters form the 120/240 Volt single-phase AC grid

Three 20 kWh Lithium Iron Phosphate Batteries – 48 V nominal – connected in parallel

Outback charge controller for DC-coupled array on roof

Distribution panels to AC loads



The Dry Room – Second PV Array

SMA SB7.7 synchronous inverter feeds power from 8.68 kW rooftop PV array to the grid

That AC either powers loads or is converted to DC by the Sunny Island inverters to charge batteries

Frequency-Shift Power Control (FSPC) – the Sunny Island inverters shift the grid frequency to curtail power from the AC-coupled arrays



The Barn – Third PV Array

SMA SB7.7 synchronous inverter feeds power from 8.4kW rooftop PV to the grid





When needed, a 22kW propane generator is used

- Not started automatically
- Inverter signals when SOC<50%
- 50 Amp max charge rate
- Average 43 hours/year

Generator is larger than necessary – legacy from prior cannabis farm, which ran it 24/7



The electric delivery van is the largest single load, in use from April 2023

Charged several days a week at 8kW – 30-45 kWh/day

Only charged in daytime

Easy … when it’s sunny!



An electric Landmaster UTV is used on-farm

Charges on 120V, 5.7 kWh full charge

4-wheel drive, 1.8 m lift bed, winch

48 km range



Major Electrical Loads

Large SAE-Level-2 EV Charger for delivery van	8.0 kW	Typical daytime charge 30-45 kWh
SAE-Level-2 EV Charger for autos	7.3 kW	Used as needed (in daytime)
Heaters for vegetable starts	0.8 kW	In springtime 24 hours/day (19 kWh)
Walk-in Refrigerator for farm produce	0.6 kW	Typically 6kWh in summer
Well pump to irrigation tanks	1.5 kW	Daytime, mostly in summer
Irrigation pressure pump	0.75-1.5 kW	Daytime, Typical summer day 5.5 kWh
Heat pump for crop drying	0.6 kW	Daytime, Summer only
Starlink internet router	0.05 kW	On a UPS for reliable communications
Kitchen Induction stove and oven	2.7-7.5 kW	Typical evening cooking 1-3 kWh
Kitchen demand water heater	5.9 kW	Typically 2 kWh (highly reactive load)
Baseline domestic loads etc.	0.3 kW	Nighttime baseline 100-300 W

Other Energy Used

Woodstoves for space heating

Mediterranean climate: rainy winters -5 C lows, clear summers 30-35 C highs



Two solar water heaters



Tractors (2 diesel)

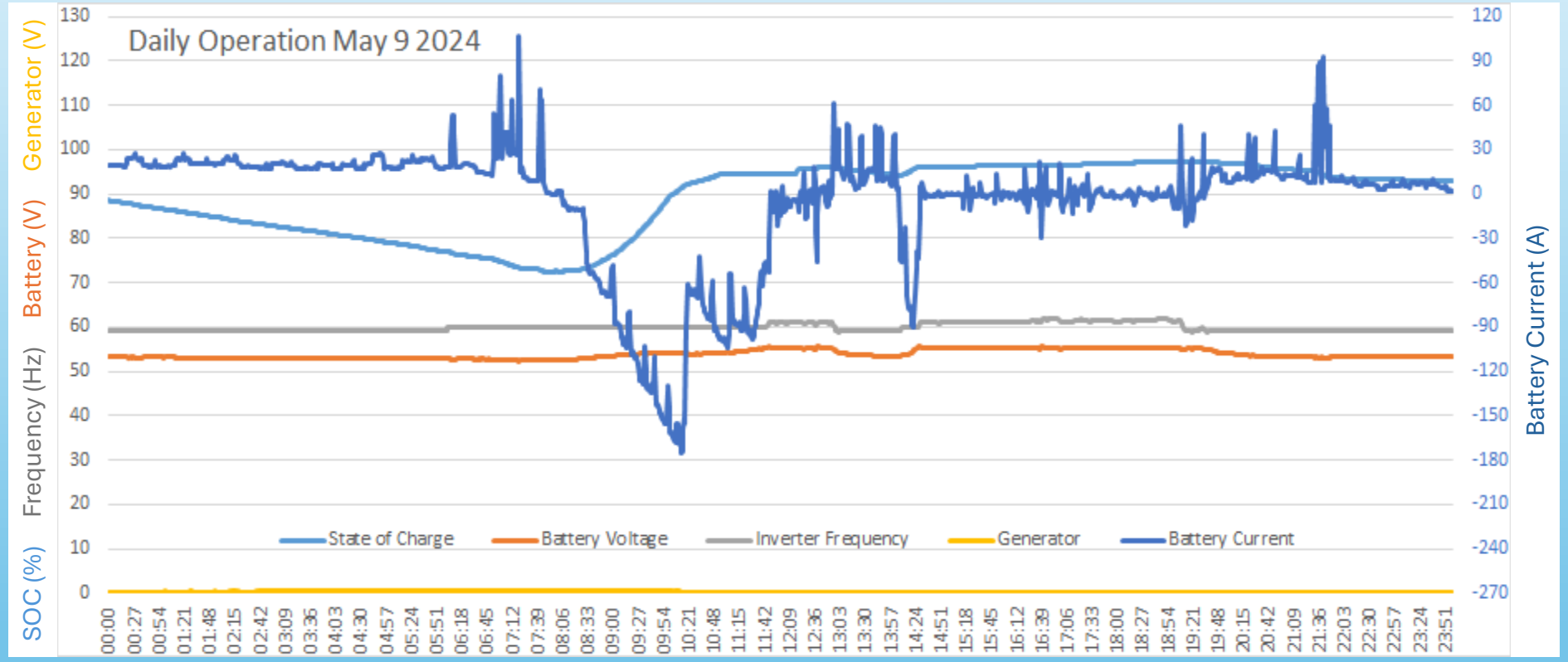
Also one electric not in use



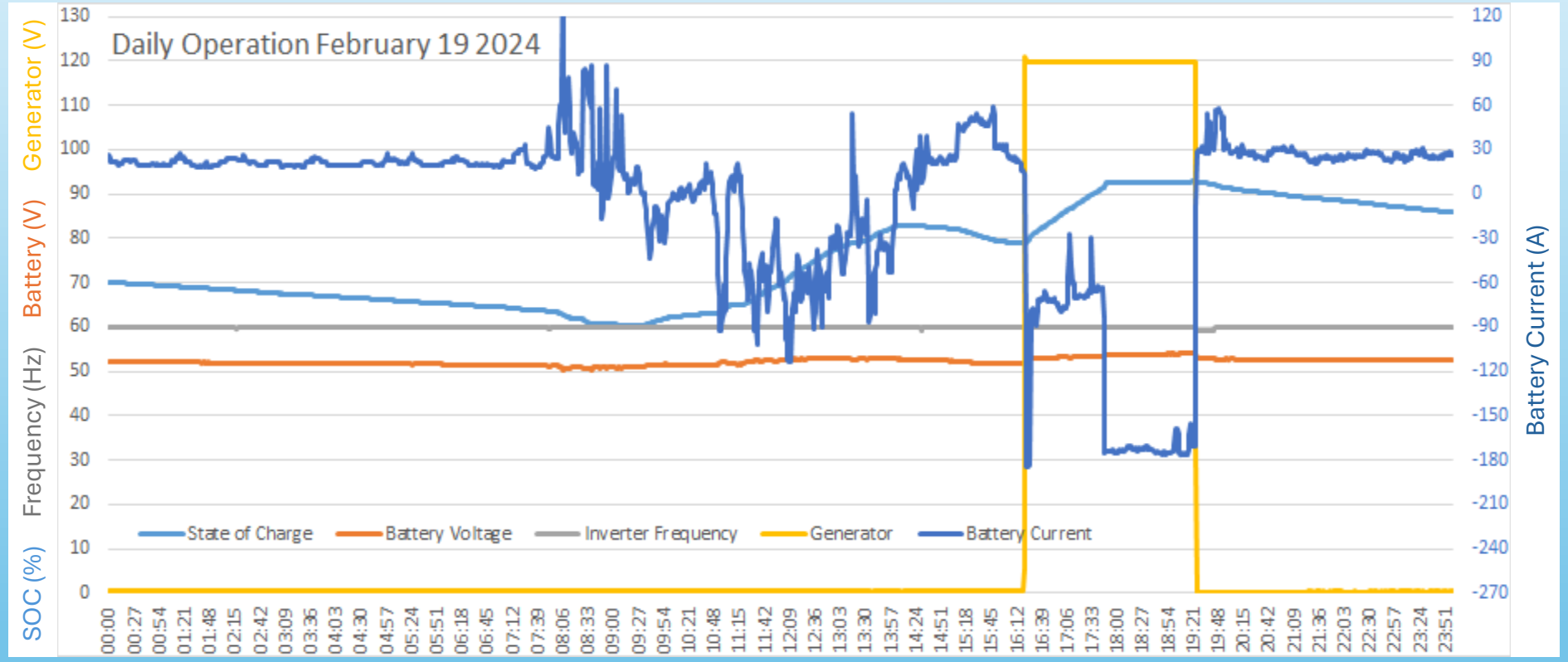
Propane used for some water heating and some cooking (and the generator)

One gasoline personal car, and one diesel flatbed truck (rarely used)

A Typical Spring Day: Nighttime load, then a full recharge



A Challenging Winter Day: Cloudy weather required generator



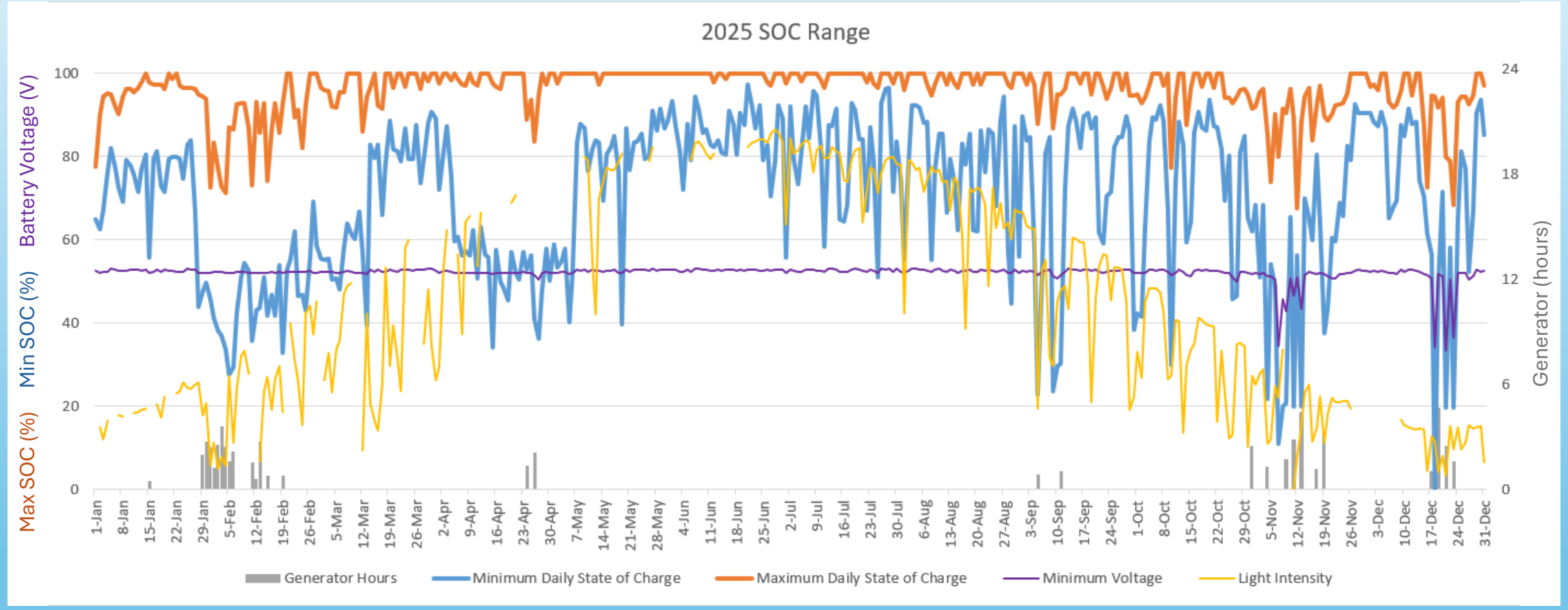
Sprout heaters overnight, down to 60% SOC

Battery charging

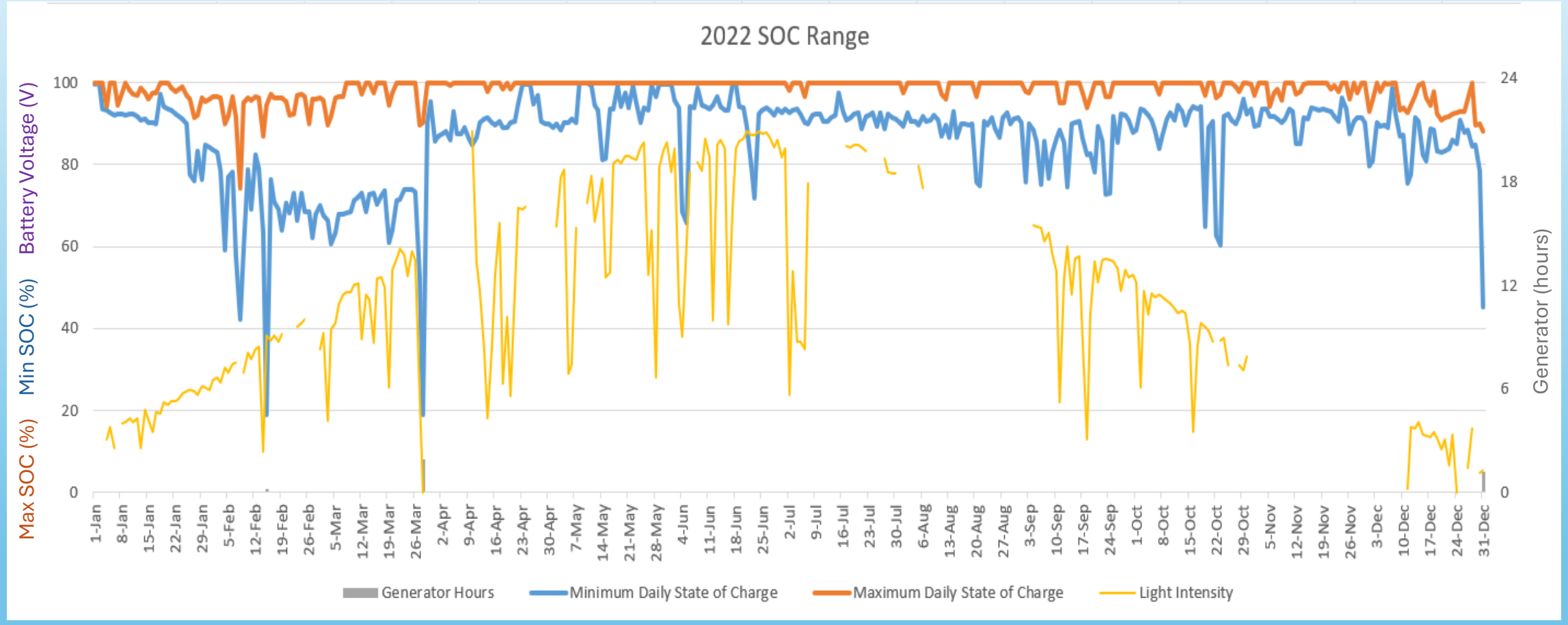
Van charged

Generator run

Annual summary 2025, charging the delivery van



The year before we bought the delivery van



In Summary, the system has worked well overall, keeping the farm running with ever-increasing loads

However, occasional problems persist with the battery configuration…

Batteries were custom made from LFP cells, using a locally designed BMS – advantages and disadvantages…

+ Easily moved with a tractor hitch
+ Top-end equalization
+ Disconnect if over- or under-voltage

- BMS does NOT connect digitally: all management is by the SMA inverters, based on calculated State of Charge

- The three batteries are wired in parallel.



Battery issue: ungraceful behavior at low SOC

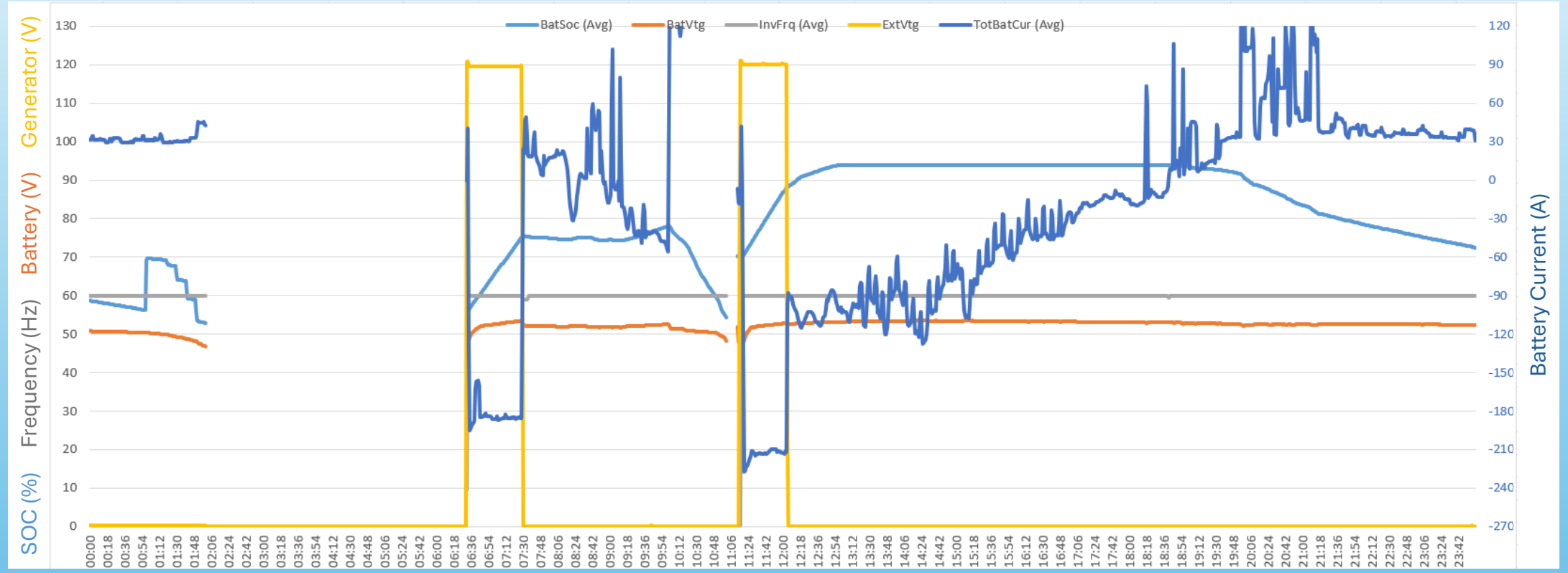
Battery relays trip before inverter stops at low SOC, due to inverter's inaccurate SOC calculation

- If one or two batteries trip, the inverter does not know this
  → the battery charge curve changes, confusing the inverter's learning
  → causing further trips
- The **SI algorithm has hard-coded behavior** specific to lead-acid batteries
- Aging or possible damage to the cells exacerbates the problem

SMA has not been responsive to request to allow a voltage-based low-end shutdown

The core issue is the connection of *self-protecting* batteries,
in *parallel*, *without* digital communication
(as well as batteries with different histories and states of health)

Bad behavior at low SOC



Batteries tripped off due to low voltage, while calculated SOC still above 50%
Also the SI “recalibrated” it’s SOC calculation upwards, and then dropped SOC rapidly as battery voltage dropped

Considering replacing the batteries

Looking at Solid-State Graphene batteries, a new technology from American Clean Energy Group

- **Would hopefully communicate with SMA inverters**
- **But these batteries would also not be "approved" by SMA – can we get any support?**

Could offer more accurate control, long cycle life, and deep depth of discharge

Opportunity to learn about this promising technology, also being considered for another microgrid

Thank You!

Bruce Ackerman <bruce@laughingcrows.net>



1982 Solarex
21 Watts
$460 ($1600 now)

Where is Big Mesa Farm?

