

MULTI-AZIMUTH PV ARRAYS FOR HIGH LATITUDES

UPDATES AND DATA

A closer look at three systems in Greenland and Alaska

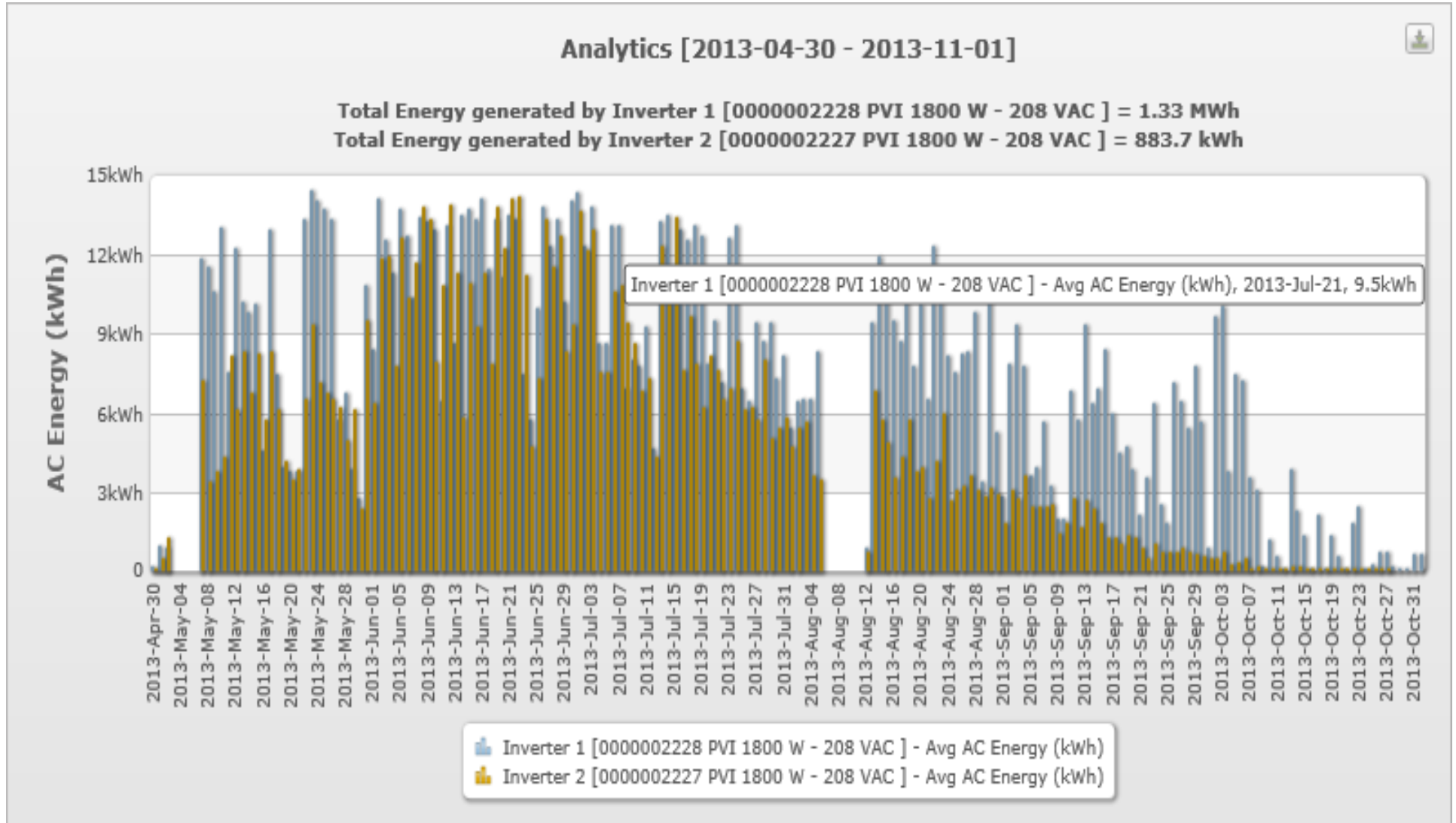
Tower of Power at Summit Station

- 5kW, 3-sided solar tower
- Diesel micro-grid interactive via Solectria string inverters



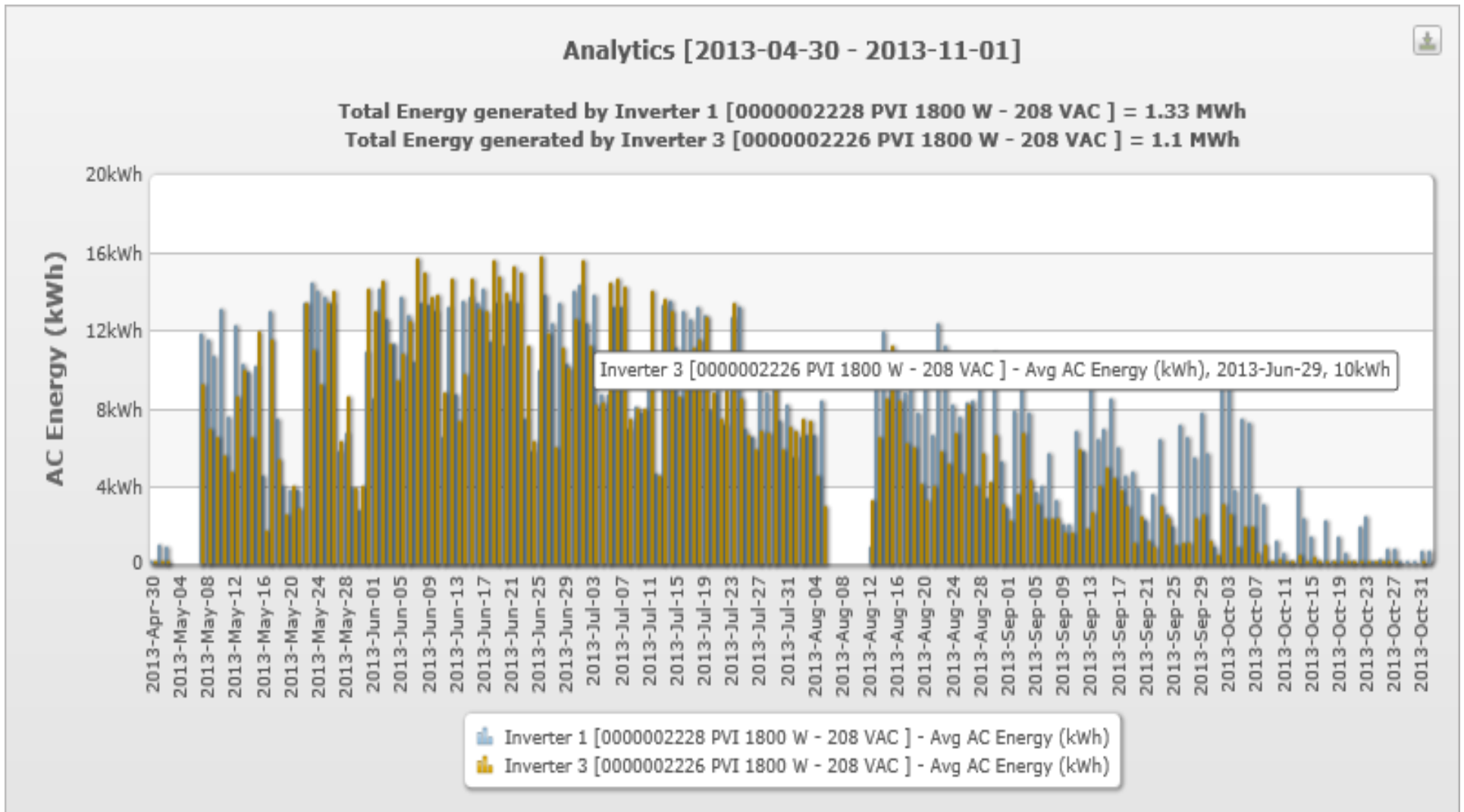
2013 Production Data for South Facet and ENE Facet

- South facet produced 1.33MWh of energy
- ENE facet produced 884kWh of energy – 66% of south facet
- In mid-summer the outputs are almost equal

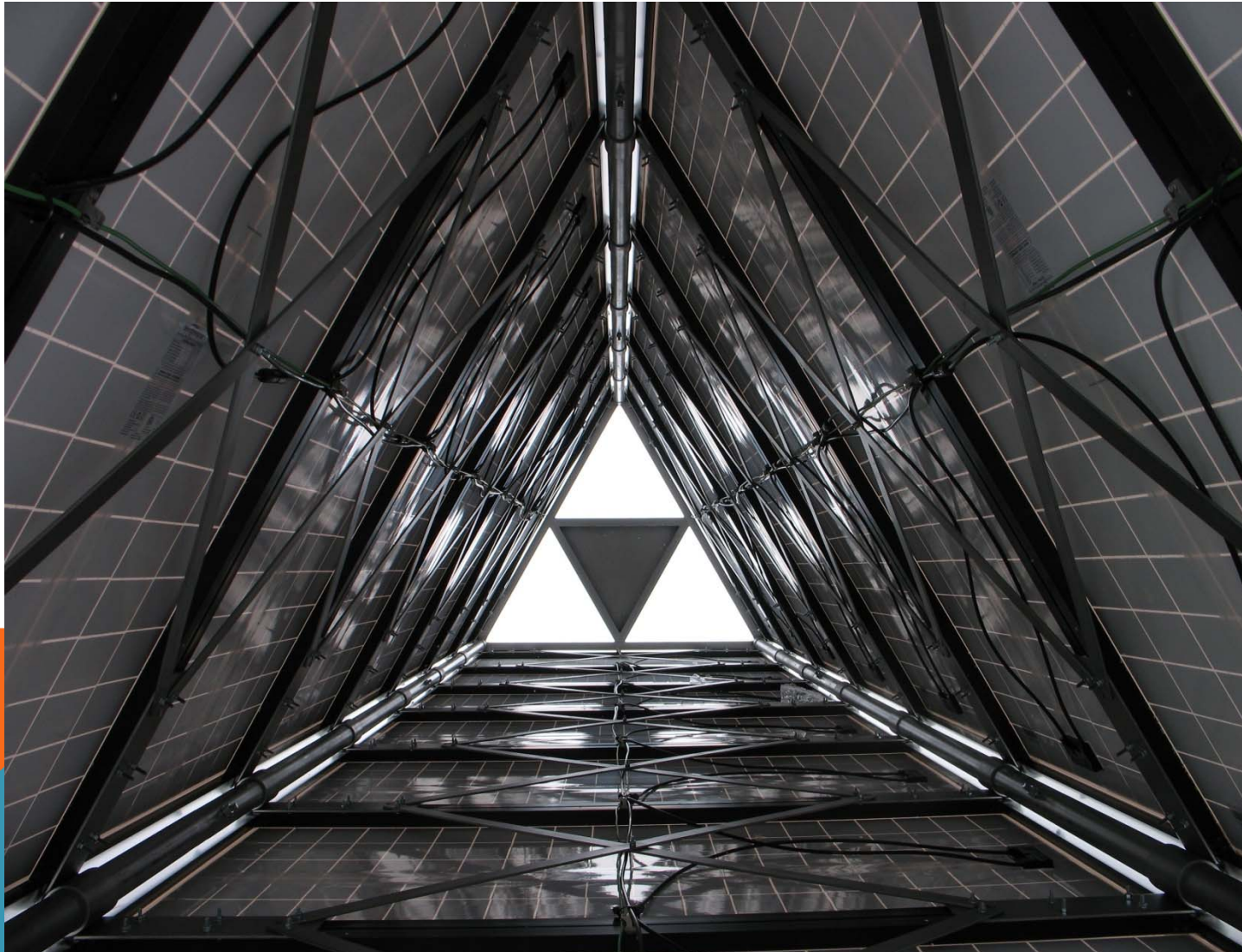


2013 Production Data for South Facet and WNW Facet

- WNW facet produced 1.1MWh – 83% of the south facet
- Sometimes out-produced the south facet in mid-summer
- Lower ENE facet production due to local meteorological conditions (morning ice fog)



- >4kW output at times, due to capture of reflected light
- Up to 6.6% instantaneous penetration onto diesel grid (>10% with Big House PV added)
- About 2% average annual penetration from PV
- No grid instability or power quality issues
- Unique, lightweight structure utilized PV panels as structural elements





Structural Failure, March 2014

Welds failed on lower extension ->

Failure Analysis:

- Rime ice added weight and wind resistance ->
- Welds on extension had inadequate penetration
- Extension design uses snow as lateral support, but the new extension was not buried – thus no support.
- Conclusion – It was a combination of factors that caused the structural failure.

Even had the tower not failed, there is an inherent design flaw, common to all “infinite leg” systems. Having to install a 4’ base extension every two years increases O&M costs and leaves too much embodied energy in the snow.



Summit Station Big House PV

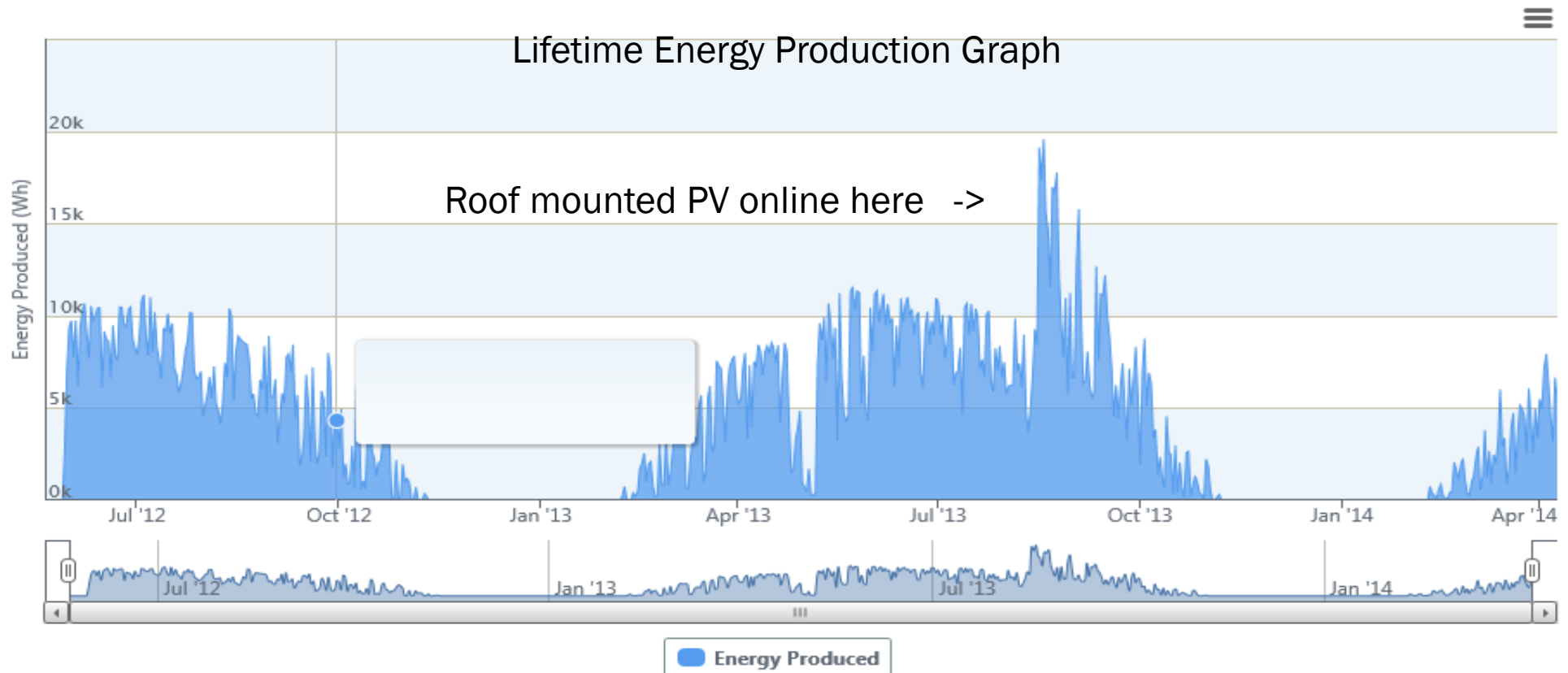


Specifications:

- Micro-inverter based – Enables high resolution, panel level monitoring
- 1.23kW on south wall – 2.46kW on roof (low angle)

Performance:

- 2.87MWh energy production to date
- Wall mounted panels outperform roof mounted – except in mid-summer I predict
- Mid February through mid-November production



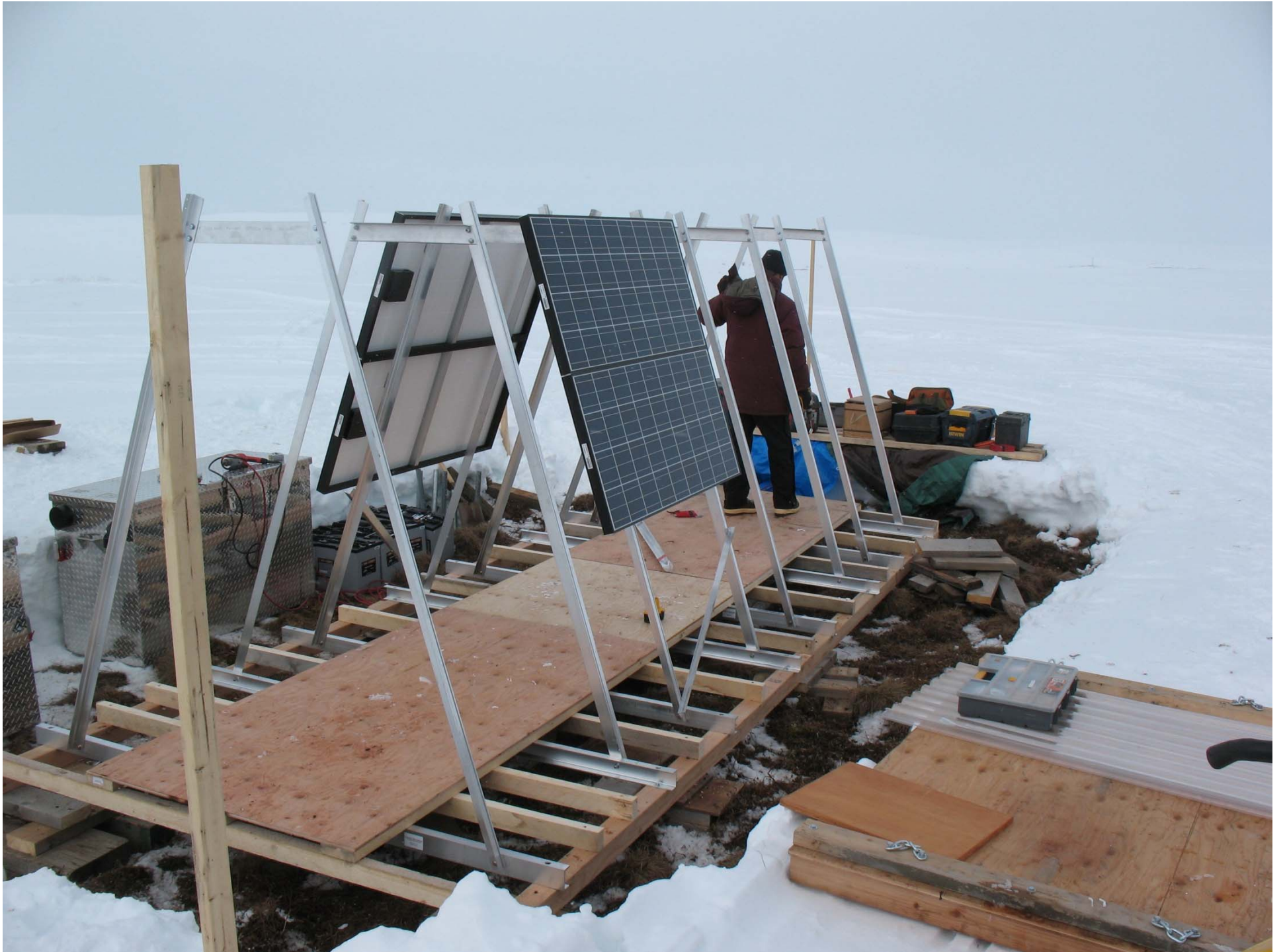
The Solar Chalet – Toolik Field Station, Alaska

- Summer-only operation
- EAGER project – Short timeline/short duration
- Approximately 500 Watt continuous load @ 120VAC
- Deploys 3.36kW of PV; 1.12kW each facet– E/S/W
- Simple A-frame structure orients facets E/W. Doubles as an environmental shelter.
- Conventional south facing array
- Series/parallel configuration allows for higher DC string voltages to MPPT charge controllers
- 48VDC nominal battery bank can be much smaller due to multi-azimuth design. Only 1/3 the period of autonomy required.



Deployment Challenges







Close Quarters

<- Note diagonal braces



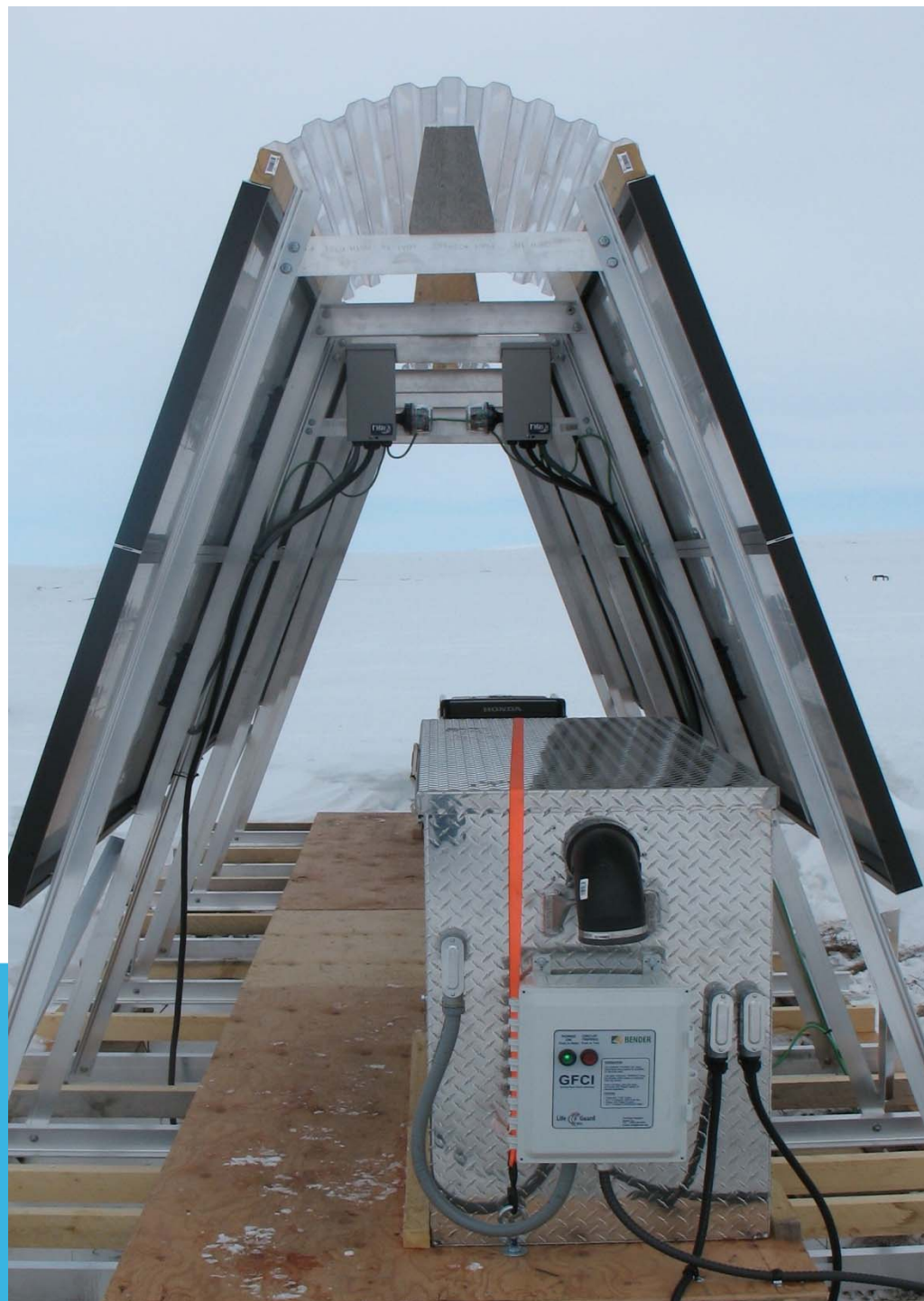


Power Electronics

- Used aluminum job boxes (insulated and paneled) for enclosures
- Outback GX1648 Inverter/Charger
- 3 Outback Flexmax 60 Charge Controllers (one for each facet)
- Outback Hub/Mate Monitoring
- 16 PVX 3050T Batteries (2 strings)
- 3 Iota 15/48 Battery Chargers
- Midnite Solar BOS Components
- Honda EU6500i Generator
- Thermostatically controlled AC muffin fans with screened intake/outlet ports

Details:

- Lightning/Surge Protection + a lot of attention to grounding
- Polycarbonate Rain Shields + the E/W arrays form an open structure. Keeps the rain off but allows snow to scour through.
- Bender GFCI Protection
- Environmentally Controlled Electronics Enclosures



Results:

- Finished on schedule and within budget
- Operated all summer without requiring generator charging
- Excellent science data collected
- One mosquito related failure with the science equipment enclosure



Conclusions:

- Solar PV is appropriate technology for high latitude operations
- Multi-faceted designs can be very effective at increasing energy capture without the mechanical complexity of tracking arrays.
- E/W facets can actually out-produce S facets at times, due to better angle of incidence
- Scalable for individual science projects or facilities
- Relatively short period of zero production in winter
- PV panels can be used effectively as structural elements, but implementing unconventional designs is not without risk.
- Disclaimer: South orientation at latitude +15 still generates the greatest amount of energy on an annual basis, but it is closer than models predict.

Carpe Diem!

