

Eagle, Alaska Solar PV Performance Overview



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Eagle, Alaska

- Population: 150 People
- Average Load is about 80 kW
 - Minimum summer loads below 50 kW

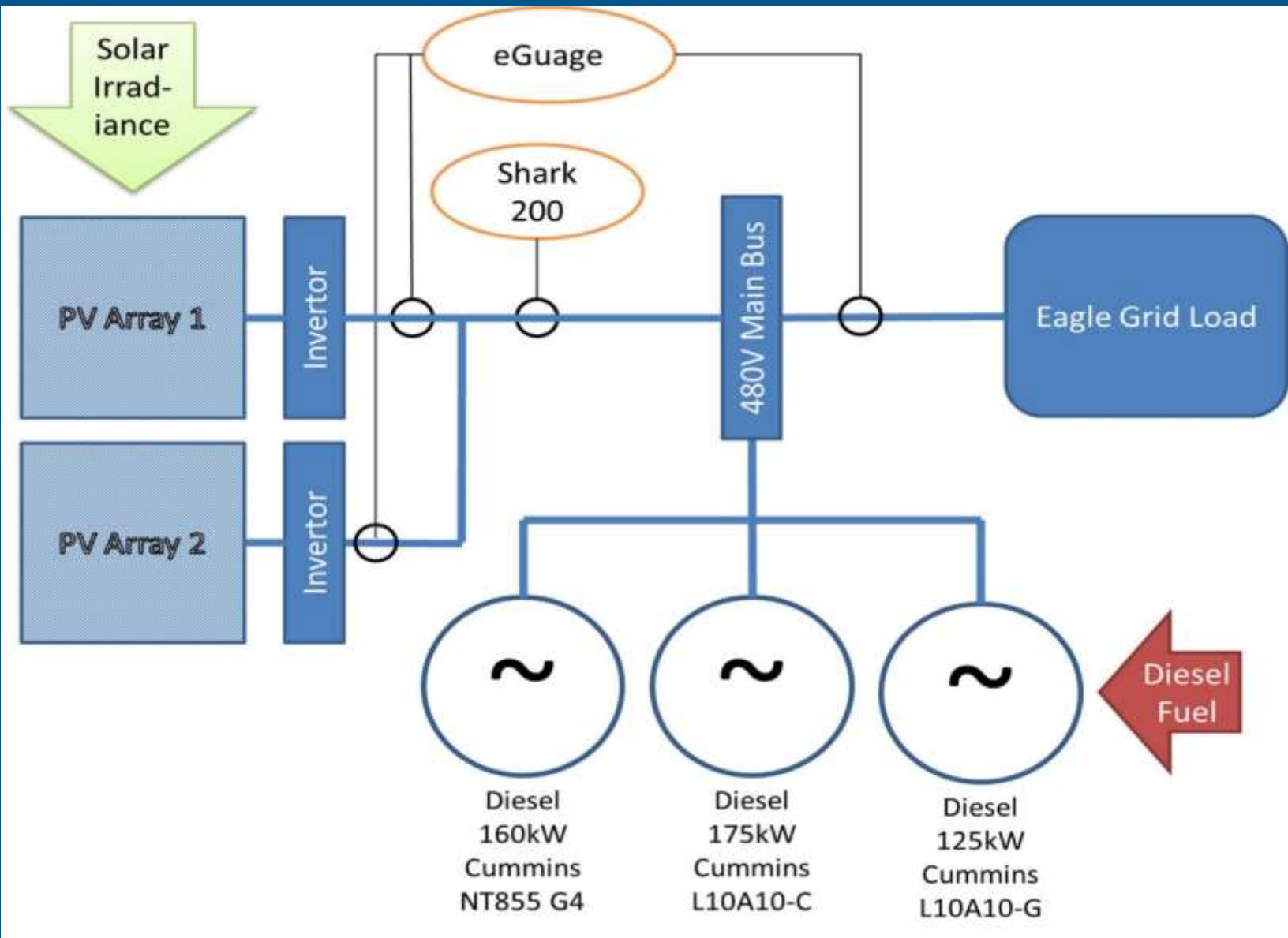


System Overview

- 3 Cummins Diesel Generators (125, 160, 175 kW)
- 24 kW solar PV commissioned May 2015 (~\$260,000)
- 8 adjustable pole mounts
- 96 Sharp 250watt polycrystalline modules
- 2 Fronius 3 phase inverters
- SCADA is monitoring and data acquisition only. There are no PV controls at this time.







Research Questions

- What are the peak solar power ramp rates?
- Does the project impact the frequency of blackouts?
- Are there power quality impacts cause by the impact of the PV?
- How does installation perform compared to PVWatts prediction?
- Do the tolerance settings to the inverter eliminate nuisance tripping?

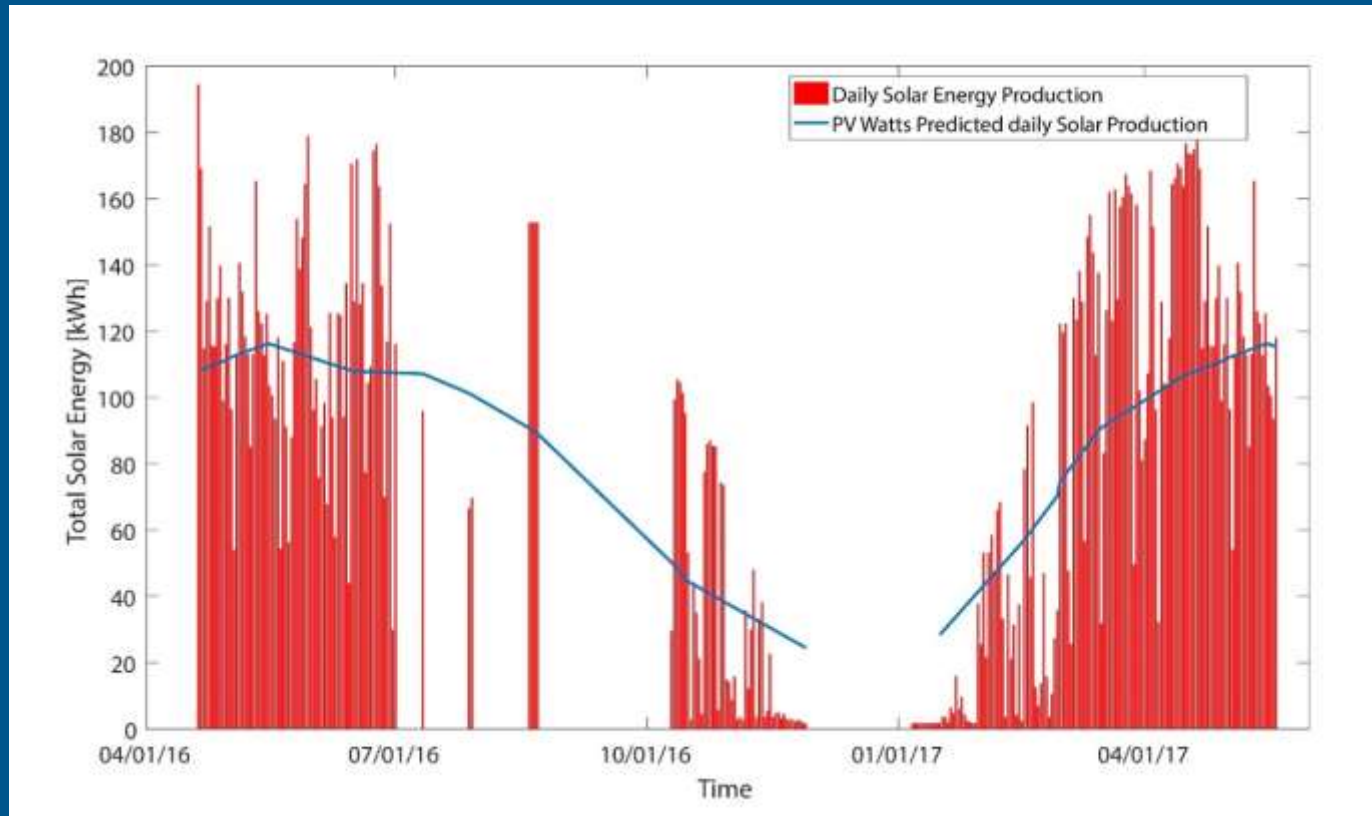
Thanks to:

-Alaska Energy Authority, Renewable Energy Fund (REF) Data Collection Project

-AP&T for data collection assistance



Modeled vs. Actual Production

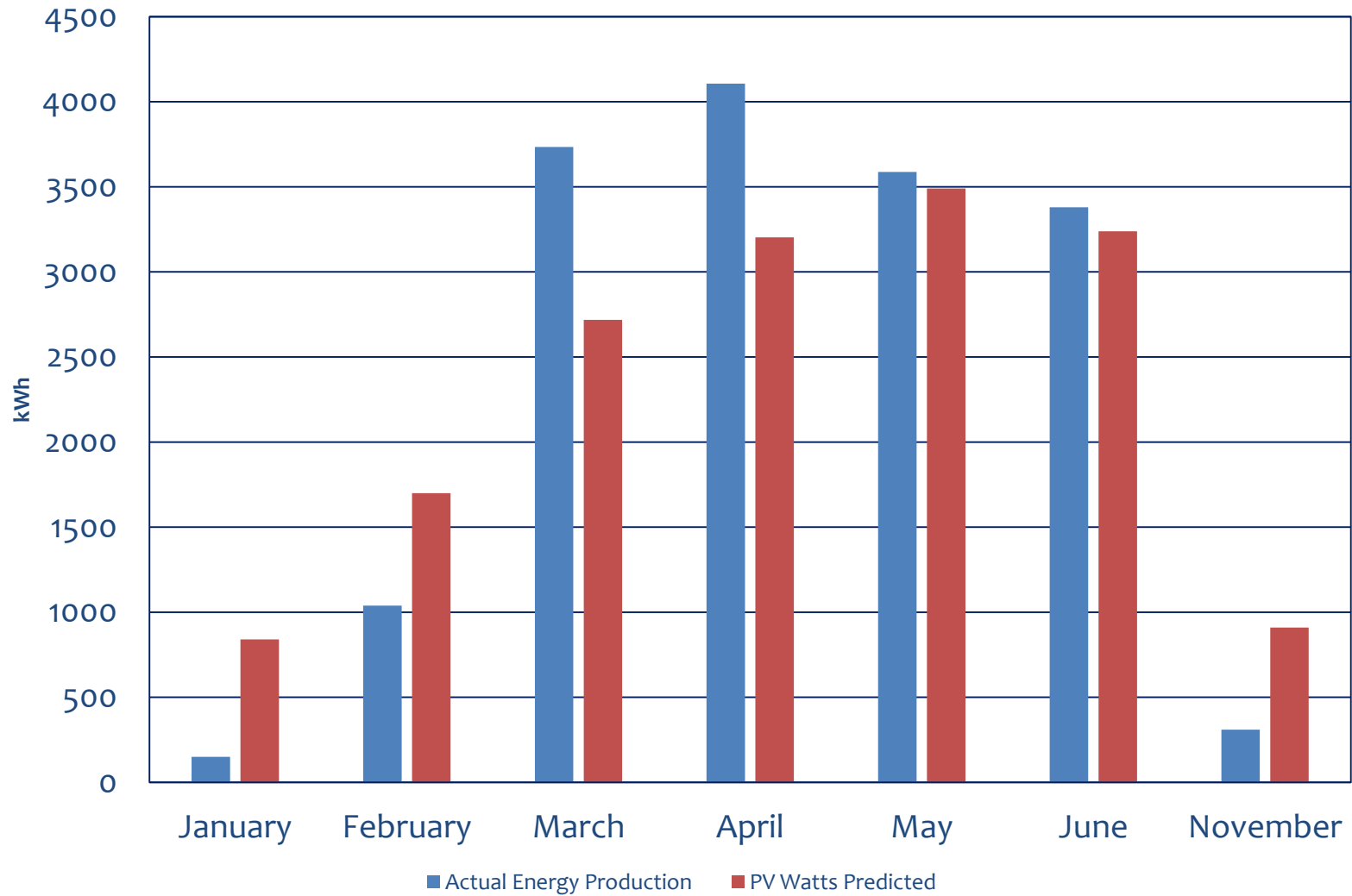


Data Collection April 20, 2016-May 20, 2017

- 65° tilt from Sept-March
- 45° tilt April- August

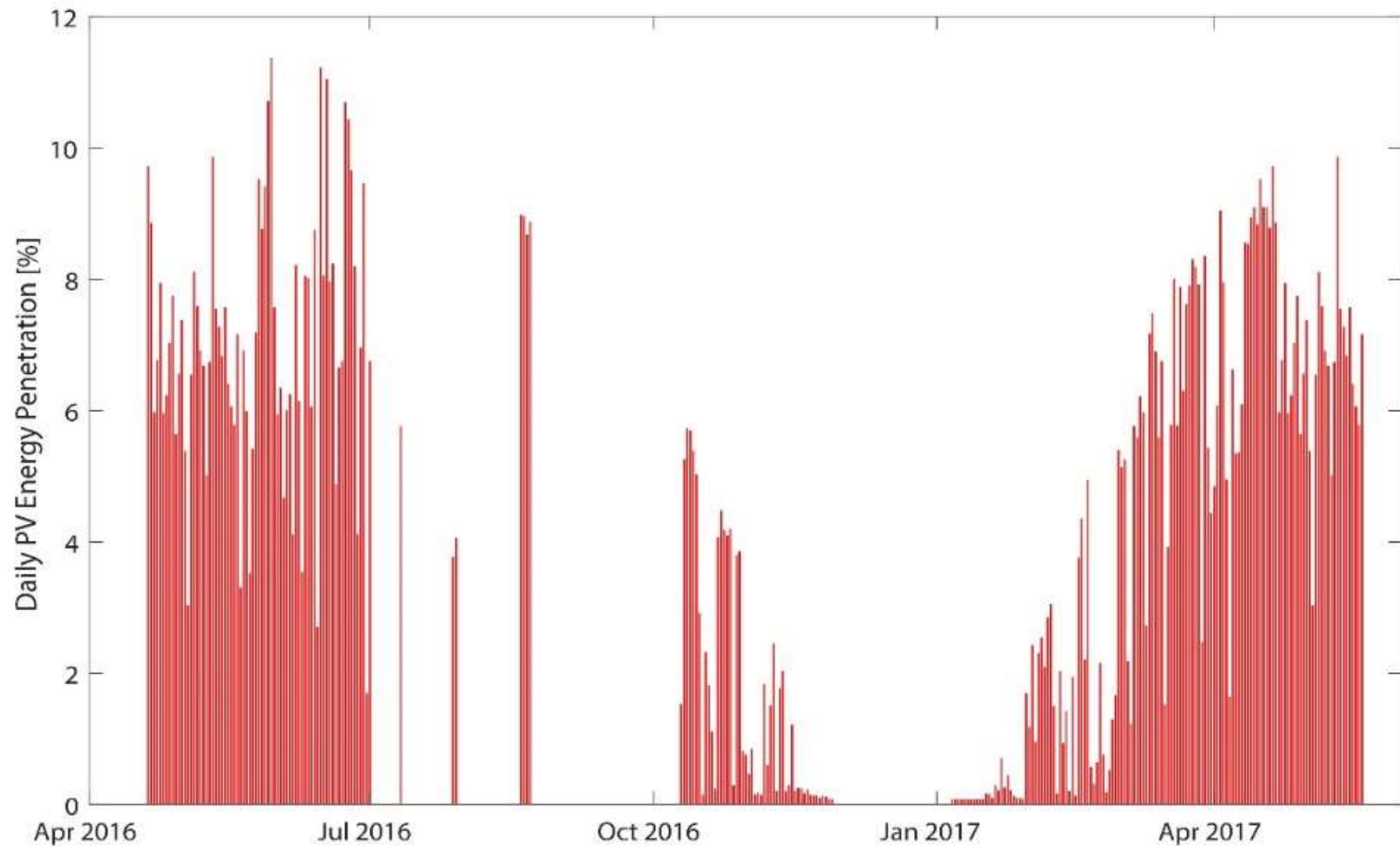


Actual Versus Predicted Monthly PV Energy Production

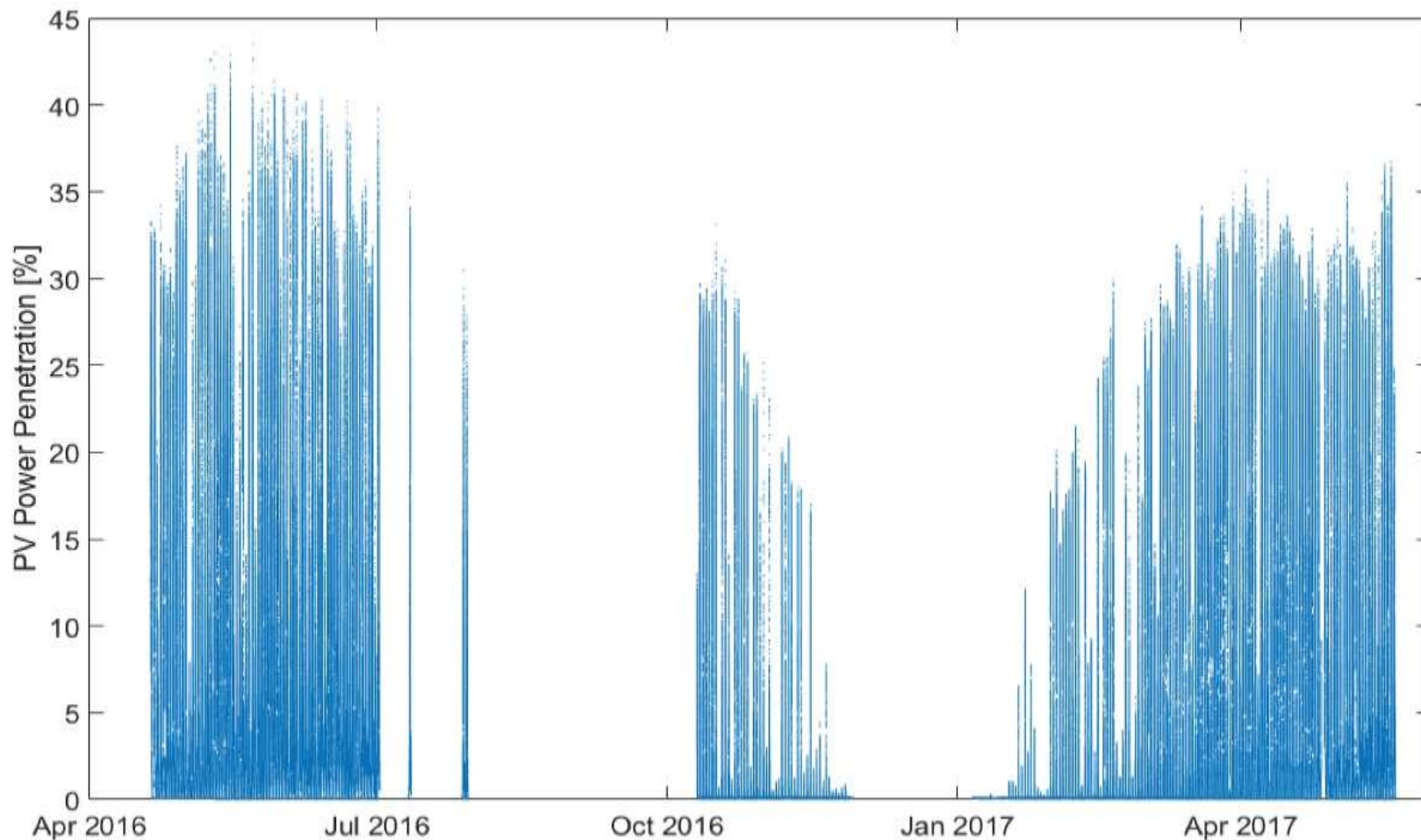


Solar Penetrations

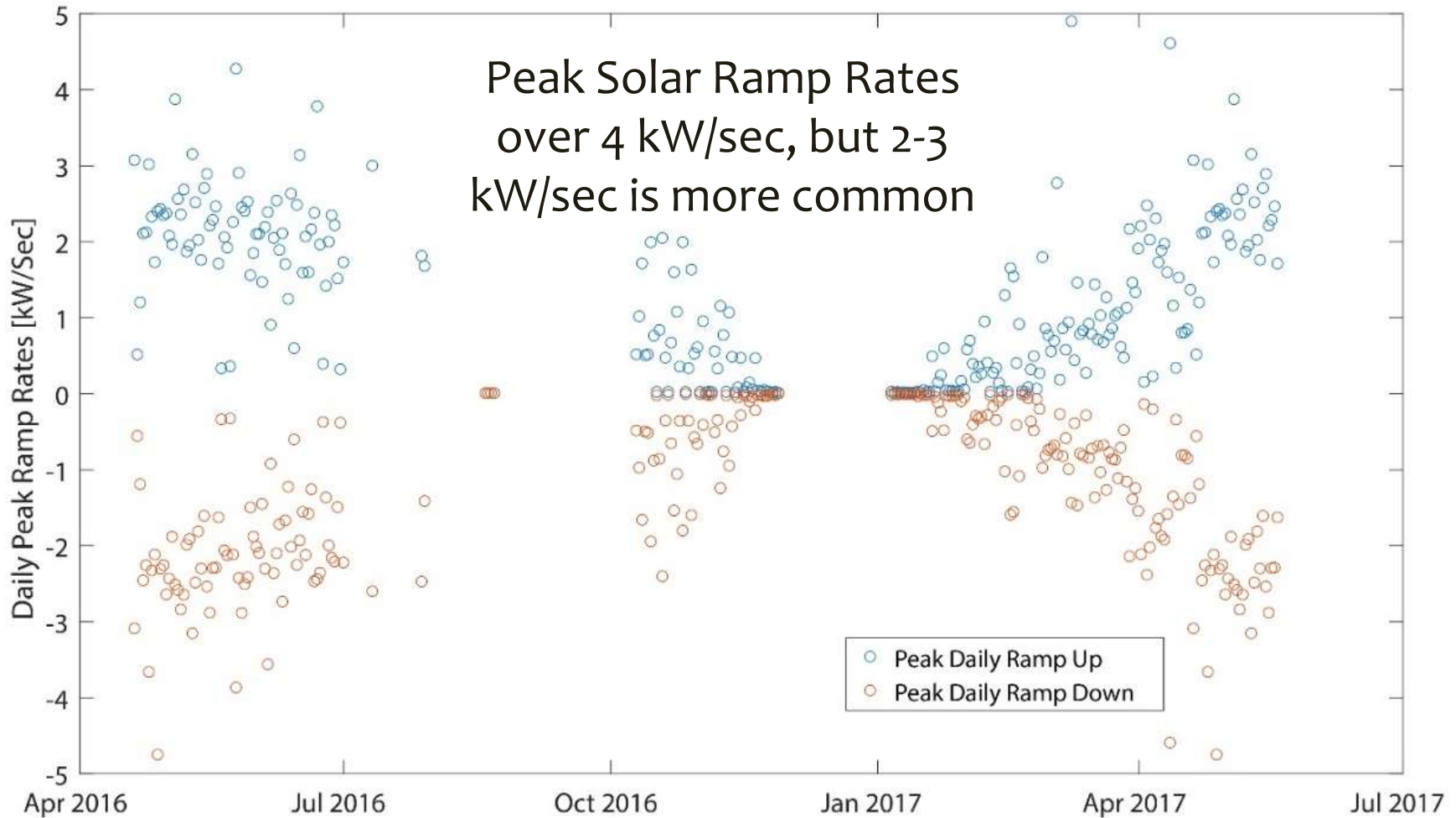
- Maximum daily solar energy penetration is just over 11%.



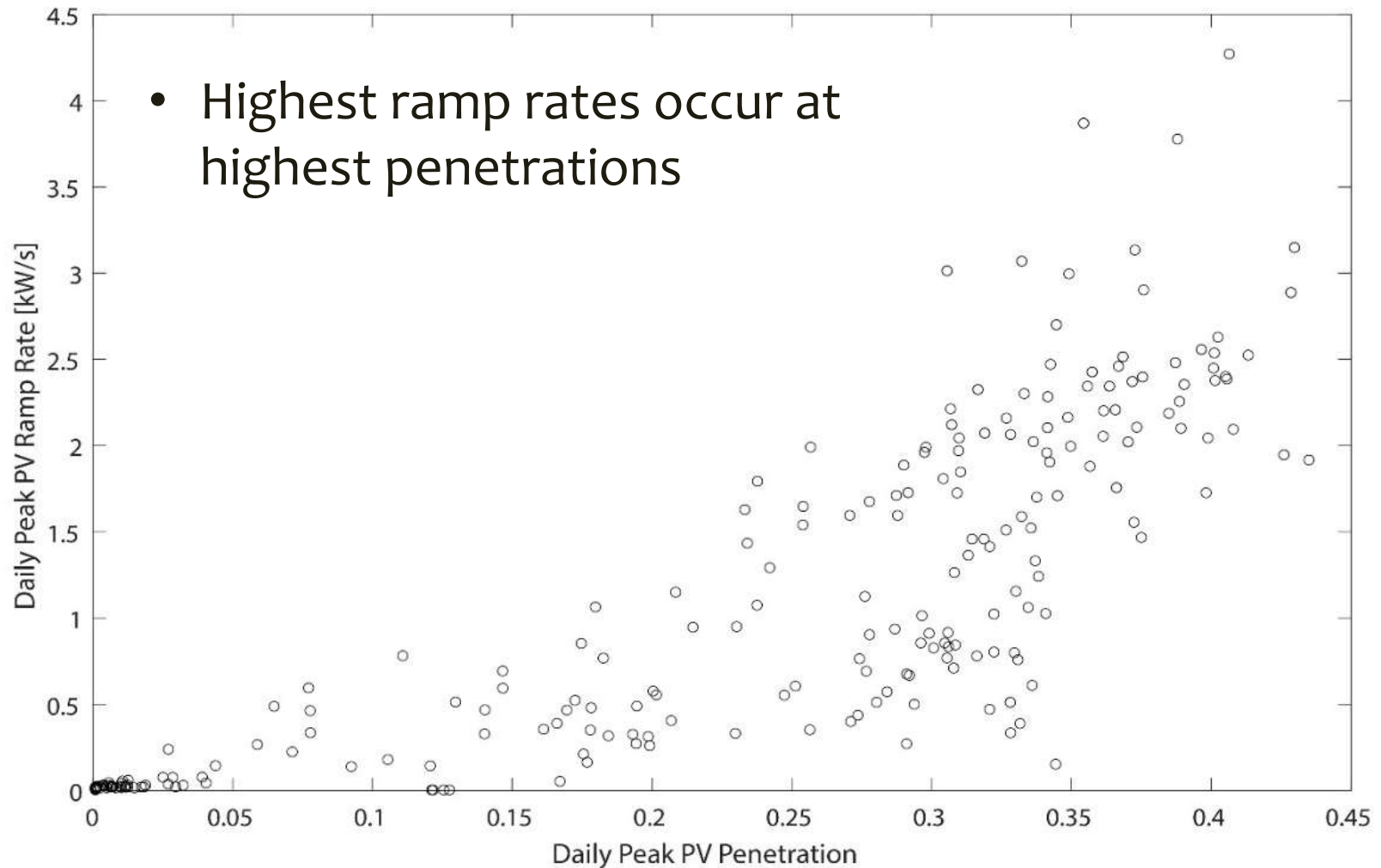
- Peak solar power penetration is 43%.



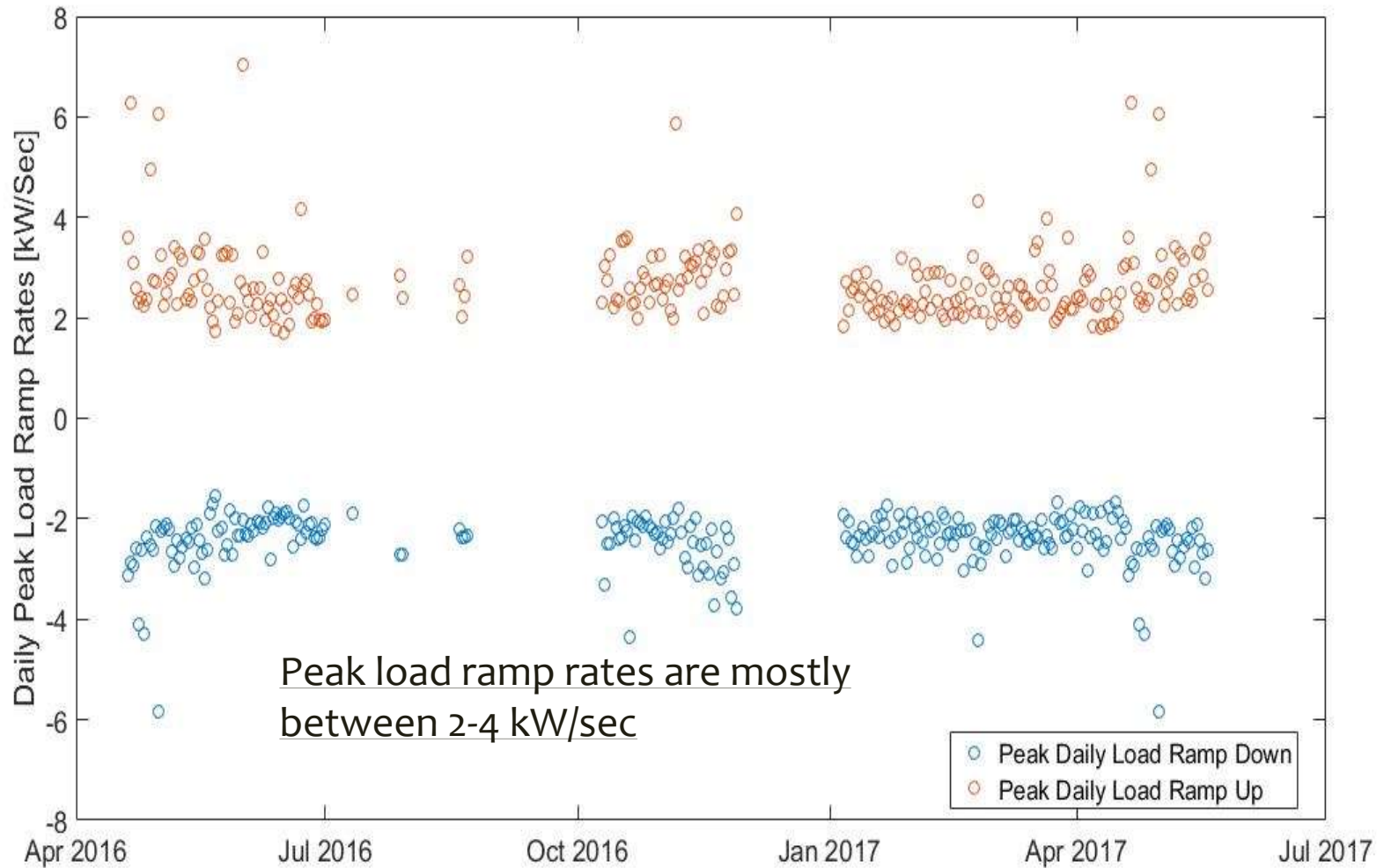
Ramp Rates



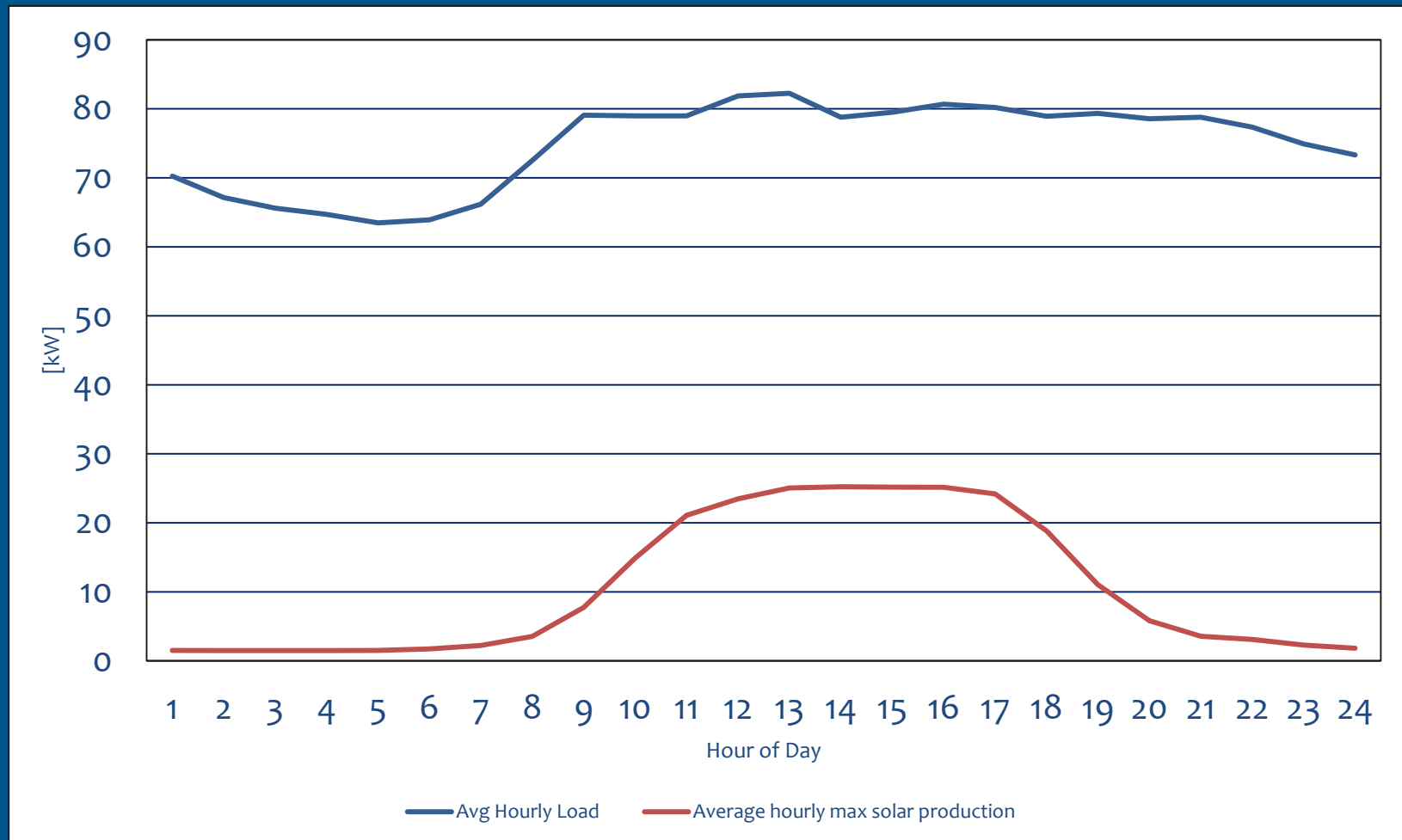
Ramp Rates vs. Penetrations



Load Ramp Rates

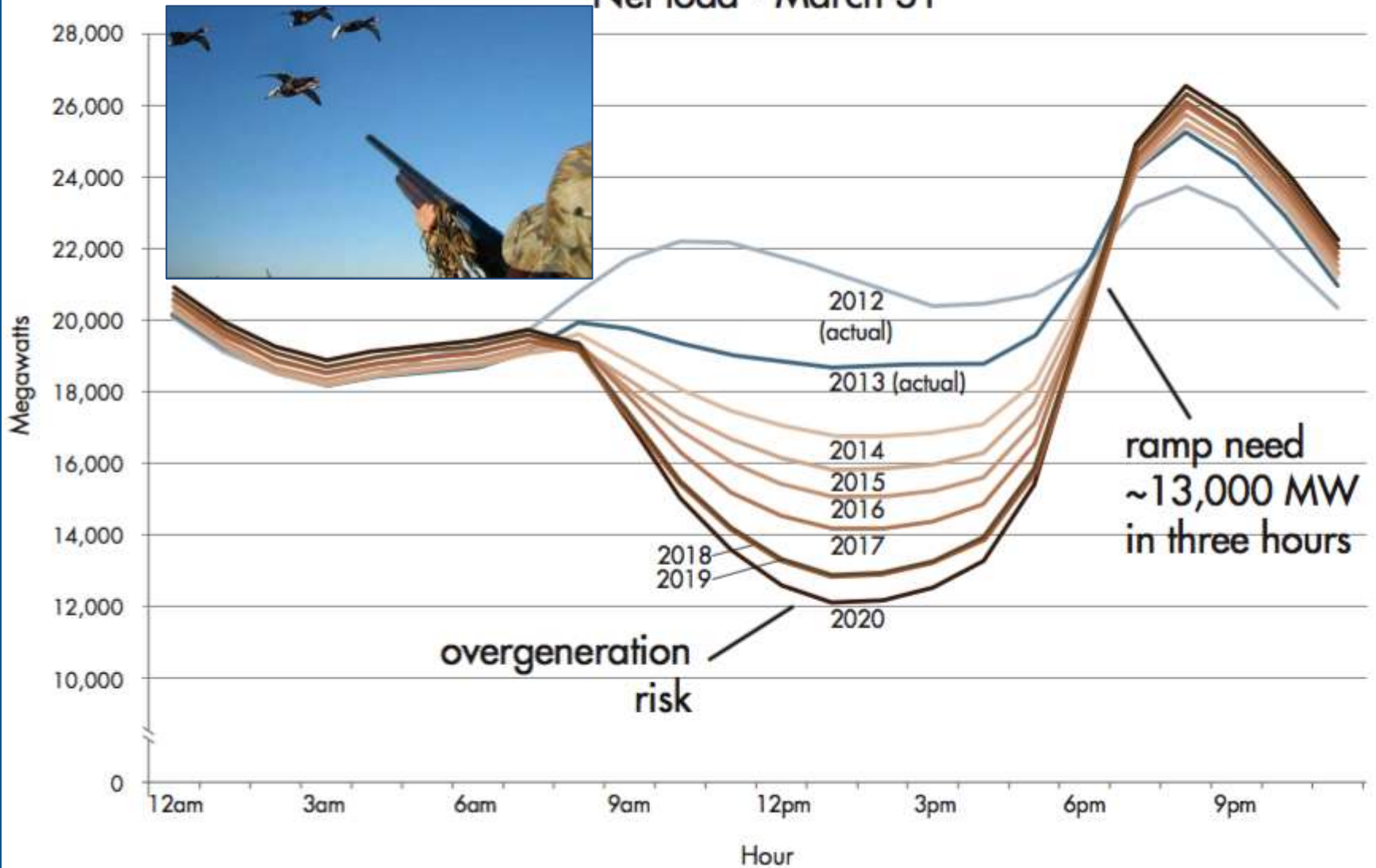


Hourly Load and Max Hourly Solar Production for March-July



The Alaskan Duck Curve?

Net load - March 31

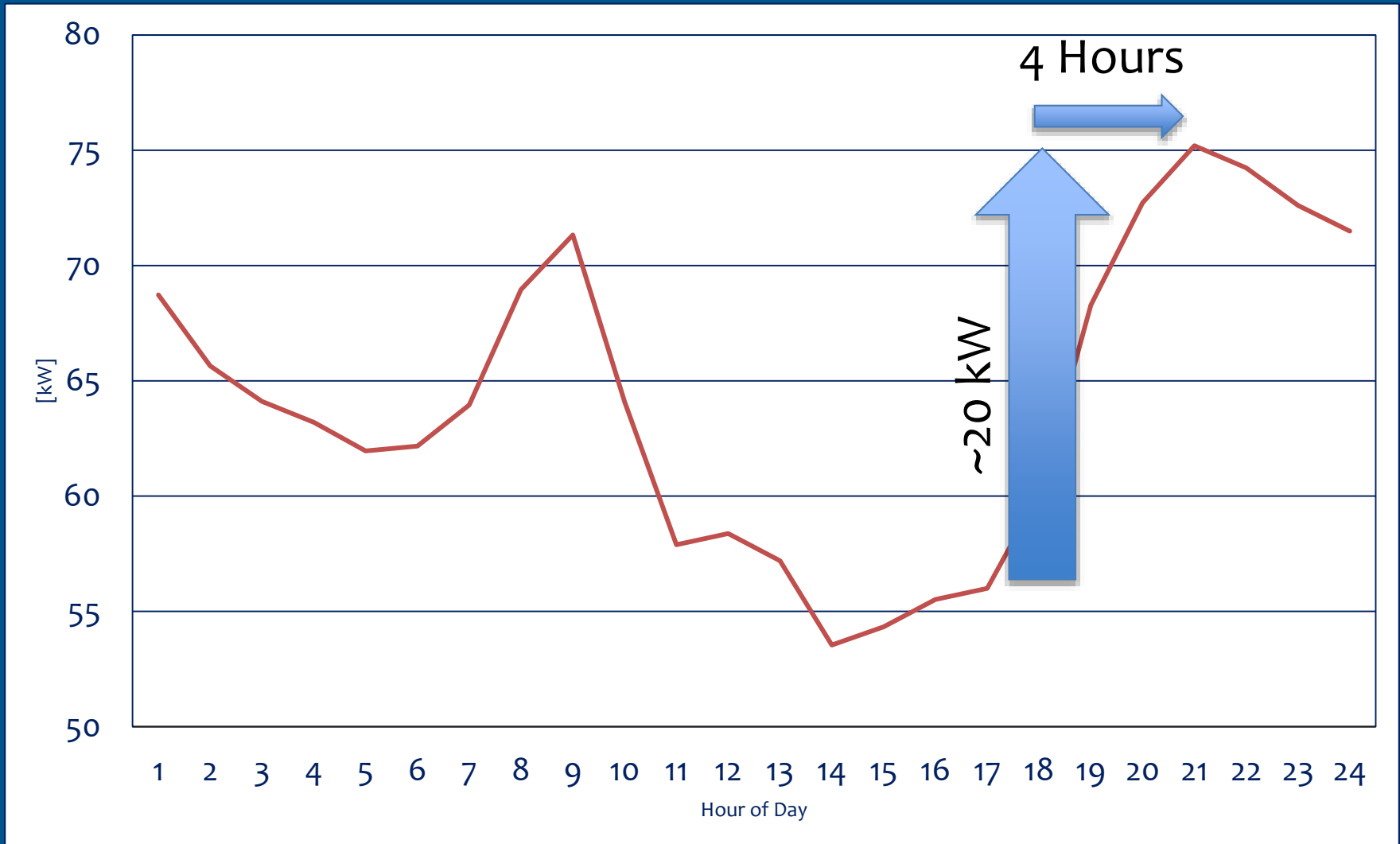


From: CAISO

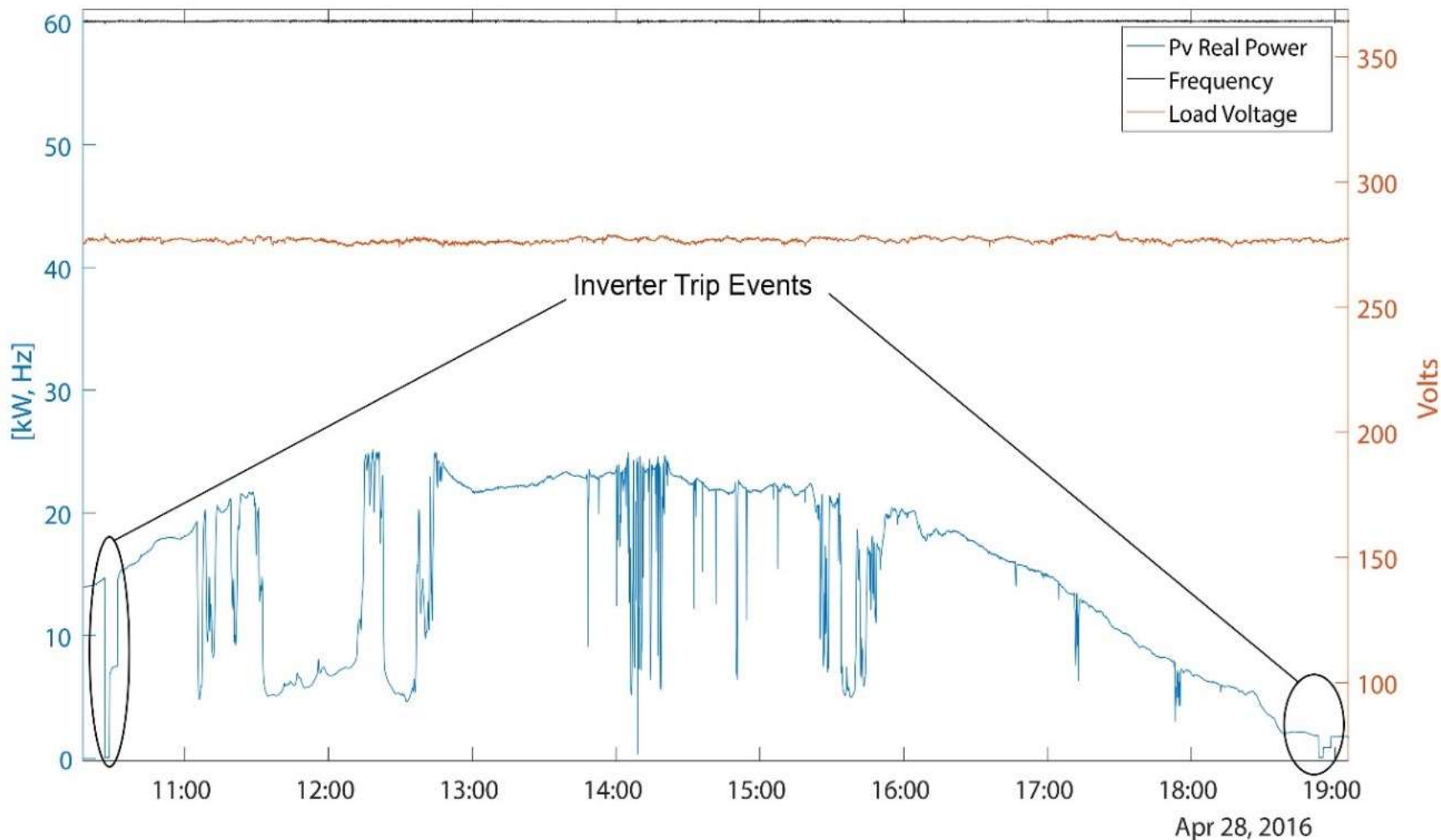


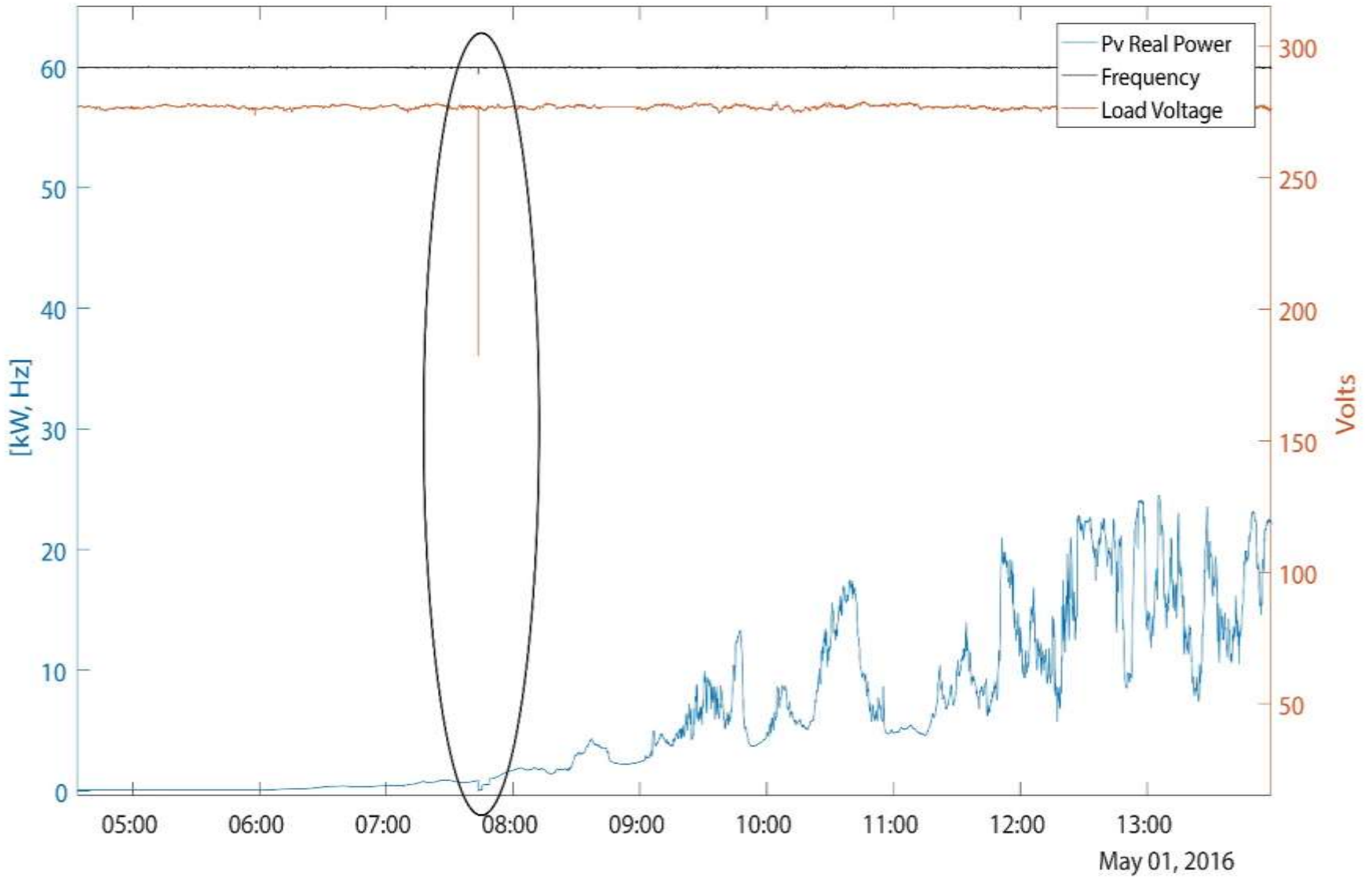
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Hourly Net Load for March-July



- 14 inverter tripping events in April and early May 2016
- Inverter tolerances changed in Mid-May 2016





Takeaways

- No noticeable operational issues. According to AP&T there has not been a significant negative impact on the engines, although long periods of low loading is a concern for the utility.
- After the initial problems, the system has been fairly trouble free.
- No obvious issues with power quality or blackouts as a result of solar PV.
- No unexpected O&M problems since ride through tolerances were adjusted.
- Ability to monitor the system was important to work out the initial challenges.



THANK YOU

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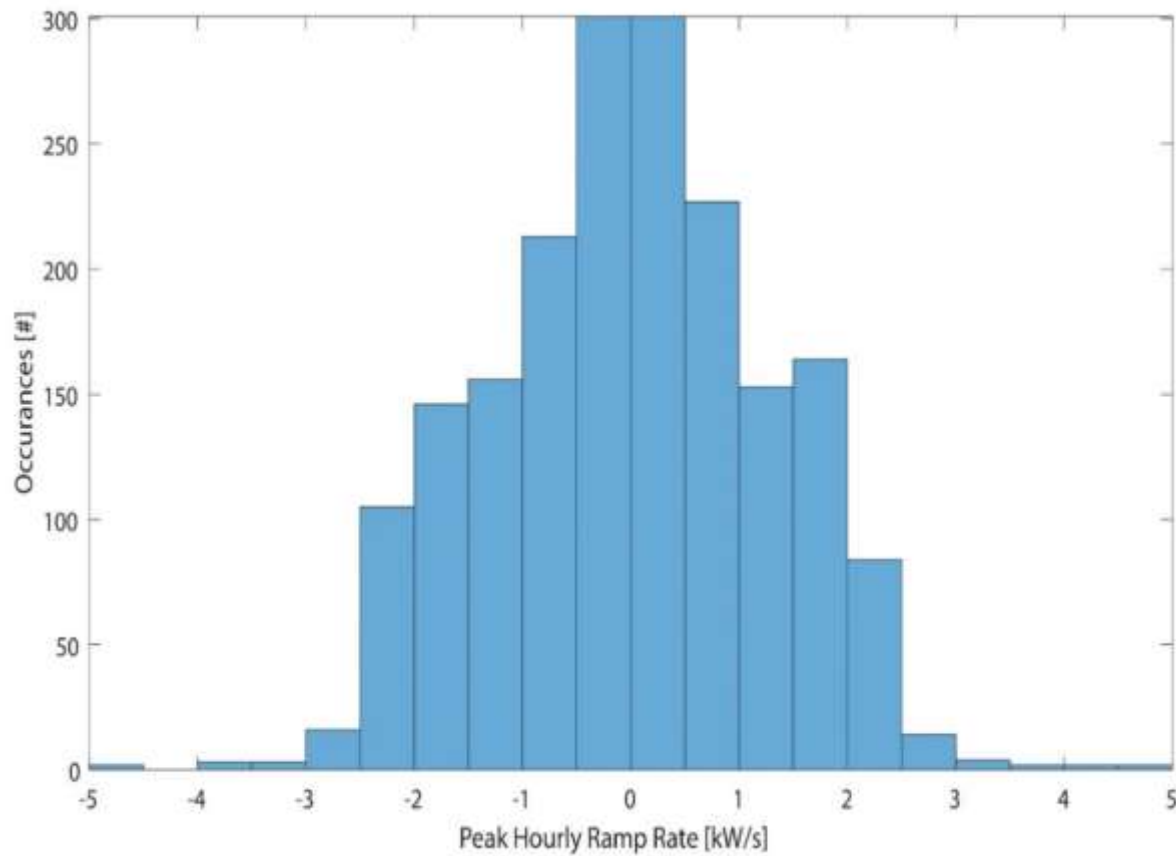
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- The Current Inverter Voltage and Frequency Settings (changed by Jarret of Wolf Solar 5/11/2016 to prevent dropouts) are shown below:
-
- V IL Max - 315 vac
- V IL Time - 158 p
- V IL MIN - 244 vac
- V IL Time - 218 p
- V OL Max - 325 vac
- V OL Time - 109 p
- V OL Min - 139 vac
- V OL Time - 109 p
- Freq IL Max - 61.5 hz
- Freq IL Time - 309 p
- Freq IL Min - 58 hz
- Freq IL Time - 309 p
- Freq OL Max - 62 hz
- Freq OL Time - 200 p
- Freq OL Min - 57 hz
- Freq OL Time - 250 p
- Start Time - (5 seconds on #1, 10 seconds on #2) Reconnect Time - (5 seconds on #1, 10 seconds on #2)
-
- Note:
- Times are in cycles (P), and not seconds.
- The MIX MODE was converted to BALANCE MODE on both inverters. They are staggered to start up 5 seconds apart upon reconnecting to the grid.
- IL = inner limit
- OL = outer limit

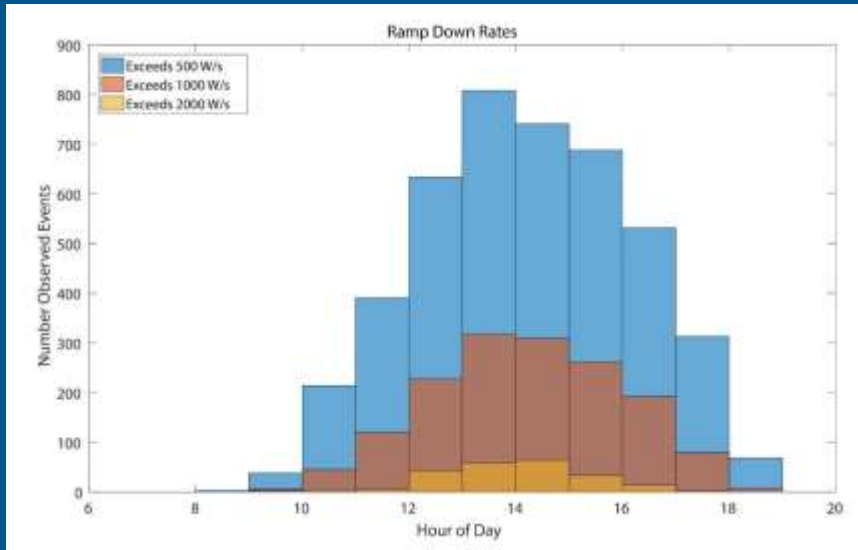




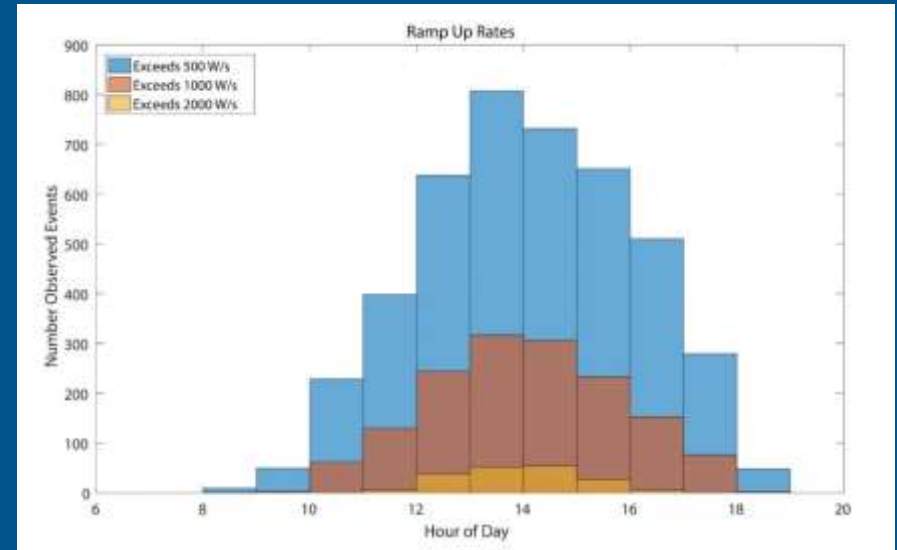
Hourly peak ramp up and ramp down rates of the Eagle PV array. Since these are daily values, each day with solar PV generation has two values: a peak ramp up value and a peak ramp down value.

An enlarged version of Figure 13. The y-axis is truncated above 300 occurrences to increase the detail that can be seen in the extreme ramp rates. The 0–0.5 kW/sec ramp rate has 5816 occurrences, and the -0.5–0 kW/sec ramp rate has 5528 occurrences.





Time of day for PV ramp down events in excess of 500 W/s. The highest ramp rates occurred between noon and 4 p.m.



Essentially the same as Figure 18, this graph shows time of day for ramp up events in excess of 500 W/s. Peak ramp rates occurred between noon and 4 p.m.

