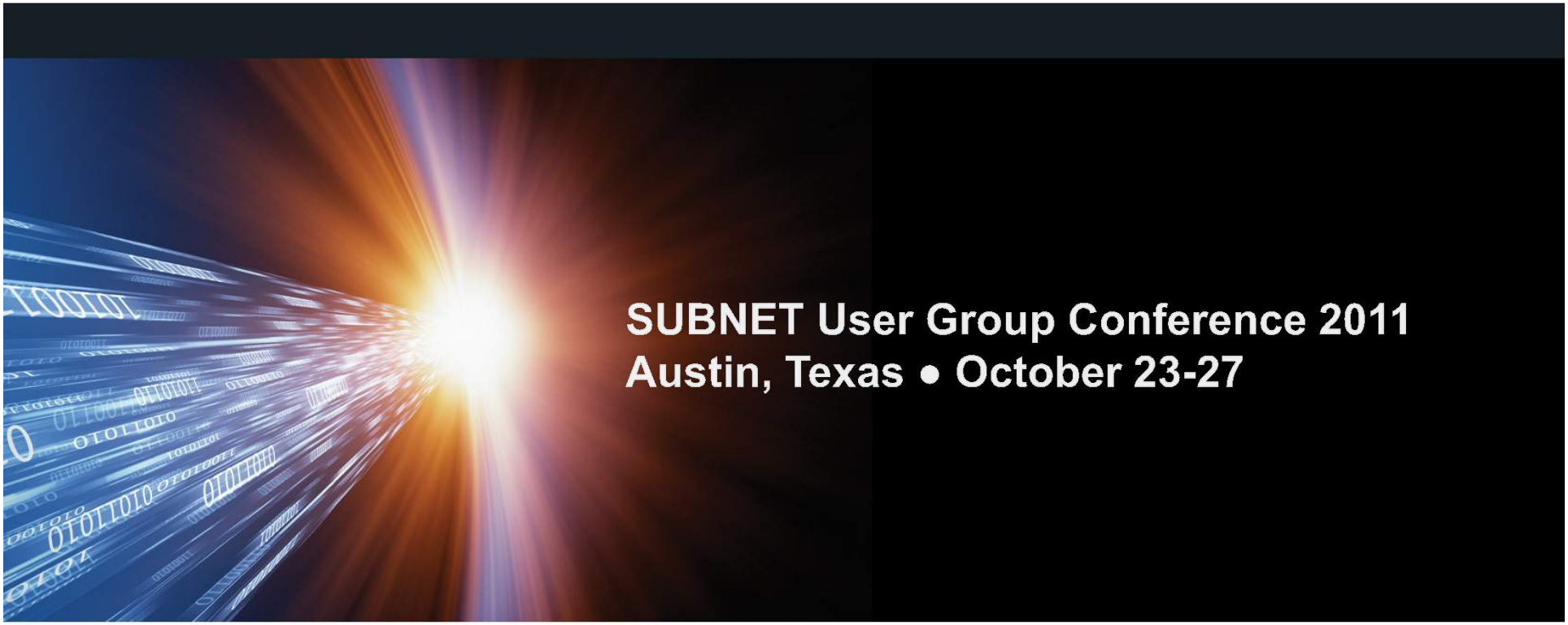


Cloud Based Communications Reliability for Utility Scale Photovoltaic Plants

Greg Linder, SCADA Engineer, Juwi Solar inc.

Presentation Outline

- About JSI
- JSI installed assets
- JSI SCADA System
- JSI „Cloud-based“ Communications Reliability
- Examples of Data Use
- JSI and Subnet: Problem Solved!

ABOUT JSI

Who is JSI?

- JSI is Juwi Solar Inc.
- JSI is owned by the Juwi Group, one of Europe's largest solar/wind/biofuel companies.
- JSI is an EPC (Engineer / Procure / Construct) company with a strong O&M group and an interest in keeping our plants in tip-top shape.

JSI INSTALLED ASSETS

JSI Installed Assets

- JSI presently controls 46 MW DC of PV assets across five states (New Jersey, Ohio, Texas, Colorado, Florida)
- There are currently 25 MW entering the construction phase (Nevada, New Jersey, Arizona).
- That's > 70 MW across seven states.

Jacksonville: 15 MW DC

Wyandot: 12 MW DC

New Jersey: 2.2 MW DC

Blue Wing: 16MW DC + Test Facility

Plants Under / Near Construction:

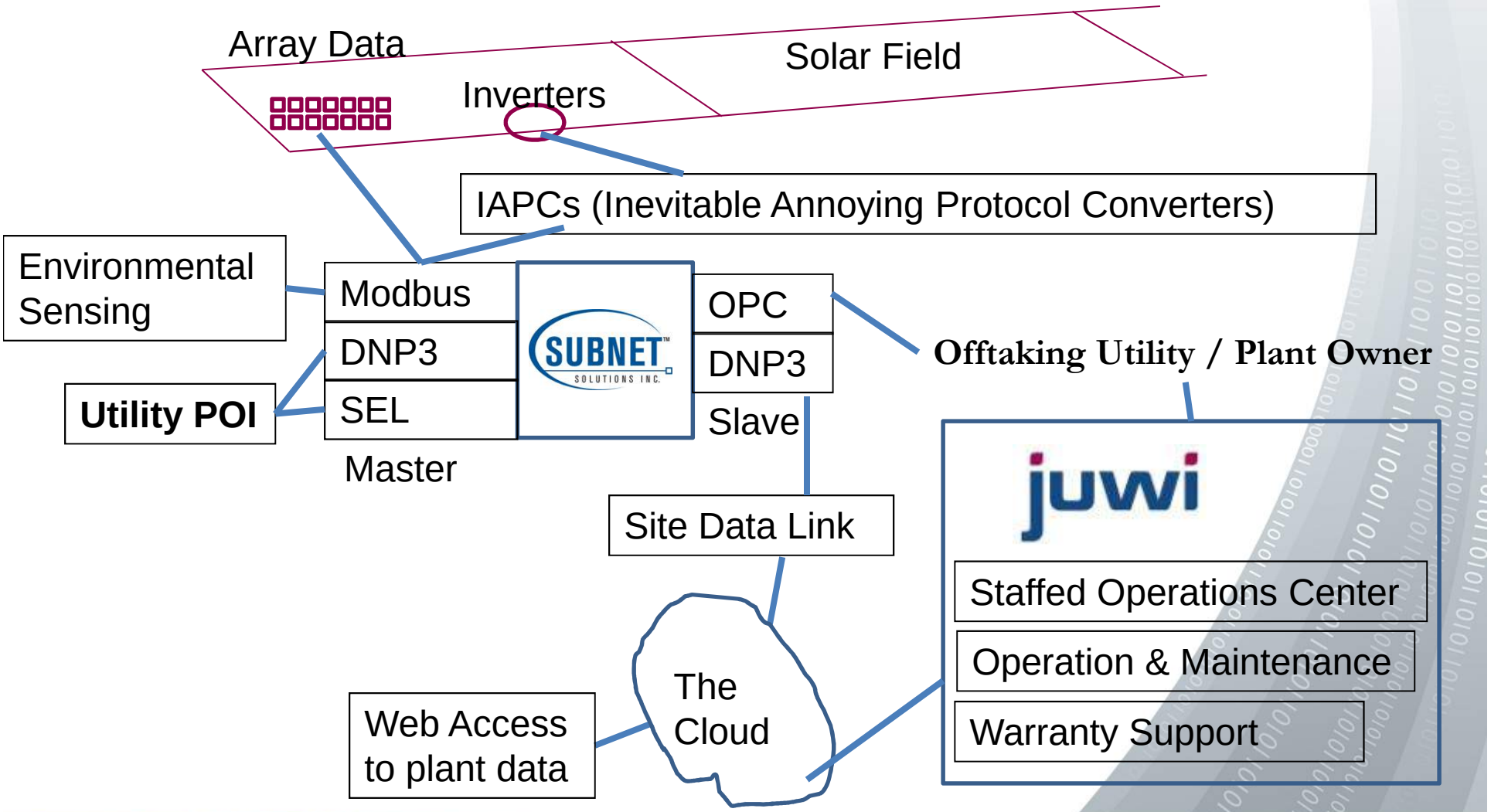
- 4.4 MW DC Plant in New Jersey
- 500 kW DC facility for Mars Candy
- 20 MW DC Plant connecting to SRP

THE JSI SCADA SYSTEM

JSI SCADA System goals:

- Operations and Maintenance / reliability
- Plant performance and power delivery assurance
- Monitoring data for all involved stakeholders
- Reliable unstaffed site operation
- VAR Control / Dispatch control
- Solar Resource Monitoring and Prediction

JSI SCADA General Layout



The “Site Data Link”

- JSI needs to get data from its sites to its operations center in Boulder.
- The O&M budget isn’t sufficient to allow for any sort of long-distance dedicated communications systems.

JSI does not own any data communications infrastructure

JSI Doesn't own any data infrastructure

This means we really kind of get stuck using the cloud…

JSI Doesn’t own any data infrastructure

We move data via the following technologies, depending on what’s available at each site:

1. DSL Modem
2. Cable Modem
3. Steal Someone Else's Access (Port 80, most likely)
4. Cellular Data Radio

The Cloud, you say?

- JSI Maintains our SCADA master and operator consoles at our offices in Boulder, CO
- We host our hot failover machine in a co-location facility elsewhere in Colorado
- Our VPN is hosted in several places:

  Cellular through a VPN SIM provider in Chicago

  SSL-based VPN links through a virtual server in Texas

  Site to site VPN through commercial VPN appliances

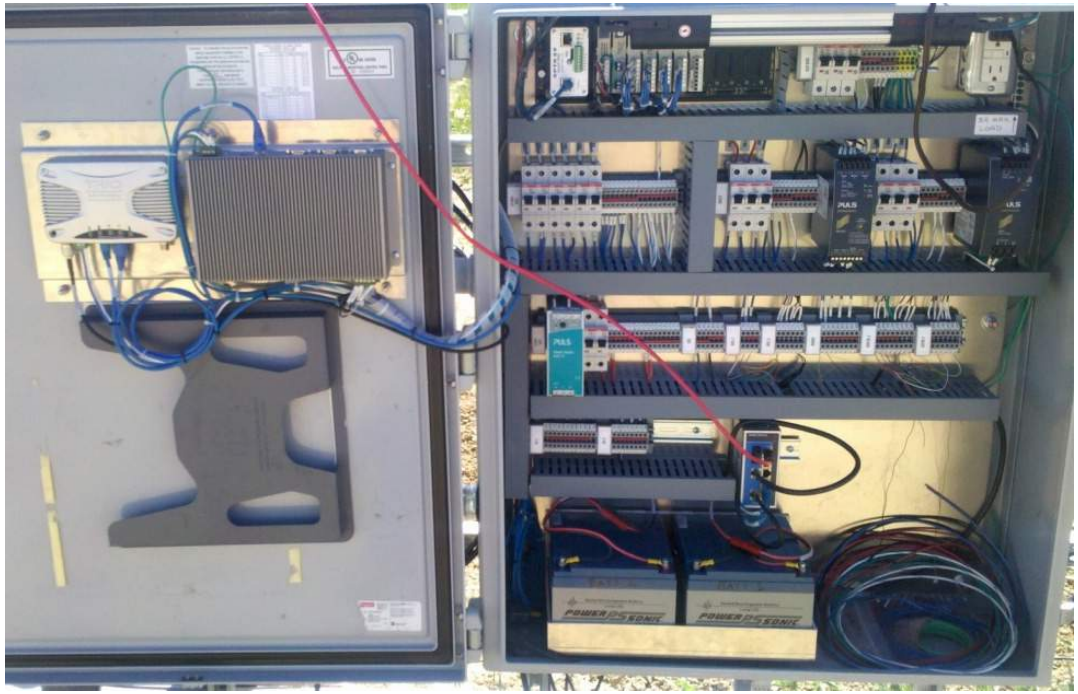
On-Site SCADA Hardware: Blue Wing

Site Data Link:
DSL to Texas
VPN host.

On-Site SCADA Hardware: Wyandot

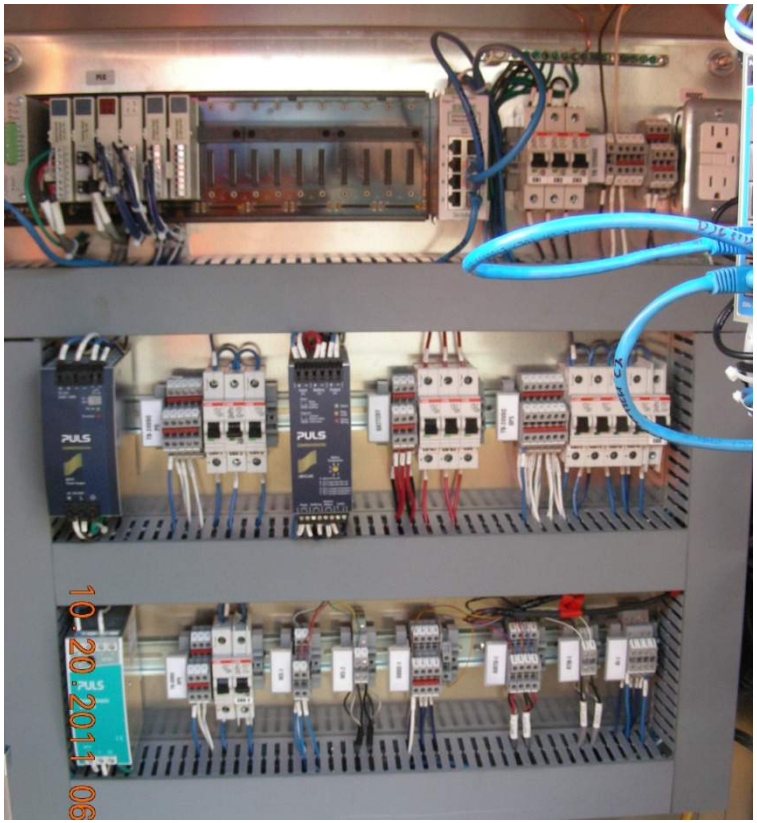
Site Data Link:
Cellular Data Link to Chicago VPN SIM provider

On-Site SCADA Hardware: Loveland



Site Data Link:
900 MHz Radio link to “Steal Someone Else’s”, then on to Texas VPN host

On-Site SCADA Hardware: Mill Creek



Site Data Link:
Cable Modem to Texas VPN host

JSI Communications Reliability: Bandwidth

- Use of DNP3 means we could use dial-up lines of at least 19.2 kbps for any of our site data links.
- Remote admin is difficult via RDP over such slow links. This dictates the order of our preferred communications options:

1: DSL 2: Cable 3: Steal Someone's 4: Cellular Radio / Satellite

JSI Communications Reliability: Uptime

- Our Texas virtual server has had zero unplanned outages since first commissioned (14 months).
- Our DSL lines have had zero unplanned outages since first commissioned (20 months).
- Our Cable lines have also had zero unplanned outages since upgraded (6 months ago, at Jacksonville.. See next slide)

Jacksonville: Auurghhh…

- Originally connected via Cellular data via our Chicago VPN SIM provider.
- Cellular Link Failed nearly every week, had to return three cellular modems.
- After lots of sleuthing over the phone…

Giant Radar Planes…

- Aircraft sporting 10 MW radar sets flying low altitude training from the local air base.
- Replaced Cellular radio with Cable Modem, communications problems vanished

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Communications Reliability:

- Use of disjoint “cloud based” communications technologies have lead to a reliable SCADA system, with no forced outages due to any of our communications lines going down, save for that Jacksonville cell modem.

SCADA DATA APPLIED: WHAT DO WE DO WITH THIS?

Real Time Data

E1	PS1	E2	E1	PS4	E2	E1	PS7	E2	E1	PS10	E2
46.9	AC kW	48.2	48.6	AC kW	47.9	49.9	AC kW	49.7	49.8	AC kW	49.7
54.32	DC	54.11	59.59	DC	53.8	56.25	DC	54.21	63.37	DC	57.87
4623.2	kWh-Day	4699.5	4685.6	kWh-Day	4676.7	4583.1	kWh-Day	4514.5	4494.8	kWh-Day	4474
60.9	DC Amps	57.9	56.8	DC Amps	54.6	63.8	DC Amps	60.6	85.8	DC Amps	78.6
E1	PS2	E2	E1	PS5	E2	E1	PS8	E2	E1	PS11	E2
46	AC kW	49.9	43.9	AC kW	47.9	50.4	AC kW	51.7	57.5	AC kW	48.3
52.57	DC	56.25	54.72	DC	54.21	58.08	DC	58.08	61.19	DC	54
4749	kWh-Day	4784.7	4624.3	kWh-Day	4645.8	4541.5	kWh-Day	4492	4400.6	kWh-Day	4435.3
58.9	DC Amps	59.6	65.4	DC Amps	60	76.9	DC Amps	76.1	86.8	DC Amps	73.2
E1	PS3	E2	E1	PS6	E2	E1	PS9	E2	Demo Facility		
47	AC kW	48.6	55.2	AC kW	49.5	58.5	AC kW	61.9	41.26 kVAR		
52.77	DC	54.42	59.99	DC	55.85	61.38	DC	63.57	17.92 kW		
4688.4	kWh-Day	4609.9	4651.6	kWh-Day	4615.1	4608.8	kWh-Day	4593.3	454586 kWh tot		
54.3	DC Amps	58.4	69	DC Amps	59.6	86.3	DC Amps	83	0.4 PF		

Solar 1 Recloser

Open	Trip
Closed	Enabled

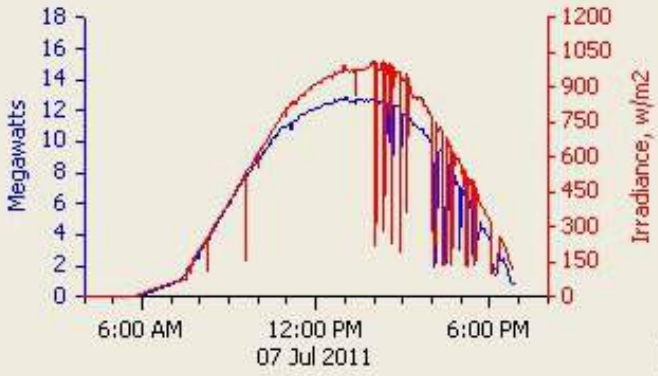
MW 0.44
kwh del 10495592
kwh rec 52637

Solar 2 Recloser

Open	Trip
Closed	Enabled

MW 0.4
kwh del 10148854
kwh rec 54205

Plant Power and Irradiance



Comm. Enclosure
- PS Good
- UPS Low Batt
- UPS On Load
- Battery Fail
- Ether. Switch
- Firewall
- Brooks RE
- Elmendorf RE

PS1 UPS
- On Load
- Battery Fail
- UPS Ready

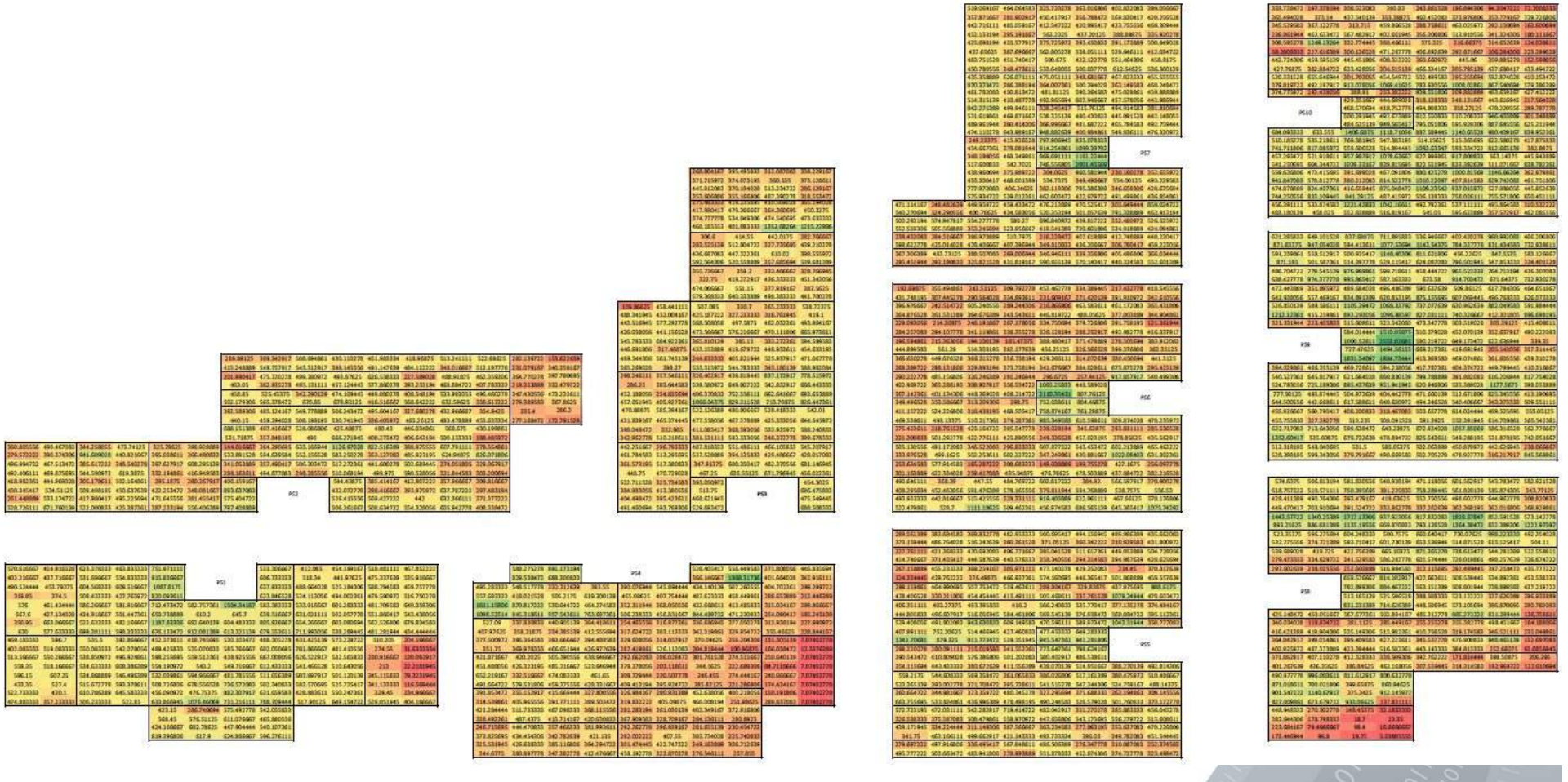
Plant Weather

Ambient Temp, C	35.06
Relative Humidty, %	29.29
Wind Speed, m/s	2.45
Rain Intensity, mm/hr	0

POA Irradiance (Watts/sq. meter)

PS 1	72.68
PS 6	63.75
PS 11	115.82
Avg.	84.08

Historical Data: Integrated Array Energy



SUBNET™ SOLUTIONS INC.

JSI AND SUBSTATION SERVER, PROBLEM SOLVED.

Substation Server is now JSI Standard

- Previous JSI Assets were ~1,000 points / MW worth of string currents.
- Future projects have more inverter points (~400 / MW) plus tracker systems (an additional 300 points / MW)
- Going from 1000 points / MW to close to 1700 points / MW, on a 20 MW plant.

Substation Server is now JSI Standard

- Substation Server's CSV config imports combined with the repeating nature of solar field points makes it an ideal software platform for doing solar field data aggregation.
- Future plants will use cabled links, plus a cellular backup as an option, plus redundant SSNET on-site machines to simplify system upgrades.