Solar Partner Programs - APS

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APS - Company Background

- Arizona’s largest and longest serving utility – since 1886
- Service Territory
  - 11 out of 15 counties
  - 1.2 Million Customers (89% residential)
  - 34,646 square miles
- Peak Demand ~ 7300MW in August 2015
- Approx. 950MW of Solar Capacity - 4th in the nation
  - 50% of solar portfolio is distributed
  - Pioneer in solar research since 1970s

Solar Partner Program (SPP)

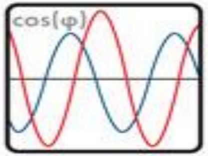
- APS owned, operated and maintained residential rooftop PV systems with advanced inverters
- Total 10MW deployment, approx. 1600 systems with average system size of 6kW
- APS customers receive bill credit of $30/month for 20 years lease
- Two 2MWh energy storage systems on two feeders
- 18 months research plan on specific use cases in collaboration with EPRI
- Information exchange through External Advisory council, conferences and other platforms

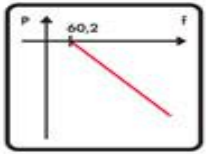
SPP – Current Status

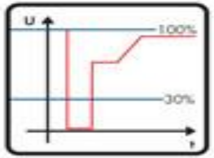
- Approximately 1500 systems installed
  - Approx. 200 on 6 primary research feeders
- UL 1741-SA certification complete
  - Two smart inverter models – SMA (primary) SolarEdge (secondary)
- Planned 1200 systems on AMI and 400 on cellular
  - Protocols - MODBUS on cellular and DNP3 on AMI pathway
- Inverters are controlled from centralized control system
  - visualization system for monitoring and analysis
- Testing for research began in April 2016
  - Follows an extensive test plan requiring daily control of inverters

Use Cases and Feeders

- Use Cases
  - Equipment Deferment
  - Voltage Management
  - Interoperability
  - Inverter Control and Functionality
  - Communication
  - Energy Storage
  - Model Validation
- Feeders
  - Six primary research feeders
  - Selected based on technical criteria and customer acquisition

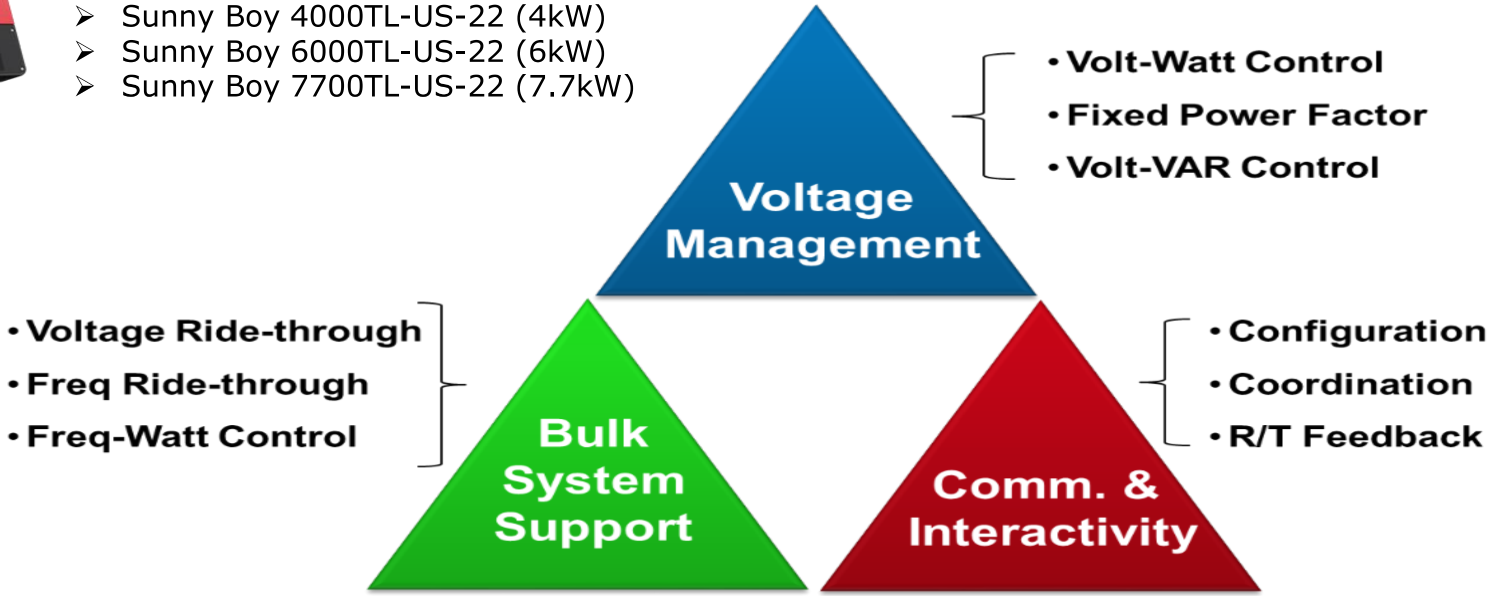




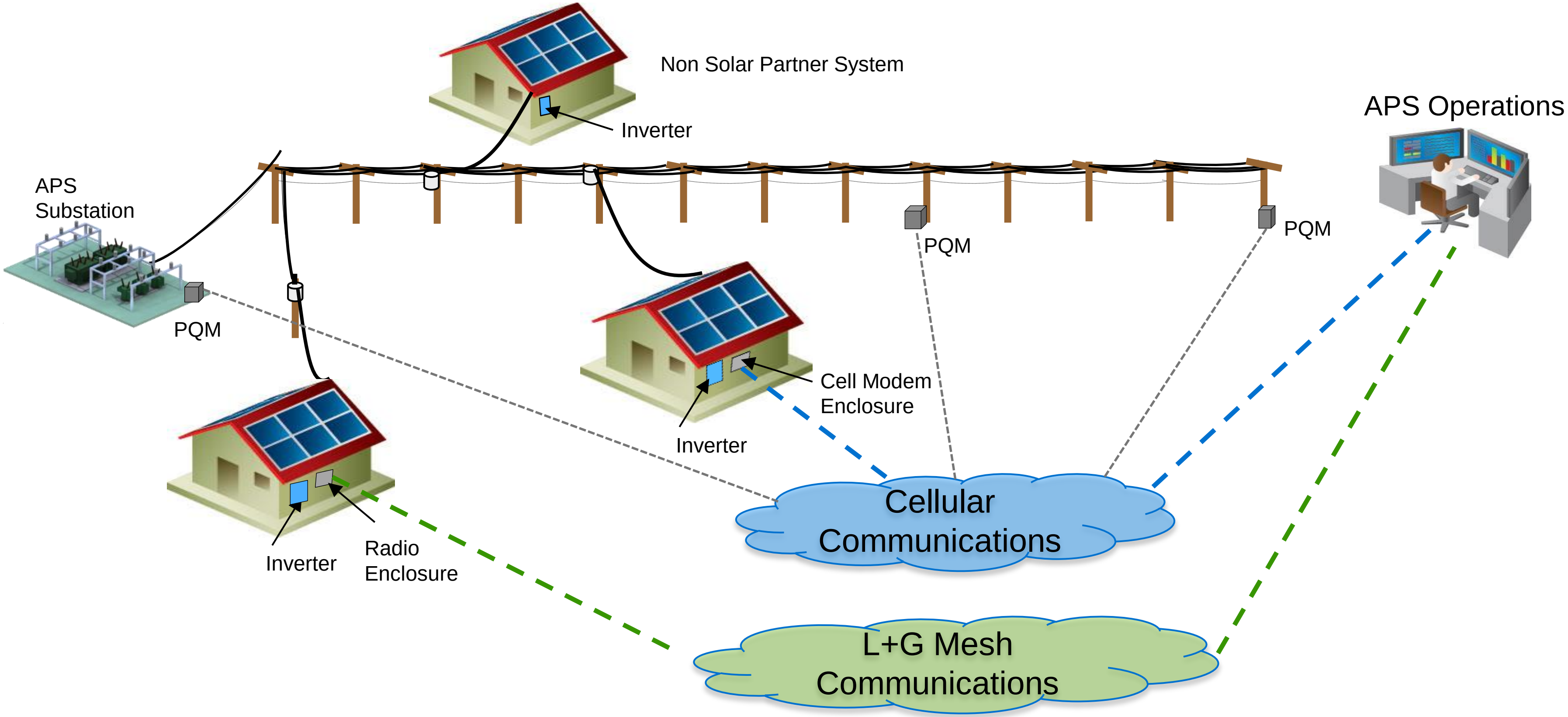


Smart Inverters

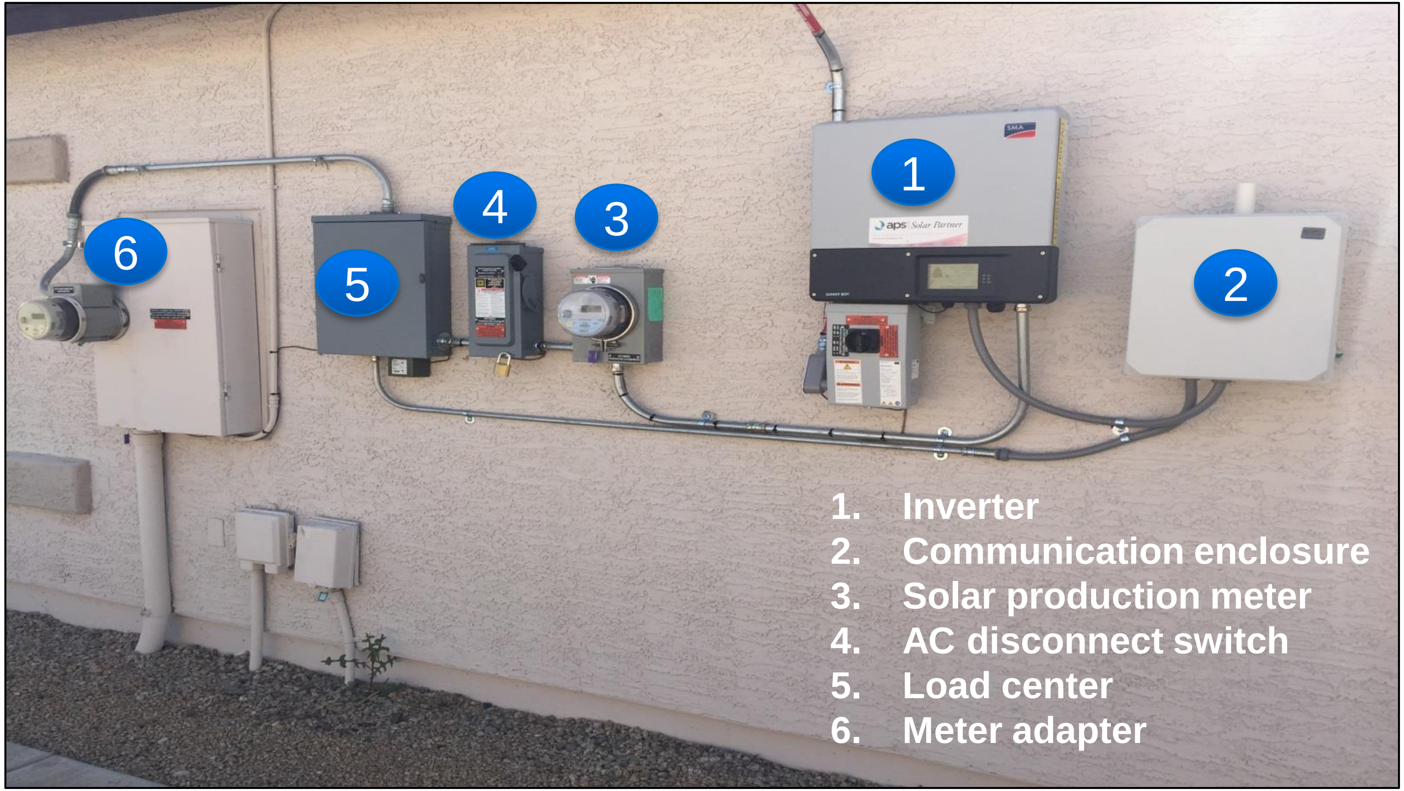
SMA inverters in SPP
- ➢ Sunny Boy 4000TL-US-22 (4kW)
- ➢ Sunny Boy 6000TL-US-22 (6kW)
- ➢ Sunny Boy 7700TL-US-22 (7.7kW)



Communication Architecture



SPP System in the Field



1. Inverter
2. Communication enclosure
3. Solar production meter
4. AC disconnect switch
5. Load center
6. Meter adapter

Control and Monitoring

- Centralized system for monitoring and control of all the inverters in the program
- Part of the inverters on MODBUS (cell modems) and part on DNP3 protocol (L&G radios)
- Approx. 15 measurement and 35 settings registers per inverters
- Different data collection frequencies depending on protocol and type of feeders
- Individual and group control for 10 advanced functions
- Interface with PI Data Archive; analytics and visualization on a separate specialized system
- Future interfaces with energy storage control and ADMS systems

Field Monitoring Installation

Field Measurements

PQ – 1 second	PQ – 1 minute	Inverters – 5 minute	AMI – Hourly
Voltage	Voltage Flicker	DC Voltage/Current	Energy Consumption
Current	Voltage THD	AC Voltage/Current	
Power	Current THD	Input Power	PV Energy Production
Reactive Power	Sequence Currents	Output Power	
Power Factor	Phase Imbalance	Reactive Power	Avg Voltage
Frequency	Total Energy	Inverter Status	Max Voltage
Fast, Accurate		*Fast, Coarse Data*	*Slow*
Few Locations		*Several Locations*	*Many Locations*

PQ monitors will also capture cycle-level data for transient events

PI Technology – Solar Partner Program

- SIEMENS SICAM PAS OPC Server (9 servers)
- PI OPC Interface
- PI OPC AutoPointSync
- PI HA Server on a zoned system (Distribution PI Server)
- PI to PI Interface
- PI to PI AutoPointSync
- PI HA Server on the APS corporate network (Enterprise PI Server)
- PI ProcessBook
- PI Coresight
- PI Asset Framework (AF)
- PI UFL (Universal File Loader Interface)

OSIsoft.

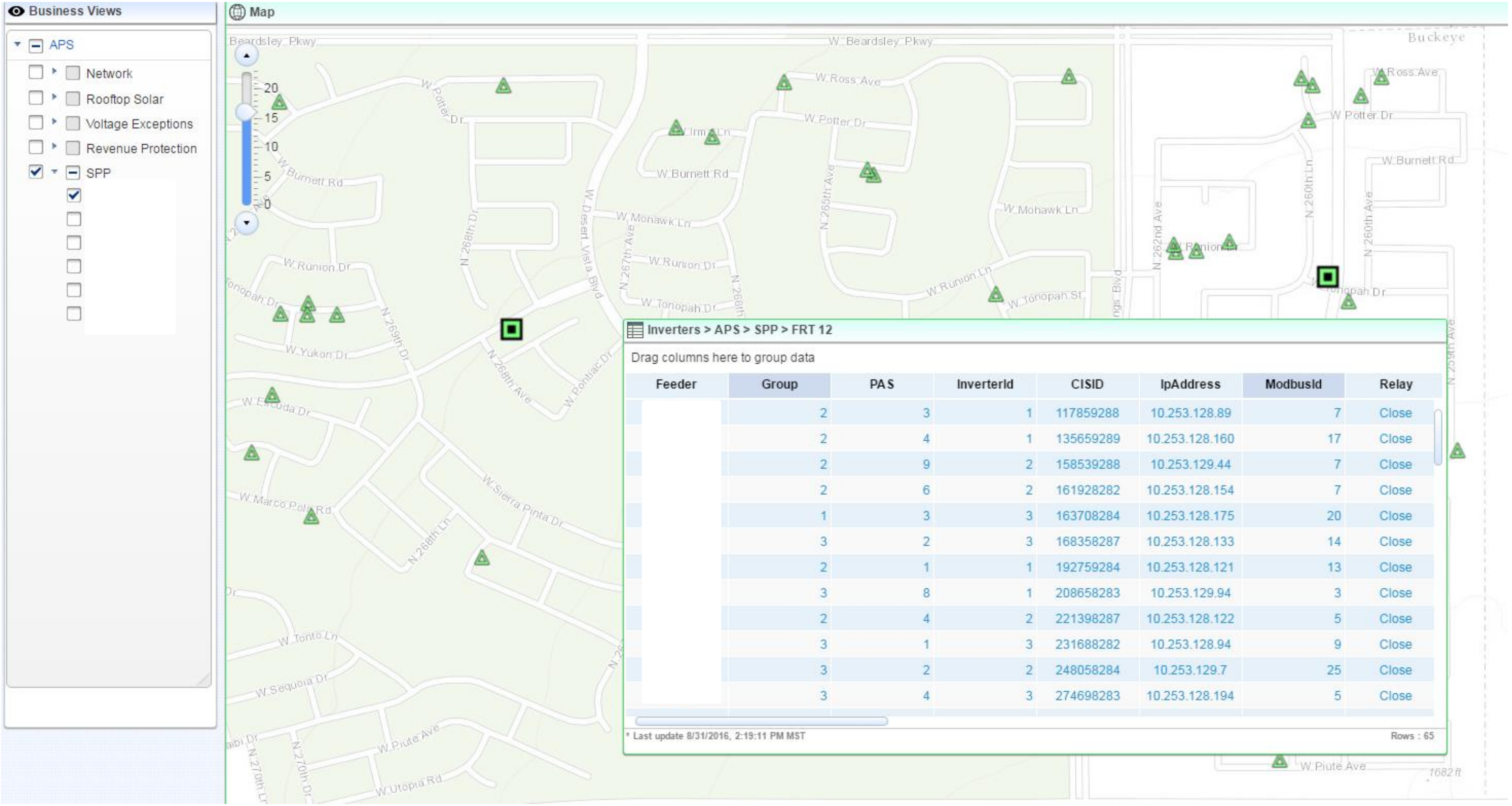
EPRI – Electric Power Research Institute

- Install Power Quality Monitors on selected Feeders
- Collect 1 second and 1 minute data on feeders
- EPRI sends collected data (CSV files) to APS via FTP.
- APS loads EPRI data into PI Server using PI UFL (Universal File Loader Interface)
- APS sends EPRI the following data
  - PV Inverter data
  - Meter read data (AMI) – Automatic Meter Reading

Future PI Data and Solar

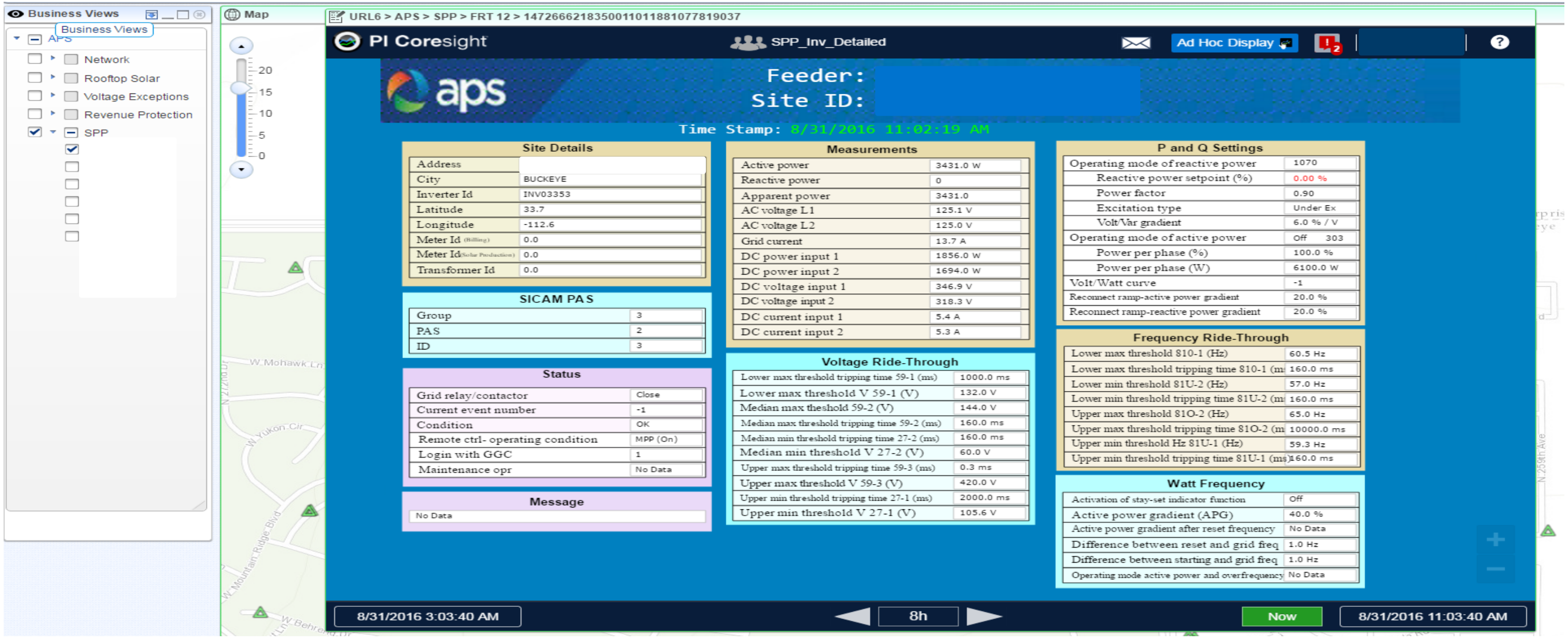
- Future PI data – weather data critical when you have lots of solar
- 7 Day forecasts – University of Arizona
- Cloud Cover/Wind
- Allows APS to run the generators more efficiently.
- Forecasting allows APS to have economical plants started and ready to go.
- We purchase gas to run plants 1 day ahead so we need forecasts.

ESRI MAP with Feeders/Inverters



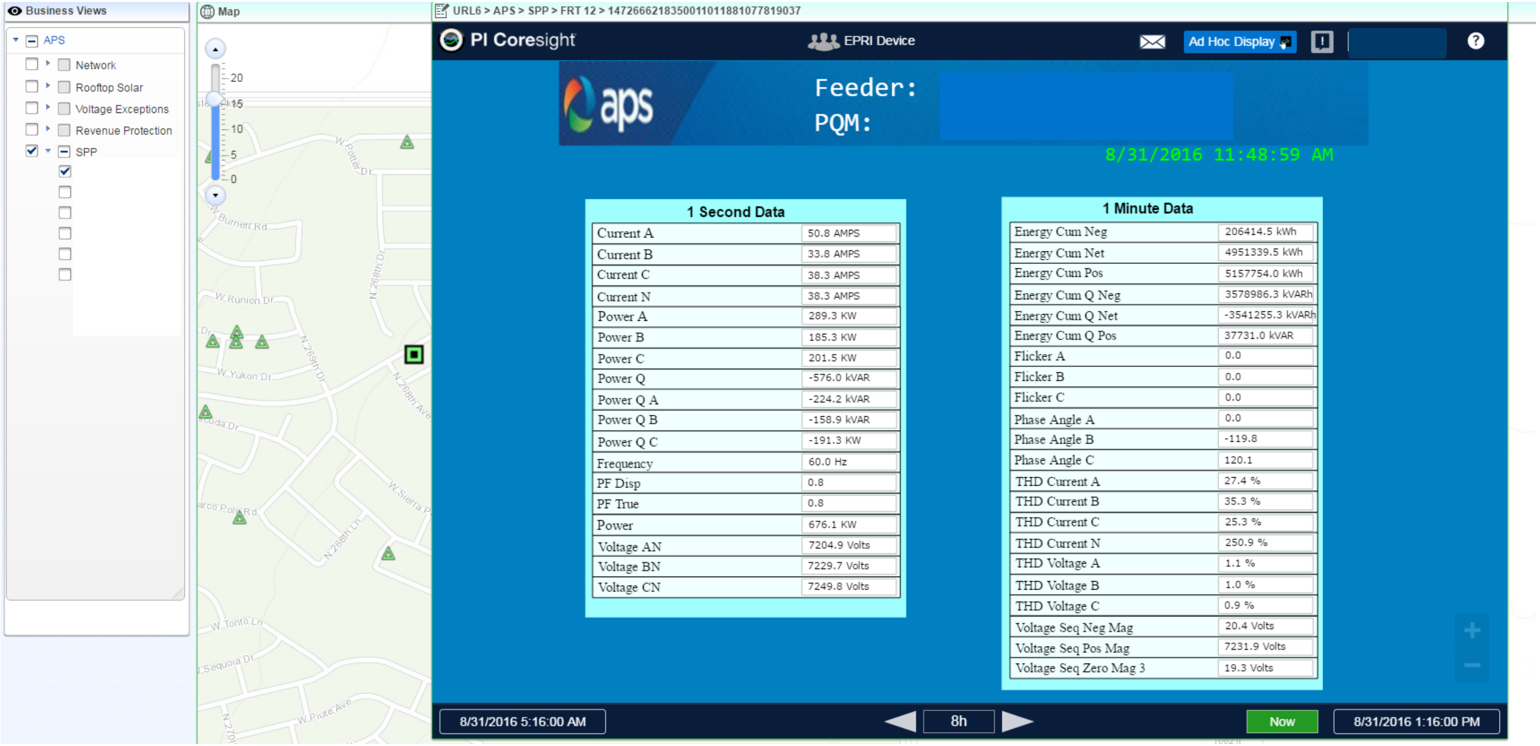
Feeder	Group	PAS	InverterId	CISID	IpAddress	ModbusId	Relay
	2	3	1	117859288	10.253.128.89	7	Close
	2	4	1	135659289	10.253.128.160	17	Close
	2	9	2	158539288	10.253.129.44	7	Close
	2	6	2	161928282	10.253.128.154	7	Close
	1	3	3	163708284	10.253.128.175	20	Close
	3	2	3	168358287	10.253.128.133	14	Close
	2	1	1	192759284	10.253.128.121	13	Close
	3	8	1	208658283	10.253.129.94	3	Close
	2	4	2	221398287	10.253.128.122	5	Close
	3	1	3	231688282	10.253.128.94	9	Close
	3	2	2	248058284	10.253.129.7	25	Close
	3	4	3	274698283	10.253.128.194	5	Close

Inverter Details



Coresight display selected by clicking on ESRI map.

Power Quality Monitors



Coresight display selected by clicking on ESRI map.

Takeaways

- PI System provides a rich set of tools for visualization, data collection, and analytics.
- OSIsoft PI is a strategic tool APS has chosen for business decisions.
- Enterprise Agreement – APS has a bi-weekly interaction with OSIsoft through the Enterprise Program Manager and Center of Excellence.

Thank You