

APS Solar Partner Program

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Integrating PV in Distribution Grids: Solutions and Technologies Workshop

NREL, Golden, CO
October 22 & 23, 2015



Agenda

- Overview
- SPP – Use Cases, Feeders
- Inverters – Technology, Standards
- Architecture – Communication, Control
- Research – Monitoring, Test Plan
- Energy Storage – Location, Specification
- Current State

APS - Company Background

- Parent company - Pinnacle West Capital Corporation
- Enterprise value ~ \$11 Billion
- Providing Energy over 120 years
- 1.2 Million Customers
- 5th Largest Service Territory in US (11 of 15 Counties)
- Operator and co-owner of Palo Verde Nuclear Generating Station



Solar Partner Program (SPP) - Overview

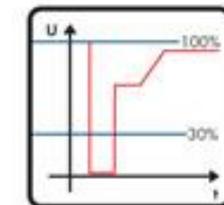
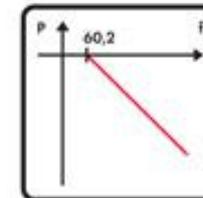
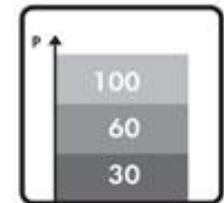
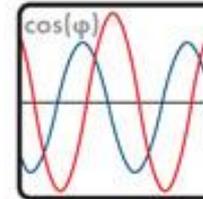
- Initiated in November 2014
- 10MW, approximately 1500 residential customers
- Rooftop PV systems ranging from 4kW to 8 kW in size
- Installations contracted to Arizona headquartered installers
- External Advisory Council comprising of industry, academia, government and research lab representatives meets twice a year
- 20 years lease, customers receive \$30 bill credit per month
- Targeted research feeders according to use cases, west facing roofs
- PV systems coupled with smart inverters
- Each system connected and controlled by central control system
- 2MW of energy storage

List of Significant Tasks in SPP R&D

1. Identification of use cases and feeders
2. Investigation and selection of inverters
3. Inverter lab testing and UL certification
4. Investigation and selection of control system
5. Control system development, testing and commissioning
6. Design and architecture of communication network
7. Design and architecture of Information Technology environment
8. Engagement with EPRI and research plan
9. Installation of field monitoring equipment
10. Data collection and research
11. Battery energy storage system locations and specifications
12. Commissioning of energy storage systems

1. Identification of use cases and feeders

1. Equipment Deferment
2. Voltage Management
3. Stress
 - a. High Solar Penetration
 - b. Interoperability
4. Inverter Control and Functionality
5. Communication
6. Energy Storage
7. Model Validation
8. Solar Forecasting



2. Investigation and selection of inverters

Inverter selection criteria:

- Technical capabilities
 - Current advanced inverter capabilities
 - Operational needs of inverter functions
 - Standards and certifications
- Communication capabilities
 - Communication protocol
 - Interactive control
 - Firmware update capabilities
 - Secure communication
- Financial, commercial and legal attributes



3. Inverter lab testing and UL certification

- Commercially available residential solar inverters have the required advanced features that can condition the power delivered to the grid to maintain power quality and reliability, but...



- UL 1741 SA is still in draft phases, process will not result in commercially certified inverters until Q1/Q2 2016
- Inverter manufacturers are still in process of developing/updating the advanced function capabilities
- APS is securing “special-purpose utility certification” for the SPP advanced-inverter models to accelerate this timeframe
- UL special-purpose certification targeted for completion in Nov 2015

4. Investigation and selection of control system

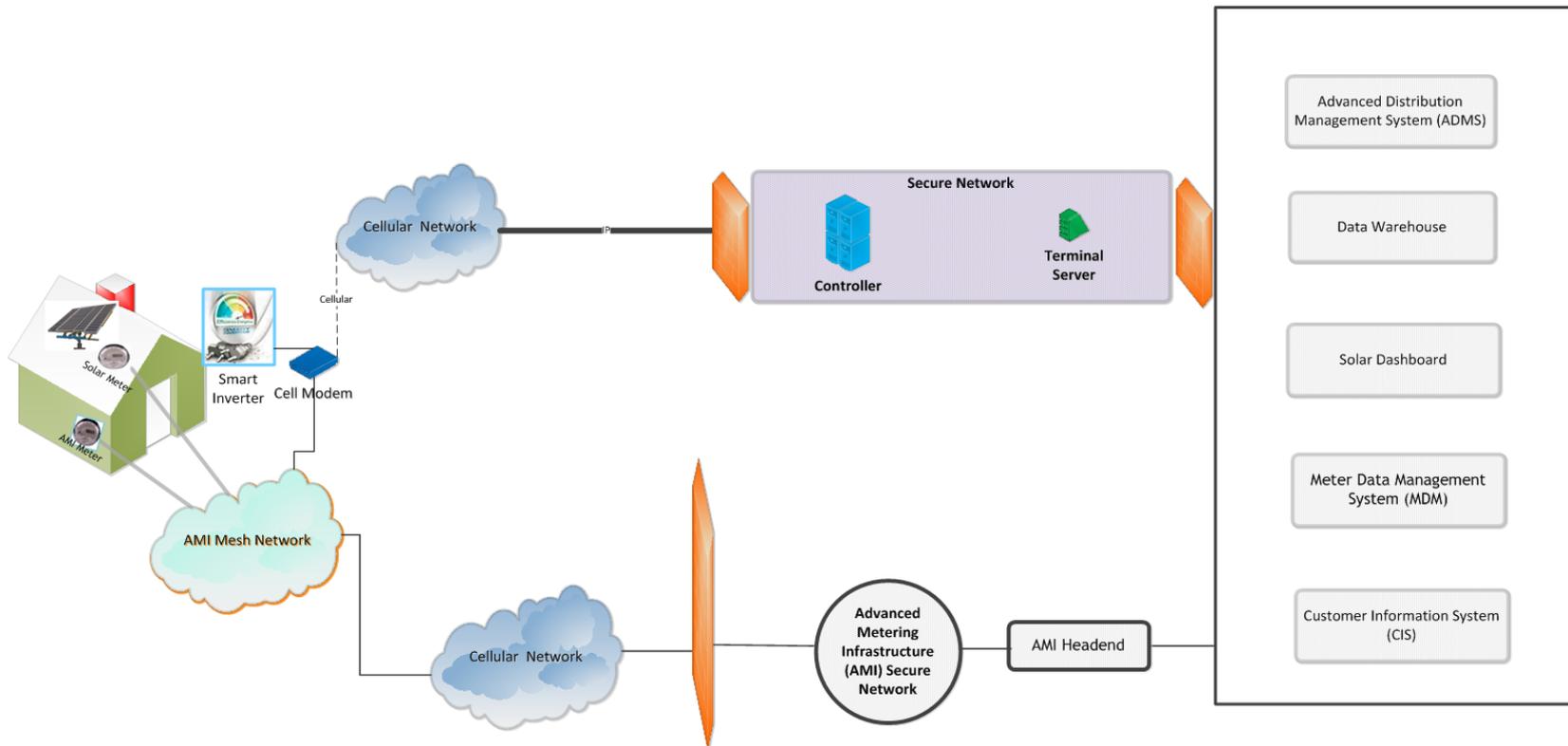
- Investigated variety of products and their capabilities in control and monitoring space
- Developed initial list of candidates
- Evaluated existing functions and integration capabilities
- Determined to pursue collaborative research and development approach
- Current APS SCADA systems do not directly integrate residential scale systems
- Existing residential scale monitoring systems do not directly integrate with utility SCADA

5. Control system development, testing and commissioning

- Requirement categories
 - System configuration and User Interface (UI)
 - Data collection and Storage
 - Inverter control
 - Alarming and reporting
 - Information Technology (IT) interfaces
 - Security and scalability
- Interoperability Test
- Factory Acceptance Test (FAT), Site Acceptance Test (SAT) and Field Testing

6. Design and architecture of comm network

Solar Partner Program (SPP) System Architecture



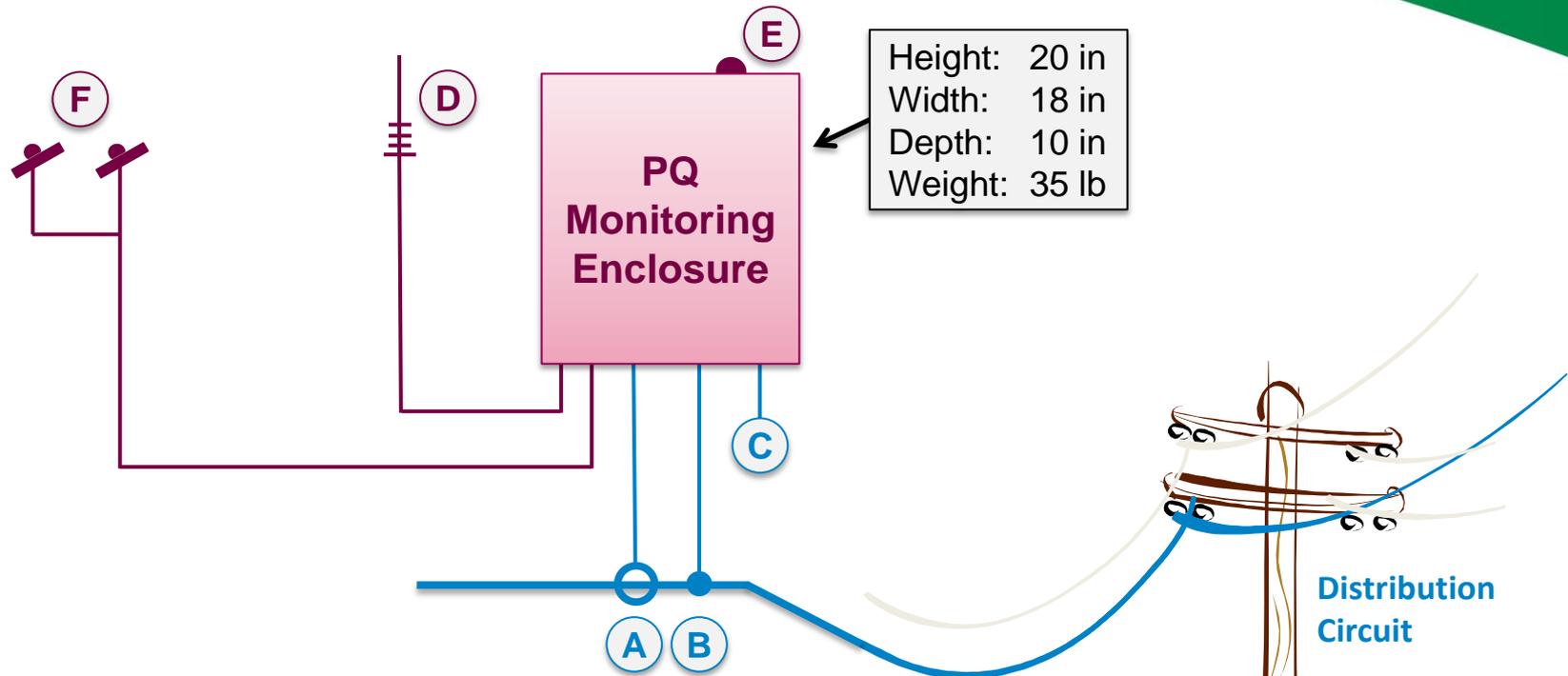
7. Design and architecture of IT environment

- It systems and environment set-up
- Data warehouse - Data storage, analysis and reporting
- Advanced Distribution Management System (ADMS) - Future interface
- Customer Information System (CIS)
- Meter Data Management System (MDM)
- Solar Dashboard
- IT operations and security monitoring
- Research partner B2B data exchange

8. Engagement with EPRI and research plan

- APS and EPRI collaboratively developed and prioritized research questions within each of the use cases
- Detailed test plan preparation in progress
- Feeder simulation to establish the hypotheses
- Monitoring and data collection from multiple sources
- Analytics on measurement data
- Reporting including lessons learned and best practices

9. Monitoring equipment installation

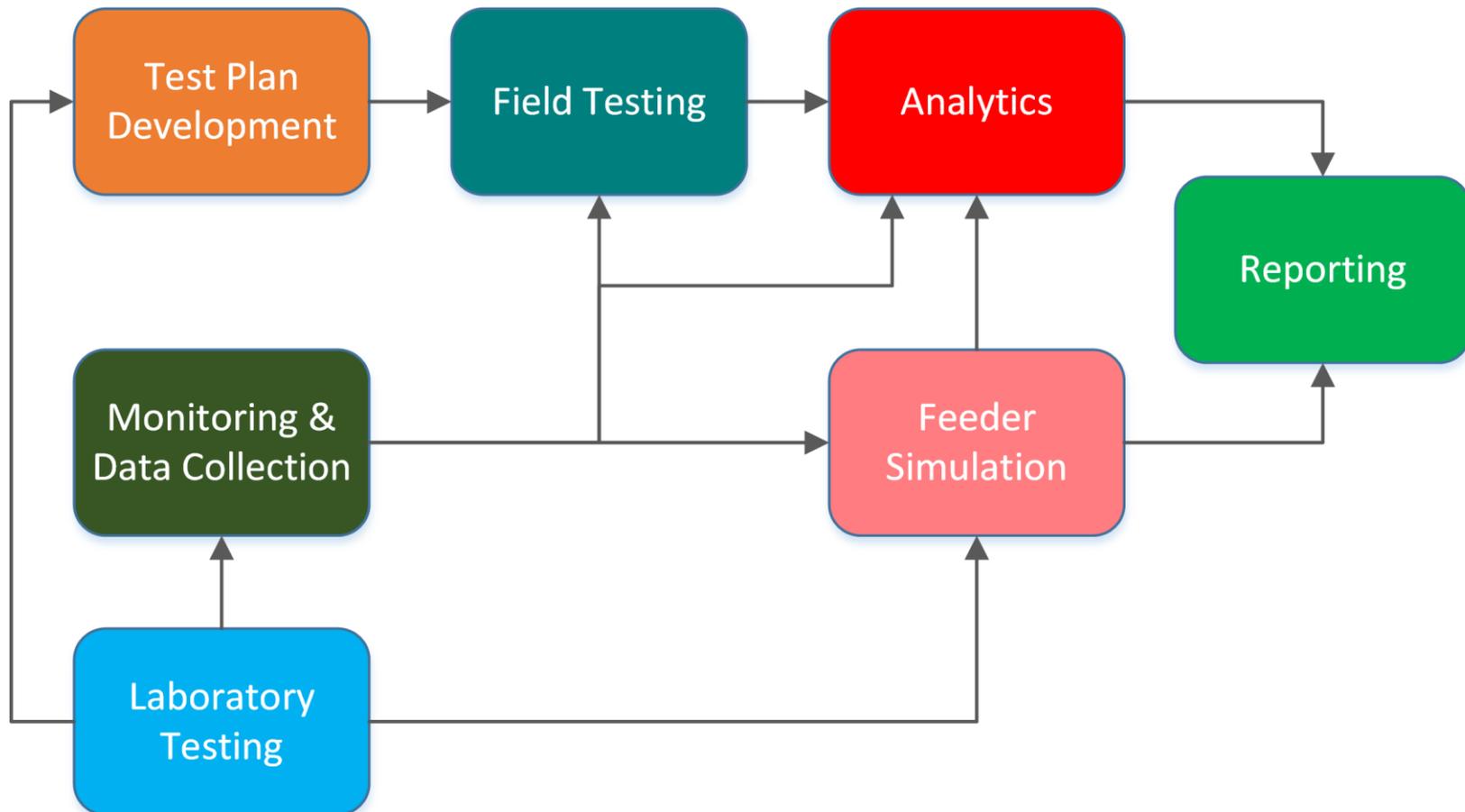


- A. **Current Transformers (CT)** (3-phase, 5A secondary)
- B. **Potential Transformers (PT)** (3-phase, 120V secondary)
- C. **Power Source** (120-480V or PT secondary)
- D. **Cell Modem Antenna** (internal or external)
- E. **GPS Antenna** (top of enclosure or external)
- F. **Pyranometers** (solar radiation sensors, quantity 2)

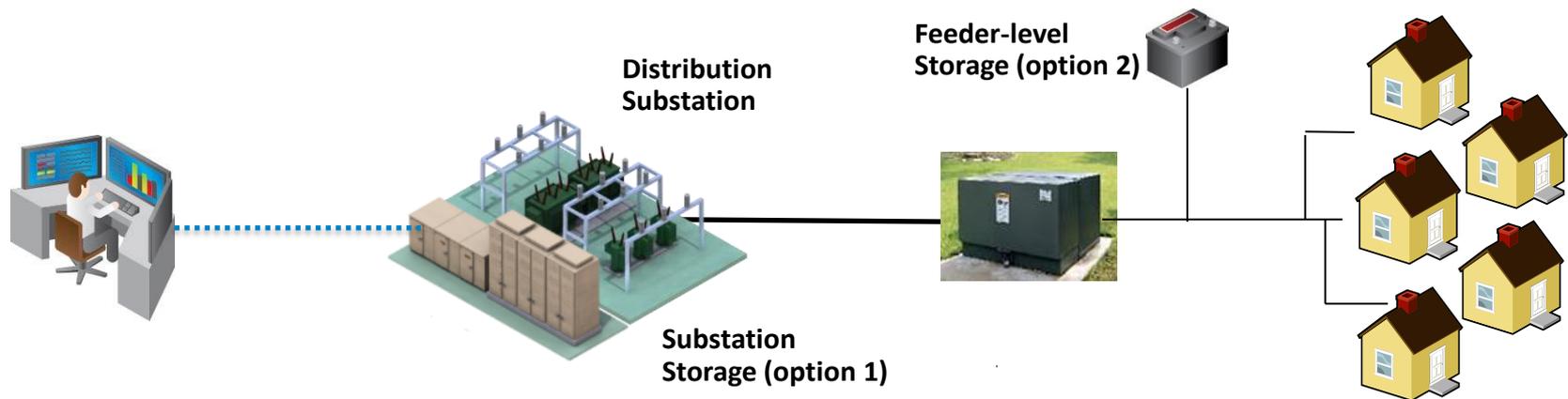
Blue: Provided
by Utility

Orange: Provided
by EPRI

10. Data collection and research



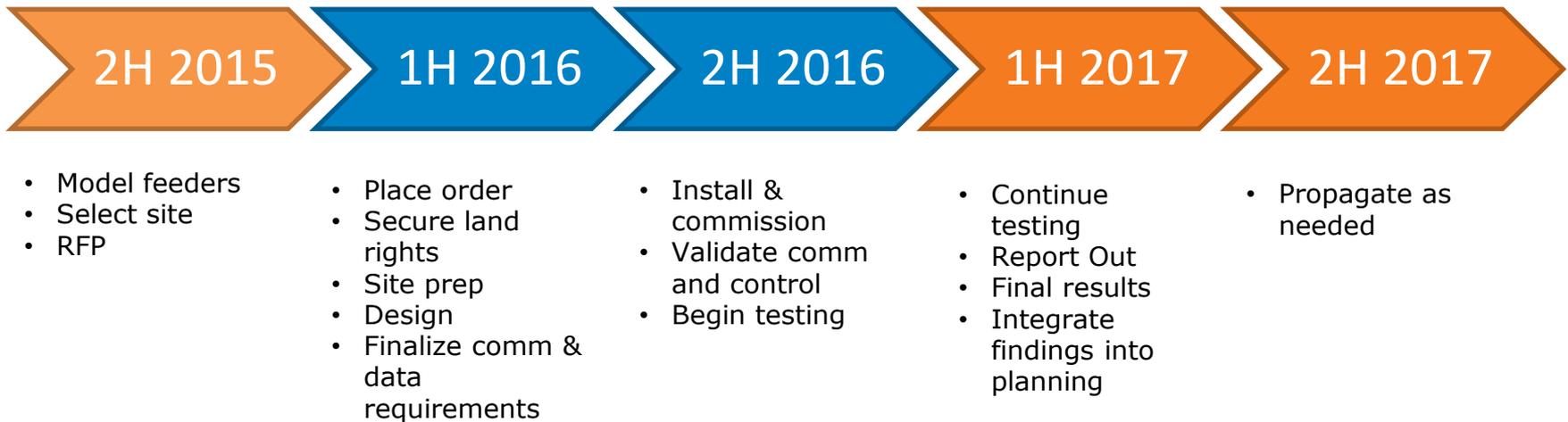
11. Battery system locations and specifications



Potential Distribution System Applications:

- **Defer** traditional upgrades
- **Time-Shift** energy from renewables
- **Regulate** and mitigate power quality issues caused by renewables

12. Commissioning of energy storage systems



Questions?

