Prescott Variability Measurement and Forecasting (Integrating Large Scale PV to the Utility Grid)

Solar Variability, Resource Prediction, & Monitoring Workshop
December 6, 2010
Ron Flood, APS

Arizona Public Service

- An affiliate of Pinnacle West Capital Corporation (PNW)
- Generates, sells, and delivers energy and energy related products (Vertically Integrated Utility)
- Service territory:
  - 11 of 15 Arizona counties
  - 34,645 sq. miles
  - About 1.3 million customers
- Load Requirements
  - Currently at 7400 Mw Peak Demand
  - Around 2.6% load growth

Renewable Energy

- RES: 15% of energy by 2025 with 20% of the 15% from distributed energy
- Operating Utility Scale: 229 Mw (all non-solar)
- Distributed Energy goal end of 2010, 140 Mw
  - 88 MWh installed, 84 MWh reserved
  - 11,000 customer DE funded
  - 320% increase in customer participation over 2009
- RFP activity in 2010
  - Three solicitations (Small Gen, DE, In-State Wind)
  - 450 proposals

Renewable Energy

- Announced Utility Scale Renewable Energy
  - 250 Mw CSP/Storage
  - 70 Mw of DE
  - Perrin Ranch (99 Mw in state wind)
  - AZ Sun (Luke AFB – 15 Mw, Gila Bend – 18 Mw)
  - Bagdad Solar (15 Mw)
  - Snowflake White Mountain Power (added 10 Mw)
- Negotiating another 60 Mw of contracts

Purpose of Study

- To better understand the effects of the variability of PV on our distribution and transmission systems.
- To understand how forecasting might be applied by the utility to get the best utilization of resources.
- To supplement other industry studies that have been conducted.

How Will We Use The Information?

- Resource Planning
  - Correlation of variable resources with load conditions with weather
  - Better planning of future regulation and reserve generation
  - Costs (both capital and operational) for integration of variable resources
  - Upgrade costs or savings on distribution systems
- Operational
  - Better allocation and management of generating resources
    - Fuel savings
    - Adequacy of generation to meet load and ancillary requirements
  - Maintaining good power quality for distribution customers
  - Better analysis of interconnecting entities for increasingly larger Photovoltaic Generators.
- Help Internal and External APS Stakeholders “feel more comfortable” with the variable resources.

Learning Experience

- Preface to “Flagstaff Project”
- Consolidation of diverse APS resources for one project
- Best methods to gather, format and store data into the APS IS
- Preserve data security while sharing with groups outside APS
- Techniques to analyze data

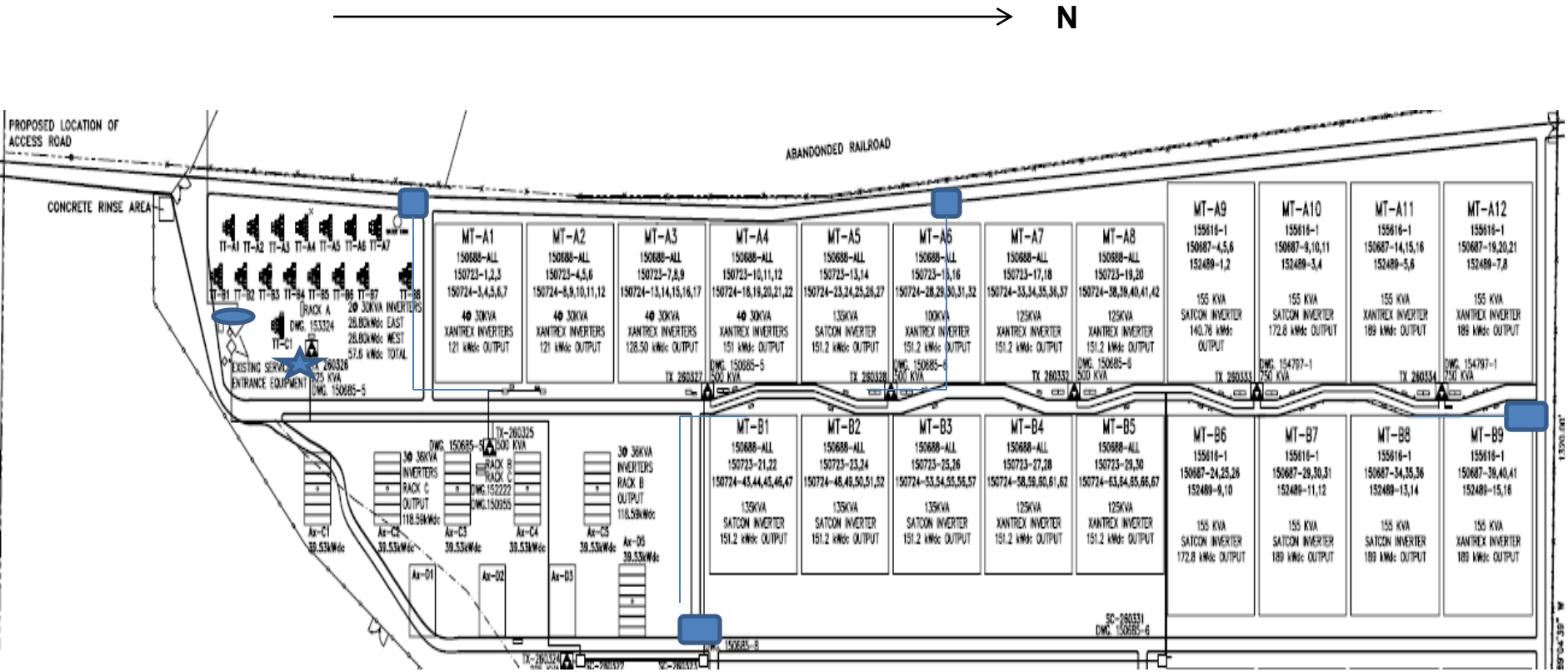
Early Challenges

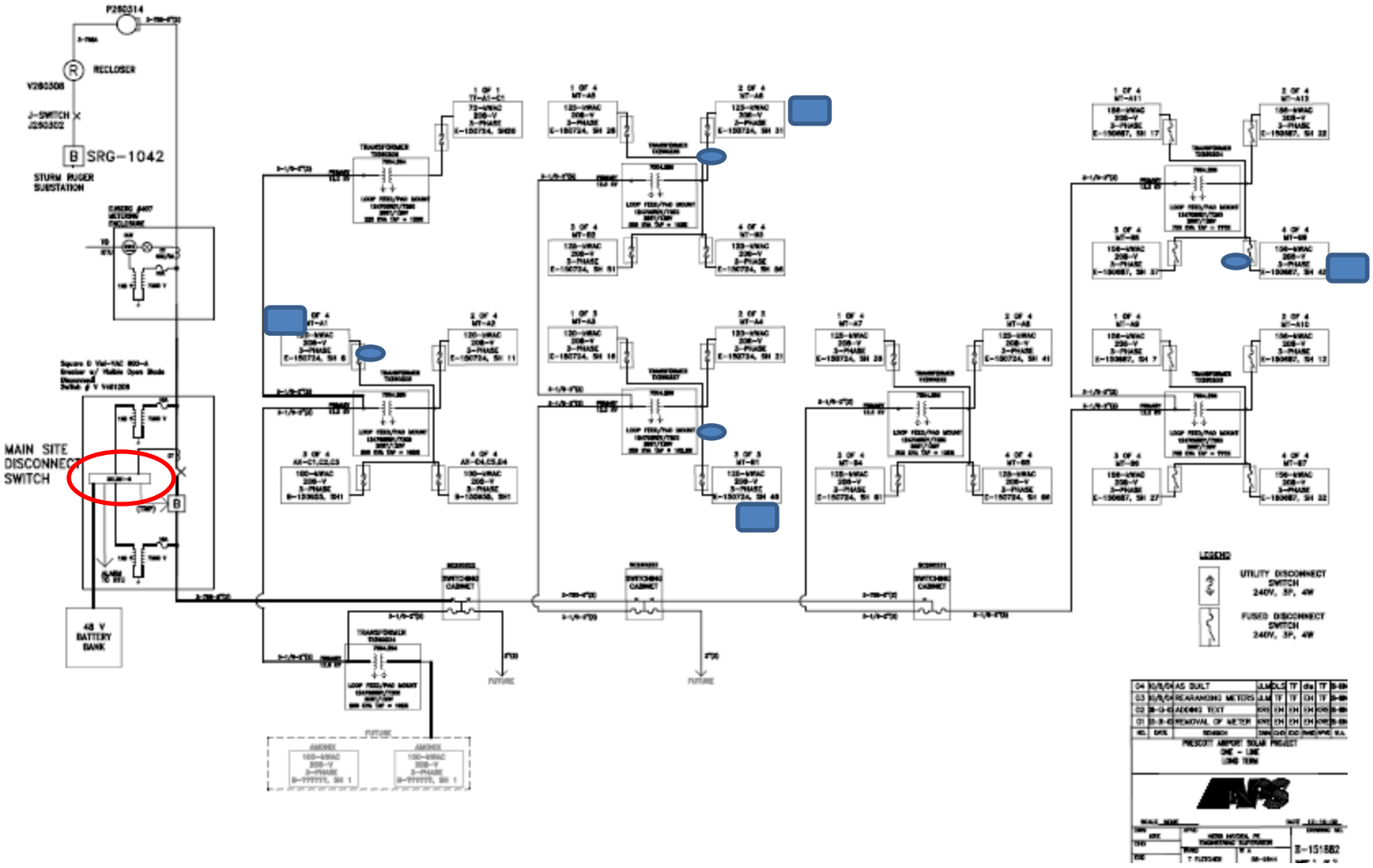
- Internal reorganizations and change in team members
- Infrastructure limitations for information transfer
- Preserving data security while sharing with groups outside APS
- Installation and equipment repairs
- Site characterization

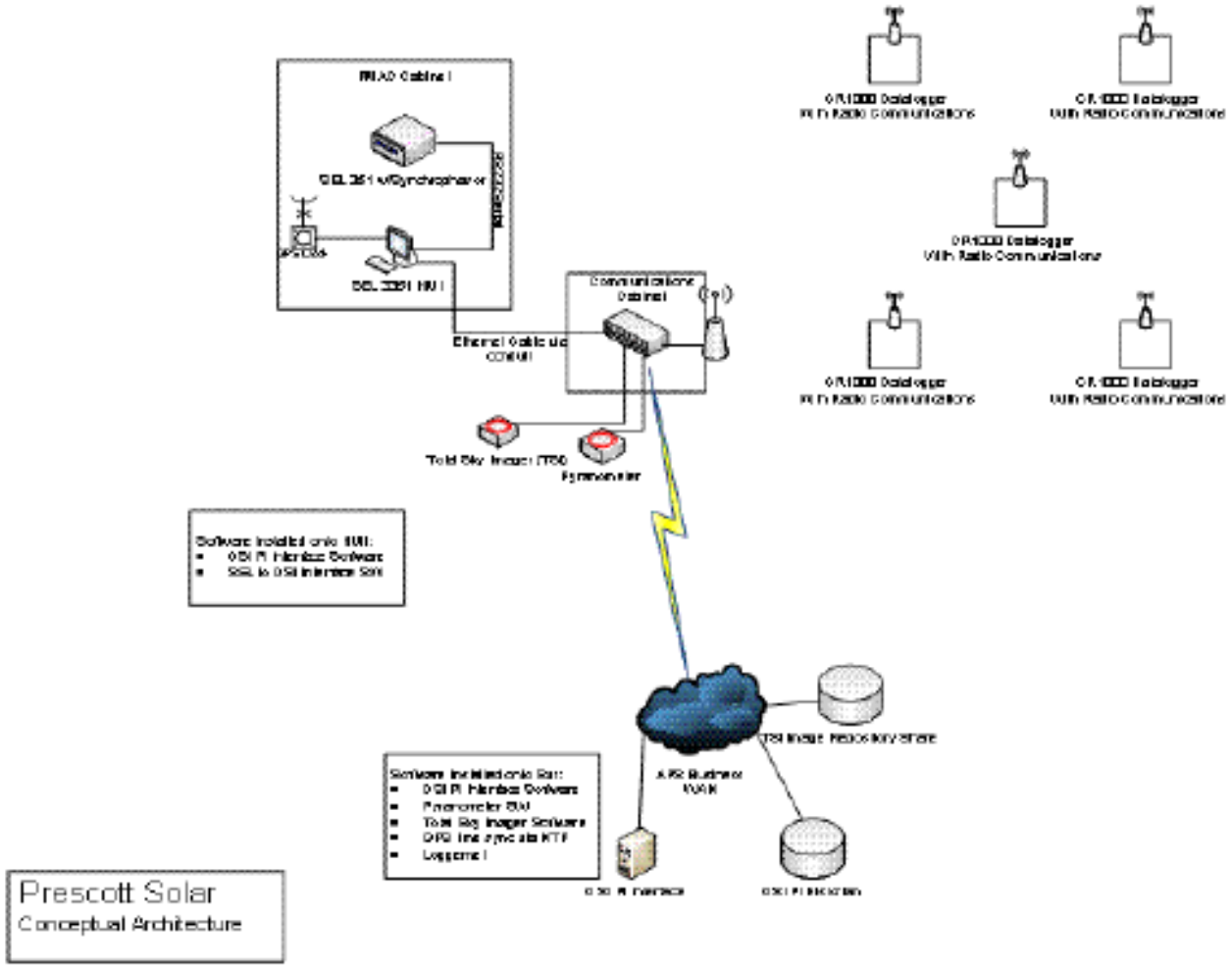
Prescott Project

- 3 Mw of PV on 12 Mw feeder
- Set up meteorological stations around the site
- Include imaging
- Improve metering capability on PV site and distribution system
- Gather time stamped one second data for at least 3 months
- Analyze and publish data results
- Share data on the Solar User Group Sharepoint site

Prescott Site




RECLOSER
SRG-1042
STURM RUGER
SUBSTATION
MAIN SITE
DISCONNECT
SWITCH
48 V
BATTERY
BANK
FUTURE
LEGEND
UTILITY DISCONNECT
SWITCH
240V, 3P, 4W
FUSED DISCONNECT
SWITCH
240V, 3P, 4W
AS BUILT
REARRANGING METERS
ADDING TEXT
REMOVAL OF METER
PRESCOTT AIRPORT SOLAR PROJECT
ONE - LINE
LONG TERM
APS


Prescott Solar
Conceptual Architecture

Project Team

- APS
  - Project Management and Report
  - Test Equipment Installation and data collection
  - Information Systems Integration
  - Distribution System Analysis
- Viasol Energy Solutions
  - Assemble Weather Stations
  - Programming of field interfaces with APS systems

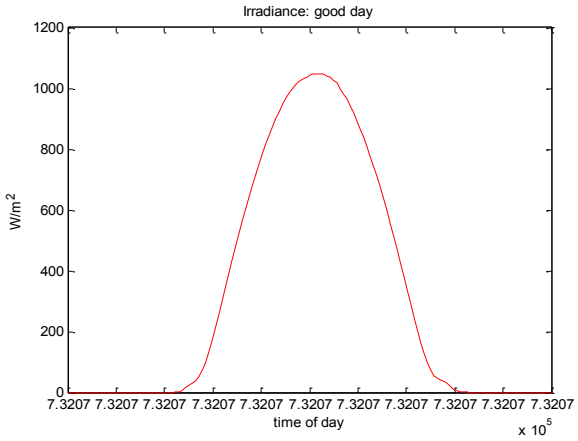
Project Team

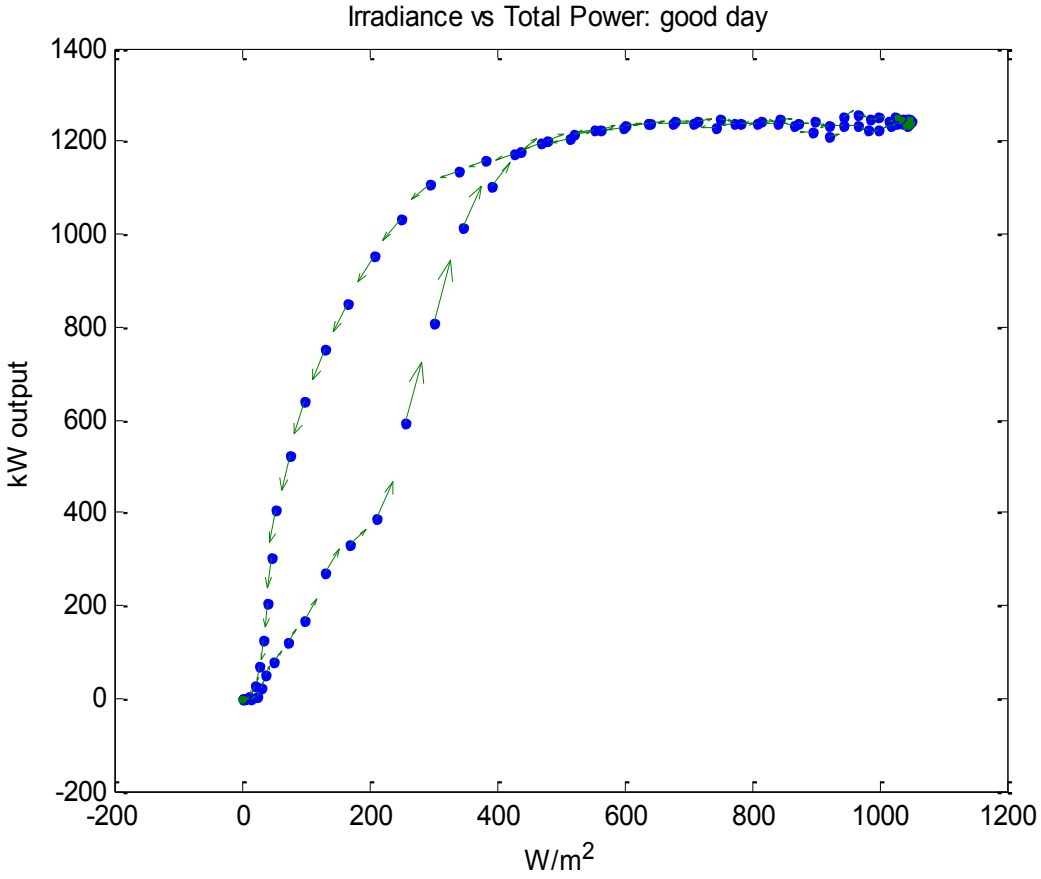
- Northern Arizona University
  - Initial site characterization
  - Data analysis
  - Support report
- 3TIER Forecasting
  - Provide regular forecasting
  - Analysis of forecast to actual weather and output

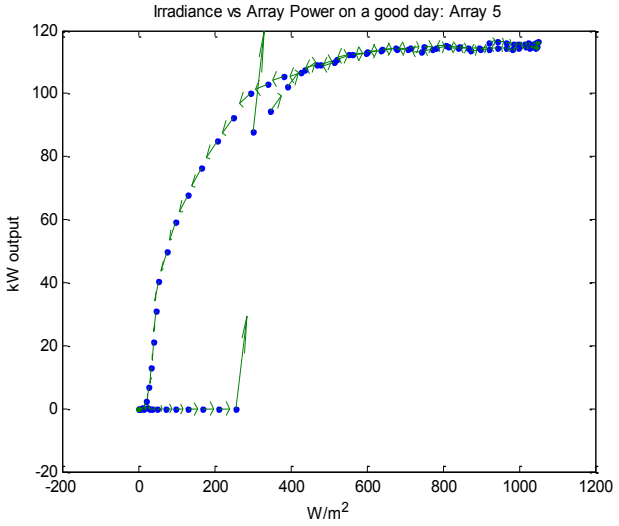
Site Characterization Challenges
Getting the technique right!

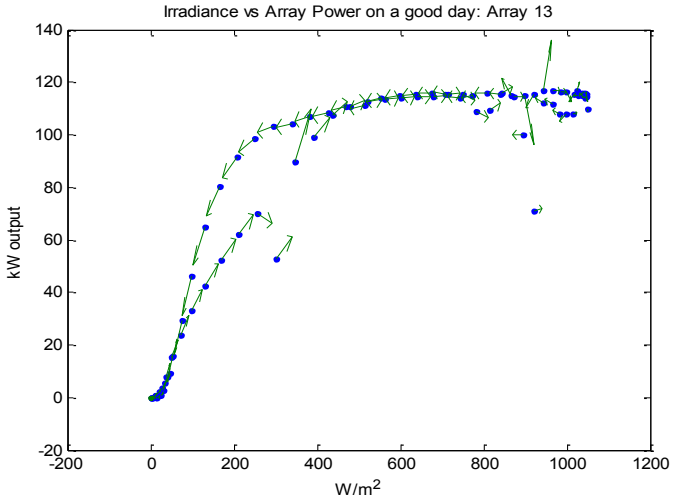
- Research and demonstration facility
- Output recorded at individual inverters only (no recorded combined output)
- 10 min. averages available
- Mix of inverters and solar panels
- MPPT algorithm differences
- Trackers not GPS synchronized (drift)
- No formal record of outages
- High degree of data scatter from sensors

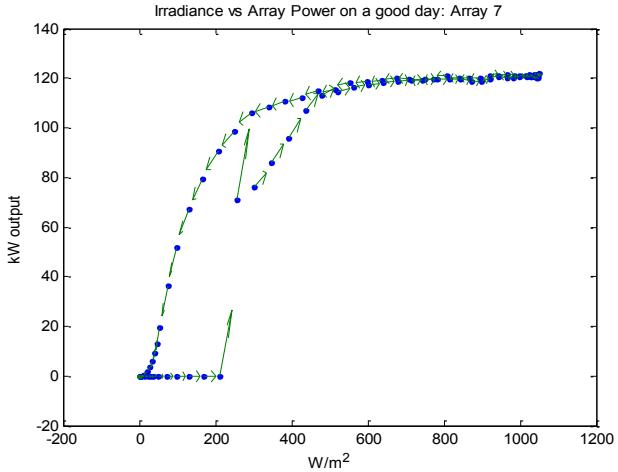
EXAMPLE:
SITE CHARACTERIZATION

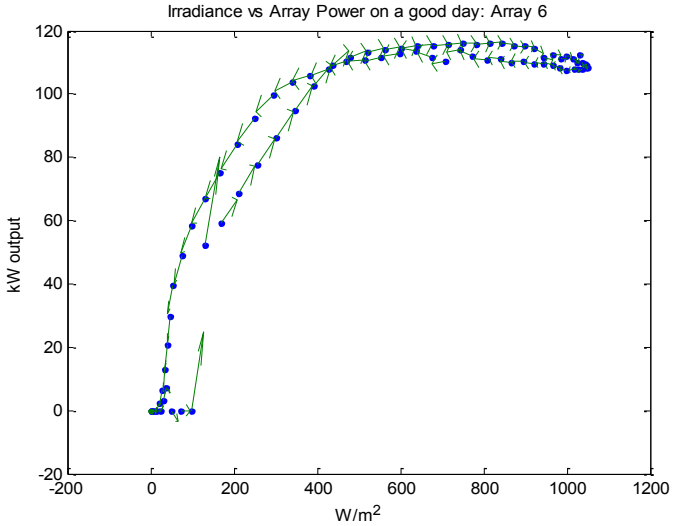

Irradiance: good day
1200
1000
800
600
400
200
0
W/m2
7.3207 7.3207 7.3207 7.3207 7.3207 7.3207 7.3207 7.3207 7.3207 7.3207
time of day
x 10^5


Irradiance vs Total Power: good day
1400
1200
1000
800
600
400
200
0
-200
kW output
-200
0
200
400
600
800
1000
1200
W/m2

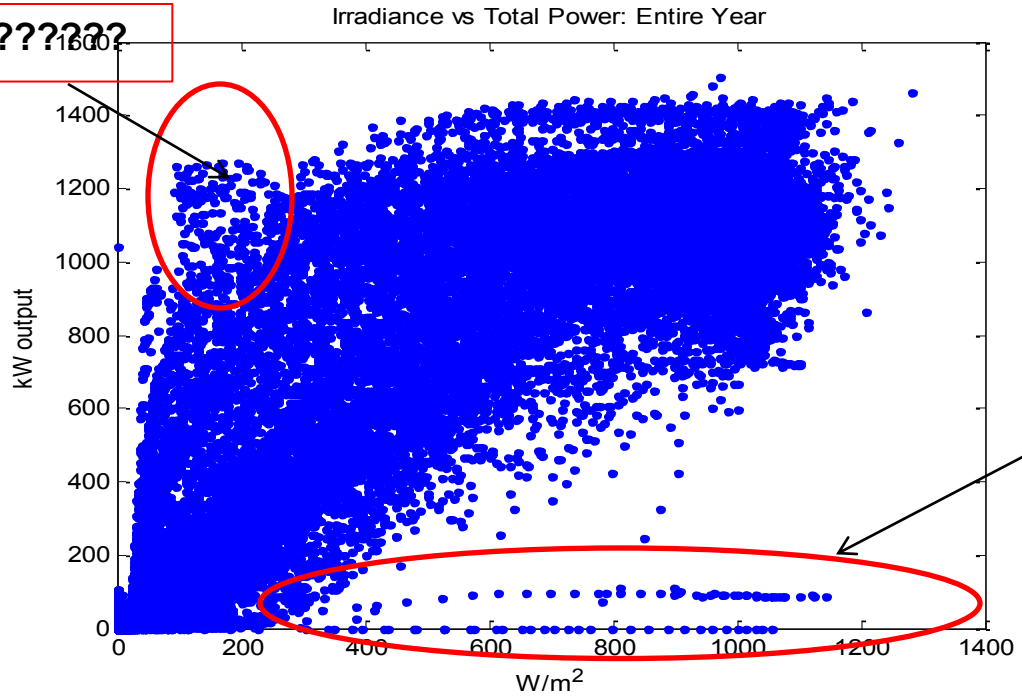

Irradiance vs Array Power on a good day: Array 5
kW output
W/m2


Irradiance vs Array Power on a good day: Array 13
kW output
W/m2

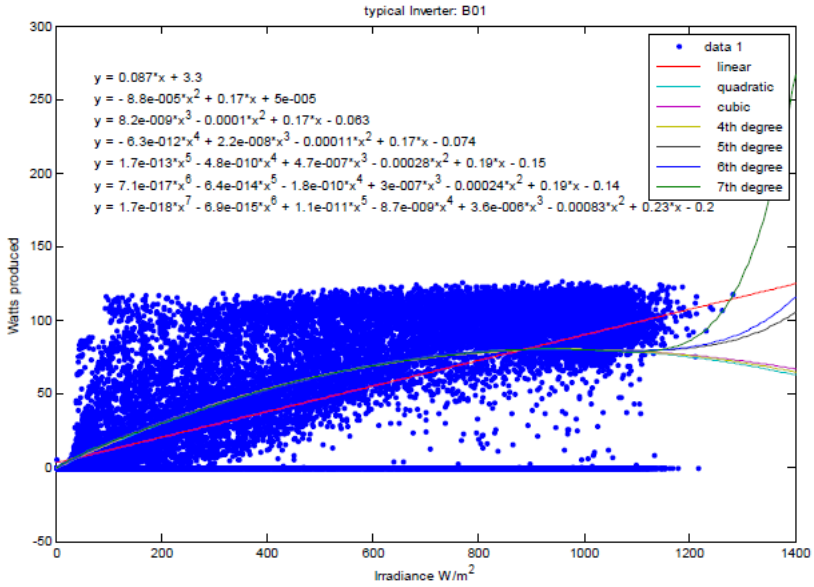

Irradiance vs Array Power on a good day: Array 7
kW output
W/m2

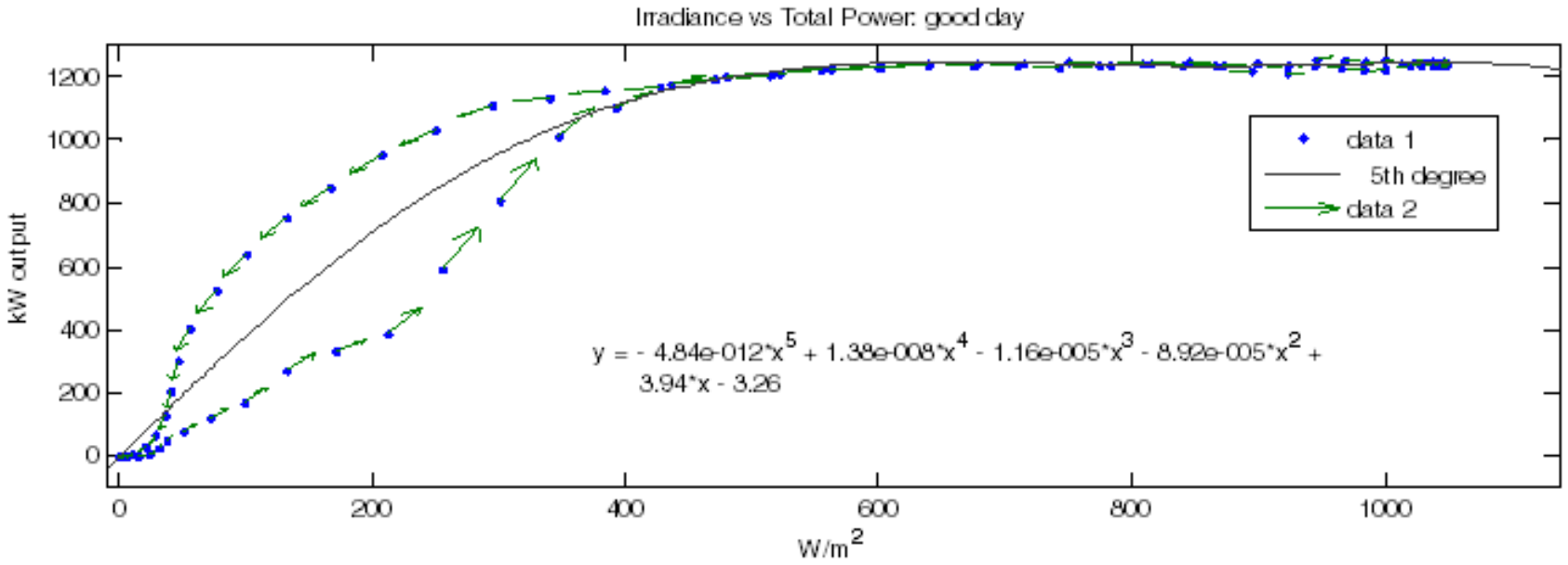

Irradiance vs Array Power on a good day: Array 6
kW output
W/m2

??????



Drop-out data points





Power Curve was based on 10 minute data and limited sensors.
New Power Curve to be derived with new installed sensors.

Project Status

- Equipment in place providing data to PI Server
- “Scrubbing” data and interface issues
- Buildup of data transfer techniques
- Reviewed and analyzed 10 minute data from previous instrumentation
- NAU provided reviews with APS on analysis and new analysis factors to consider
- 3Tier Weather Forecasting tool in place
- Considering peer participation for process and analysis/ report reviews