



How Tucson Electric Power uses the PI System to balance Reliability and Variable Generation

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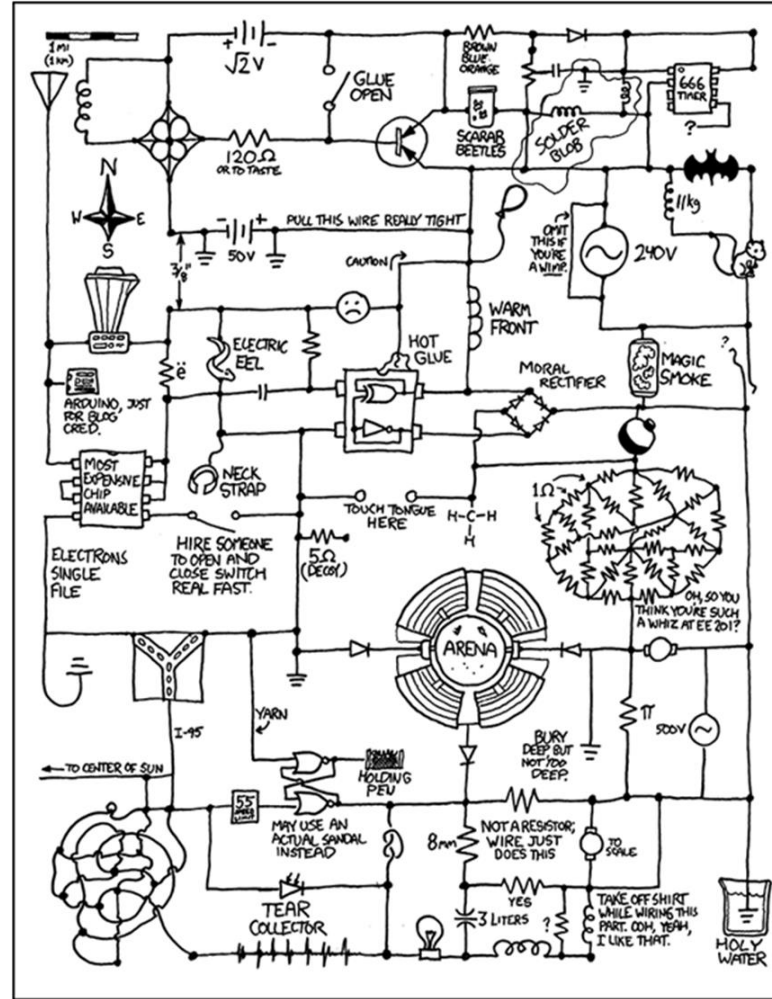
Tucson Electric Power History

- **Founded in 1892, TEPC is the principal subsidiary of UNS Energy Corporation.**
 - Serve over 400,000 customers in the Tucson metro area.
 - More than 2,200 megawatts of generating capacity
 - Approximately 1,100 miles of EHV (345 kV and 500 kV) lines and 8 EHV substations
 - Estimated variable energy 280 MW and counting...

The good..... the bad..... and the swag!

- THE GOOD – Renewable energy and variable generation.
- THE BAD - How much variable generation is installed and what is the impact to the system?
- THE SWAG - Forecasting solar weather patterns?!?!?!?

Weather



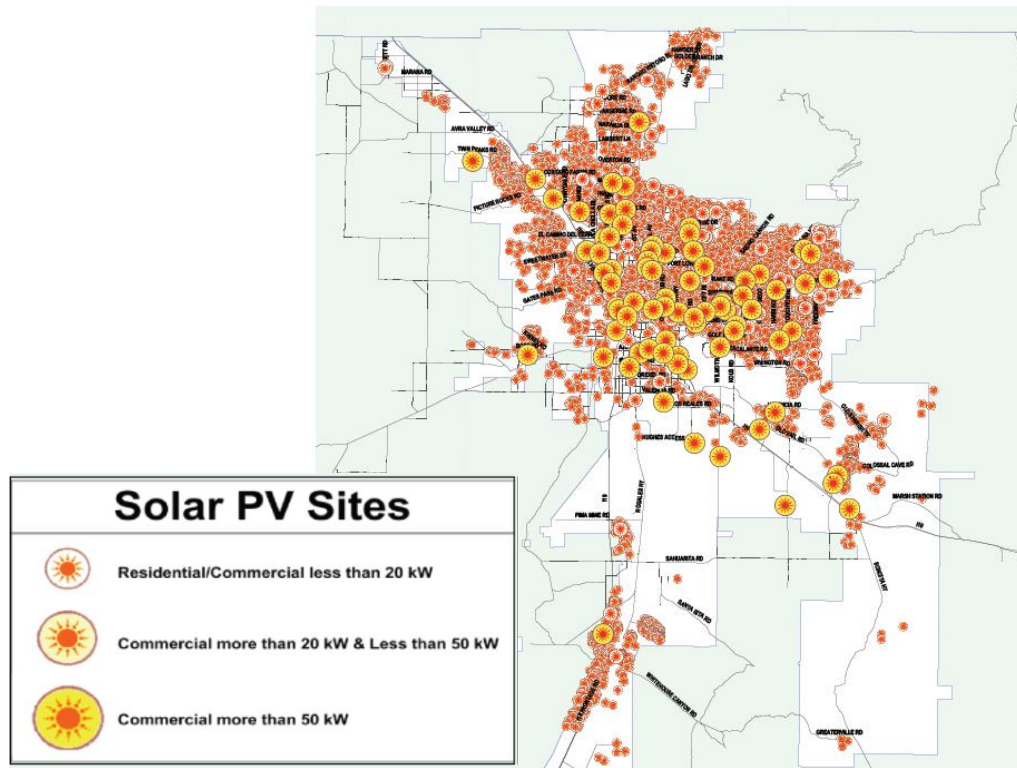
THE GOOD

- Renewable energy and variable generation
- Renewable Energy Standard and Tariff (REST), approved in 2008 by the Arizona Corporation Commission (ACC) requiring 15 percent of total power sales by 2025.
- Estimated variable energy 280 MW



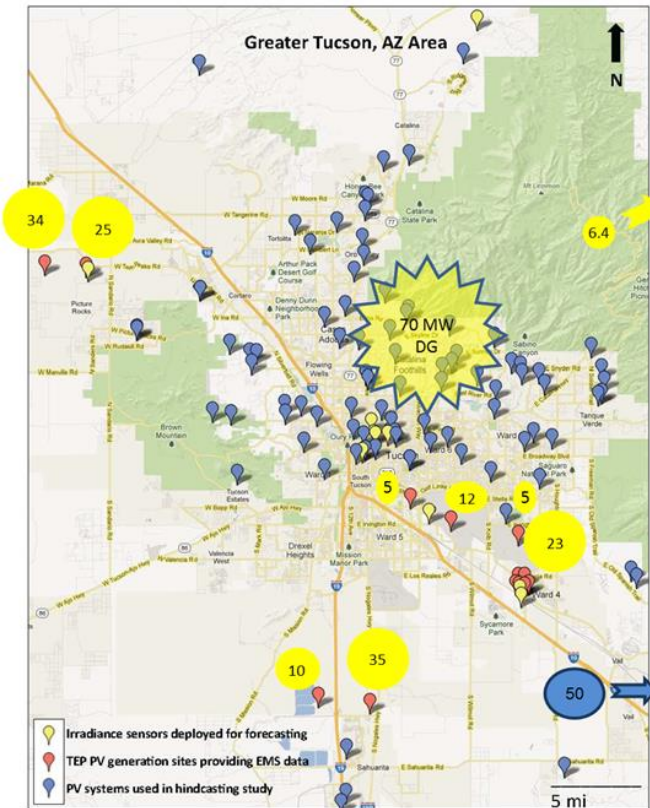
The GOOD - Solar PV Sites

Tucson Electric Power Service Territory



The GOOD - Solar Sensors

- Irradiance sensors deployed for forecasting.
- TEP PV generation sites providing EMS data.
- PV system used in hindcasting study.



The BAD – Safety and Reliability impact

- How much variable generation is installed and what is the impact to the system?
 - Type of variable energy
 - Solar
 - Wind
 - Type of construction of technology
 - Dual Axis
 - Single Axis
 - Fixed
 - Communication method
 - Real-time
 - Monthly

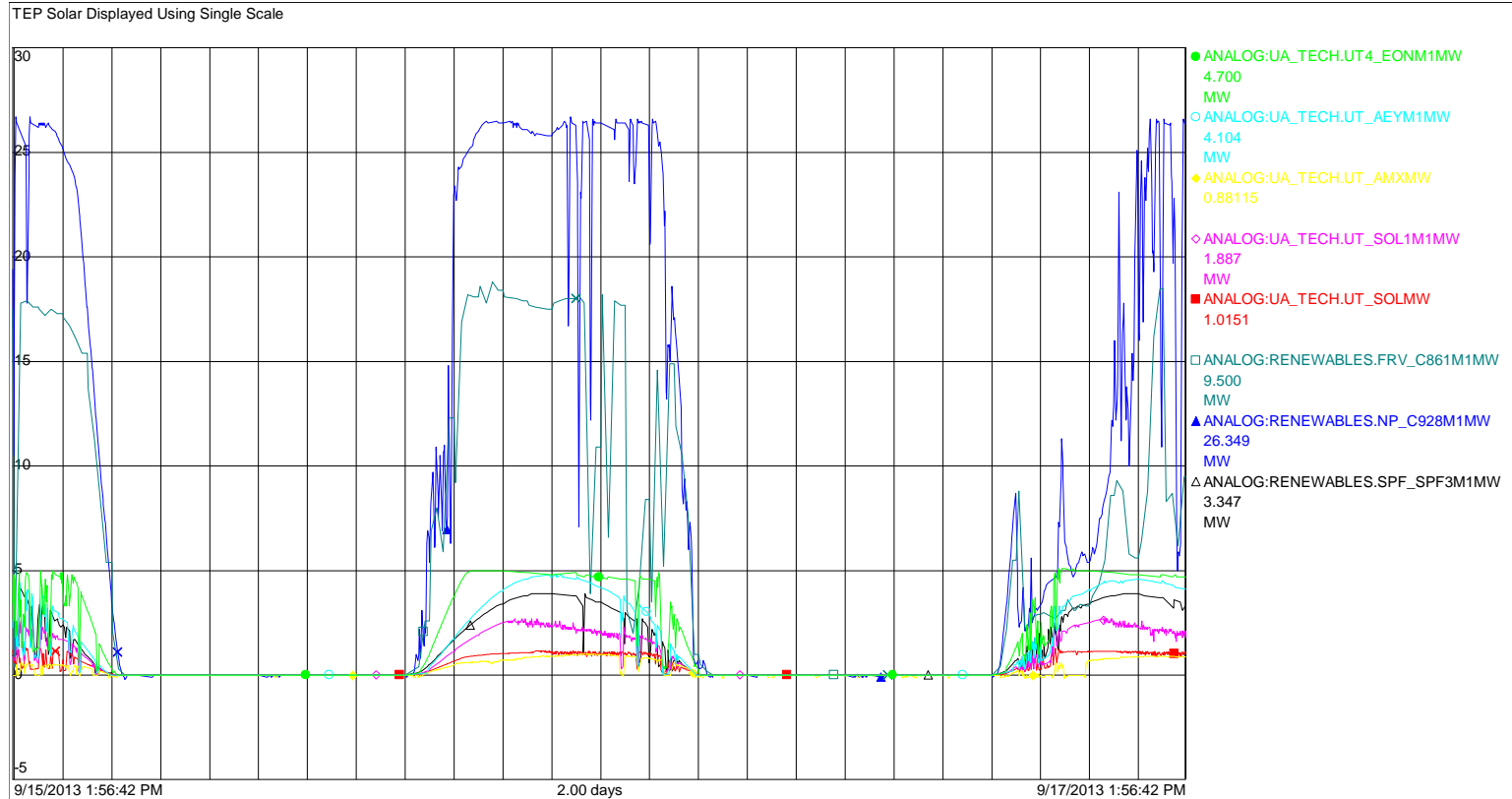
The BAD – Safety and Reliability impact

- Continued
 - Type of solar technology
 - Double axis
 - Single axis
 - Fixed or rooftop
 - Solar
 - Utility Scale – EMS, real time telemetry and MDM validated
 - Commercial – EMS estimated and MDM validated
 - Residential - EMS estimated and MDM validated

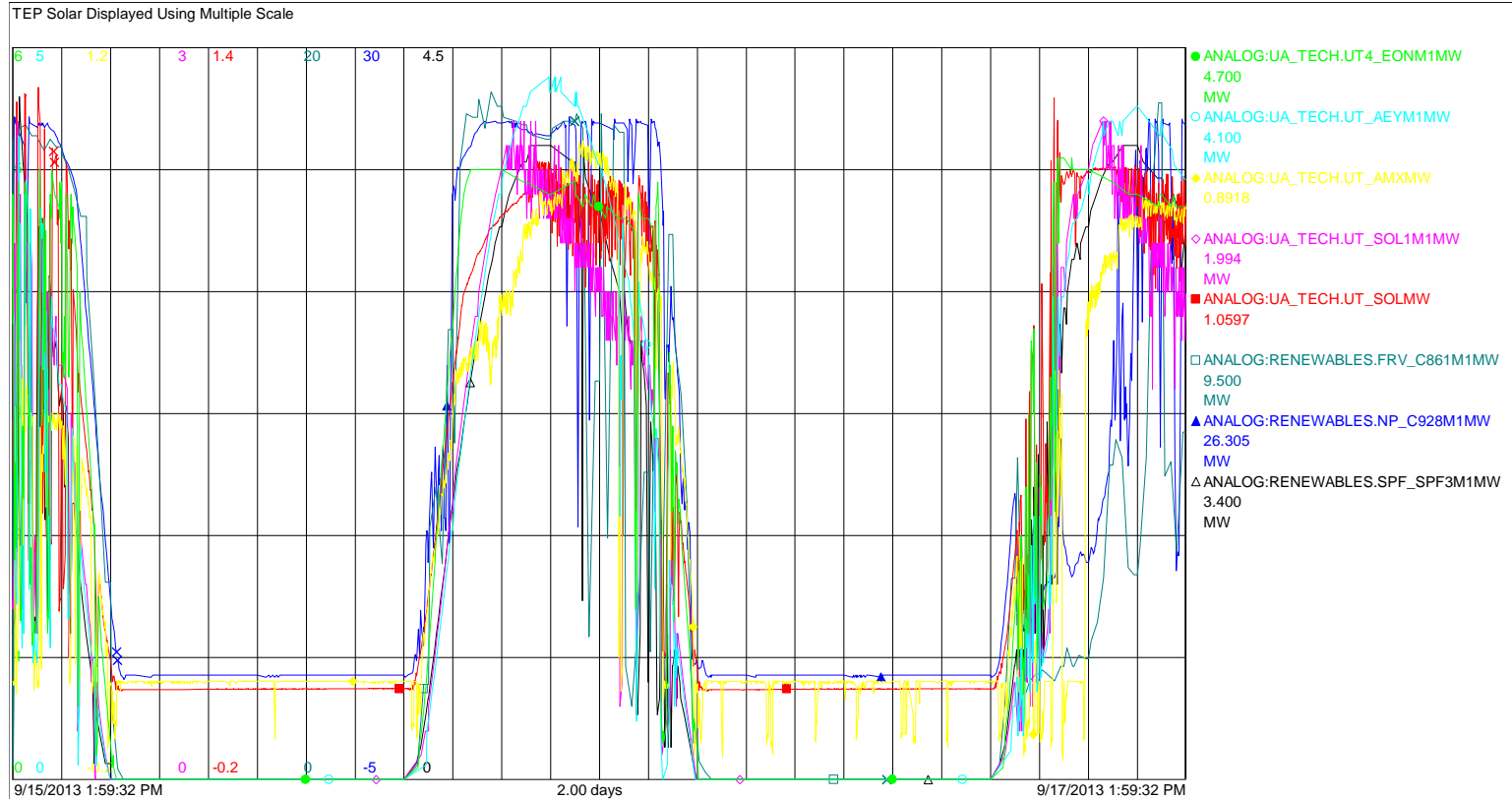
Ramp Rates

- Observed Ramp Rates:
 - From a 34 MW system we see 20 MW / 120 sec
 - From a 1.6 MW system we see 1.2 MW / 8 sec
 - From a 2 kW system we see 1.6 kW / 5 sec

Solar Data



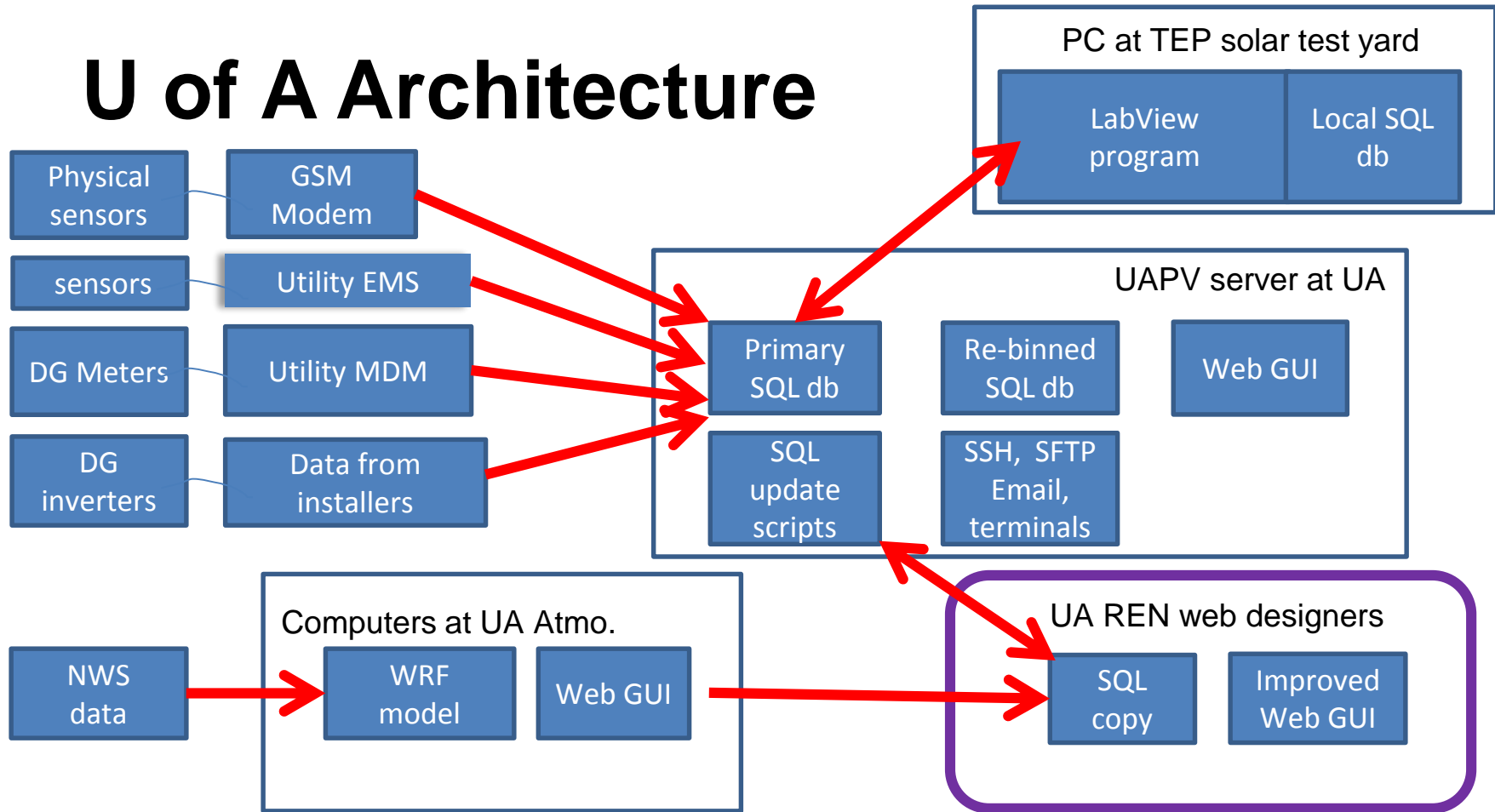
Solar Data



The SWAG?!?!?!?

- Forecasting solar weather patterns?!?!?!?
 - How does PV generation compare to total load?
 - How does geographic diversity smooth aggregate ramp rates?
 - Can we use PV data to forecast output?

U of A Architecture



Tools used to create data file

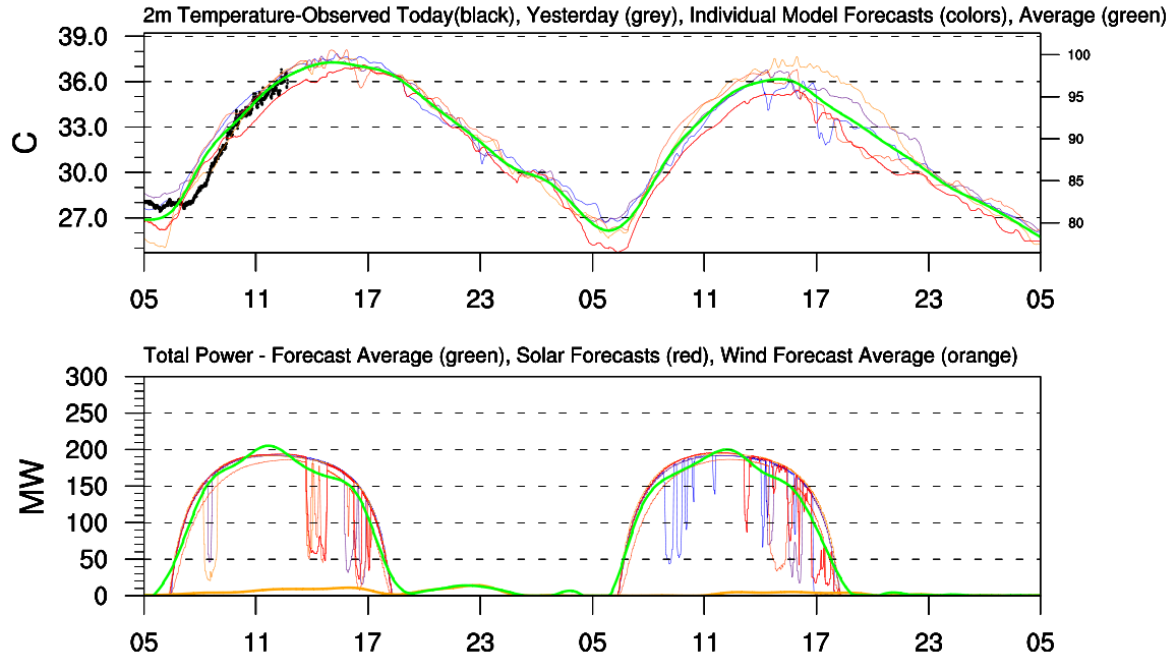
- PI OLEDB
data access method
- VBScript
program code to make calls to PI archive and
create data file
- Perl
used to substitute meter names in data file to ID #'s
- VisualCron
excellent scheduler, run tasks and ftp the file

TEP PI System Data and U of A forecast

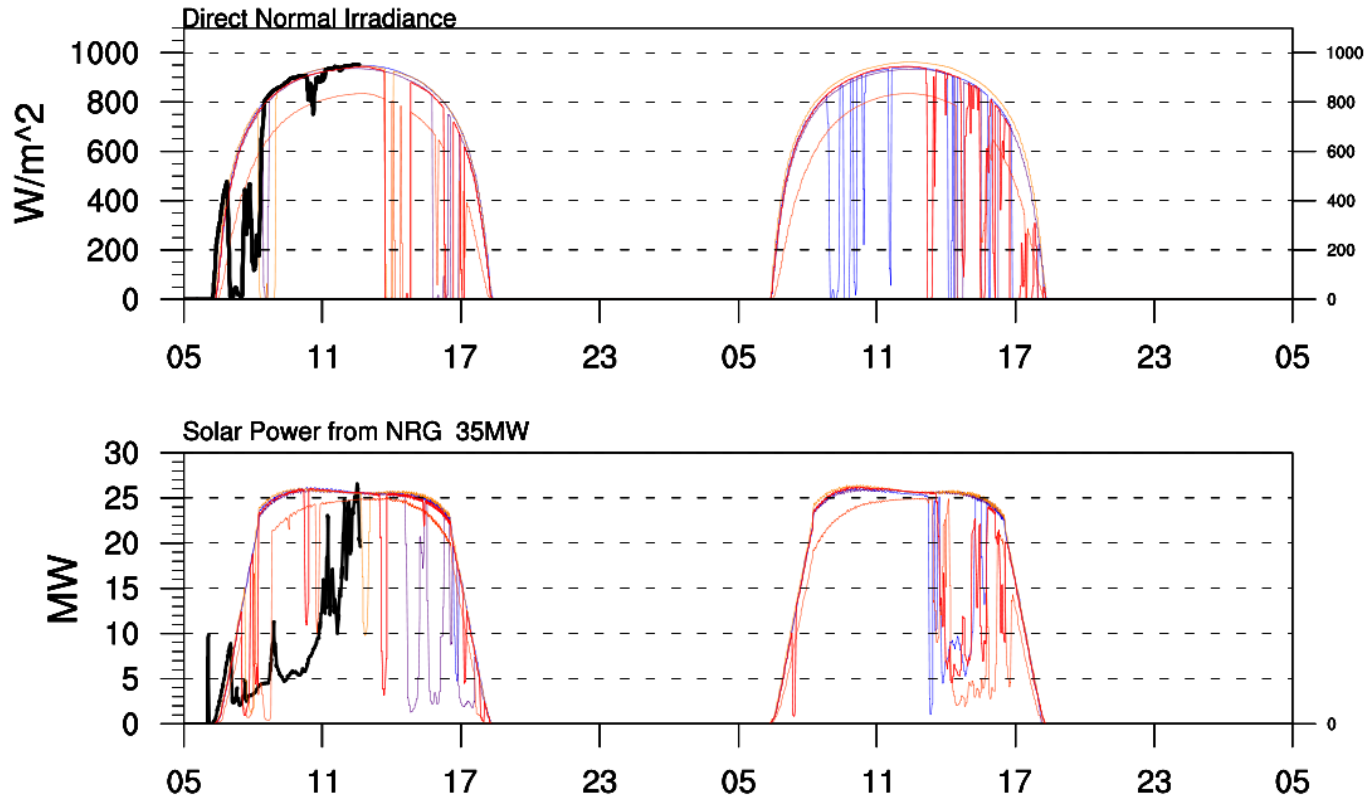
TEP Realtime Page

Current Time: Tue Sep 17 12:40:05 MST 2013

Forecast: 17 Sep 2013 12:00 UTC



TEP PI System Data and U of A forecast



PI Notifications

The screenshot displays the TEPPPIUDS - PI System Explorer application. The interface is divided into several sections:

- Top Menu:** File, View, Go, Tools, Help.
- Database Section:** Includes buttons for Database, Query Date, Back, and Check In.
- Notifications Panel (Left):** A list of notification types, including AEY Meter Value Alert, AGC System Frequency, AMX Meter Value Alert, EFV Meter Value Alert, EON1 Meter Value Alert, **FRV Accumulator Alert** (highlighted), NRG Accumulator Alert, SOLON 1 Meter Value Alert, SOLON 2 Meter Value Alert, and SOLON PRAIRE FIRE Meter Value Alert.
- FRV Accumulator Alert Detail (Right):**
 - Overview Tab:** Displays fields for Name (FRV Accumulator Alert), Unique ID (ff8f6bld-a673-4cce-959d-921a452b611), Description, Status (Running), Template, and Categories.
 - Trigger Tab:** Shows Target Station: Renewables and Condition: FRV MTMWHOUT Accumulator > 20.
 - Message Tab:** Displays 2 item(s) of custom content available to subscribers and 1 customized delivery format(s) configured for Email.
 - Subscriptions Tab:** Shows 4 subscription(s) to this notification.
- Bottom Panel:** A navigation bar with buttons for Elements, Event Frames, Library, Unit of Measure, MyPI, **Notifications** (highlighted), and Contacts.

PI Notifications

From: PI_ALERTS@utility.corp [mailto:PI_ALERTS@utility.corp]

Sent: Friday, August 30, 2013 9:00 AM

To: Arocho, Carlos

Subject: EMS METERS\Station: Renewables\Notifications[FRV Accumulator Alert] generated a new notification event.

Name: FRV Accumulator Alert

Database: TEPPIUDS

Trigger Time: 08/30/2013 09:00:16

Target: EMS METERS\Station: Renewables

State: OutsideControl

Value: 63834.91

Priority: Normal

Actions:

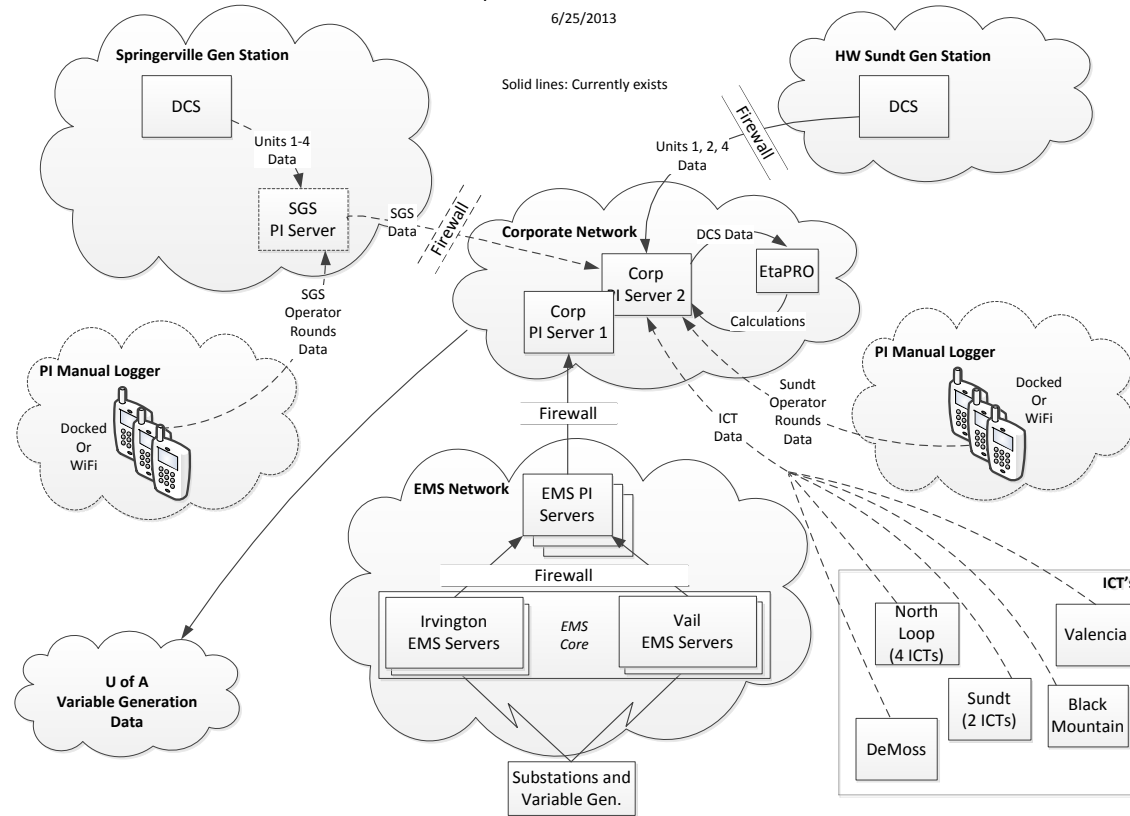
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PI System Expansion

PI Systems for UNS Generation

6/25/2013



Summary

- Benefits of PI System
 - Innovative Product Line
 - Data Consolidation
 - Diversity of Data Exchange
 - Flexible Reporting
 - Application Development
 - Excellent Technical Support

Questions?

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