PI System and Asset Framework in Wind and Solar Monitoring

Presented by **Jeremy Hunter, Sr. Technical Specialist**

Duke Energy Renewables

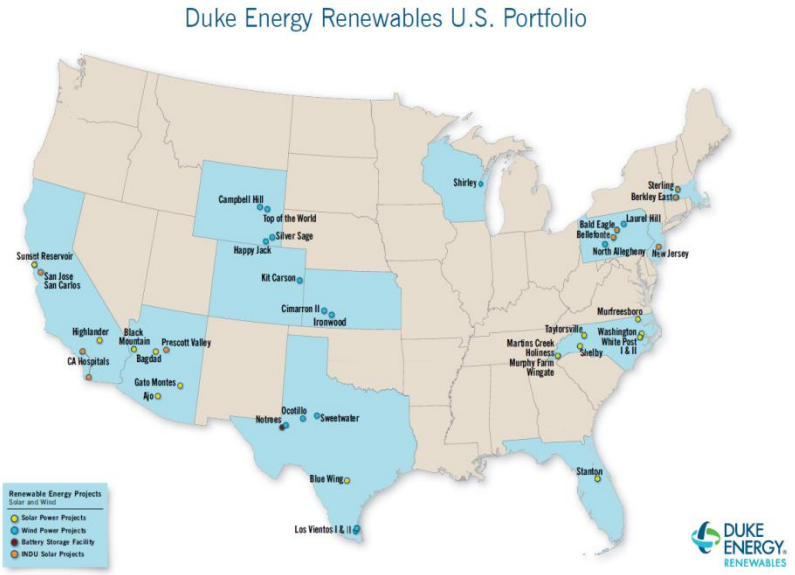
Agenda

OUTLINE

1. Introduction
2. PI System Applications
3. Real Time Monitoring
4. Using Asset Framework in Wind
5. Solar Business Strategy
6. Future Developments

About Duke Energy Renewables

- Duke Energy Renewables, part of Duke Energy's Commercial Businesses, is a leader in developing innovative wind and solar energy solutions, helping utilities, electric cooperatives and municipalities deliver affordable, reliable and increasingly clean energy to customers throughout the United States..
  - 1,600 MW wind power
  - 100 MW solar power
- Nearly all of the energy produced by Duke Energy Renewables' wind and solar projects is sold through long-term agreements with utilities, electric cooperatives, businesses and municipalities



About Duke Energy Renewables Cont.

Solar Sites

Site Name	Location	In-Service Date	Capacity (AC)	PV Panels
Stanton	Orange County,FL	Dec. 2011	6 MW	25,172
Holiness	Murphy, NC	May 2011	1 MW	4,242
Martins Creek	Murphy, NC	March 2011	1 MW	4,358
Murfreesboro	Murfreesboro, NC	Dec. 2011	5 MW	19,960
Murphy Farm	Murphy, NC	May 2011	1 MW	4,298
Shelby	Shelby,NC	May 2010	1 MW	4,522
Taylorsville	Taylorsville, NC	Oct. 2010	1 MW	4,224
Washington White Post I	Beaufort County, NC	Dec. 2012	12.5 MW	53,000
Washington White Post II	Beaufort County, NC	Nov. 2013	5 MW	27,450
Wingate	Murphy, NC	Aug. 2011	1 MW	4,340
Ajo	Pima County, AZ	Sept. 2011	5 MW	21,168
Bagdad	Yavapai County, AZ	Dec. 2011	15 MW	71,512
Black Mountain	Mohave County, AZ	Nov. 2012	10 MW	40,000
Gato Montes	Tucson, AZ	Dec. 2012	6 MW	48,000
Highlander I & II	29 Palms, CA	June 2013	21 MW	100,188
Sunset Reservoir	San Francisco, CA	Dec. 2010	4.5 MW	24,000
Blue Wing	San Antonio, CA	Nov. 2010	14 MW	214,500
		Totals:	110 MW	670,934

Wind Sites

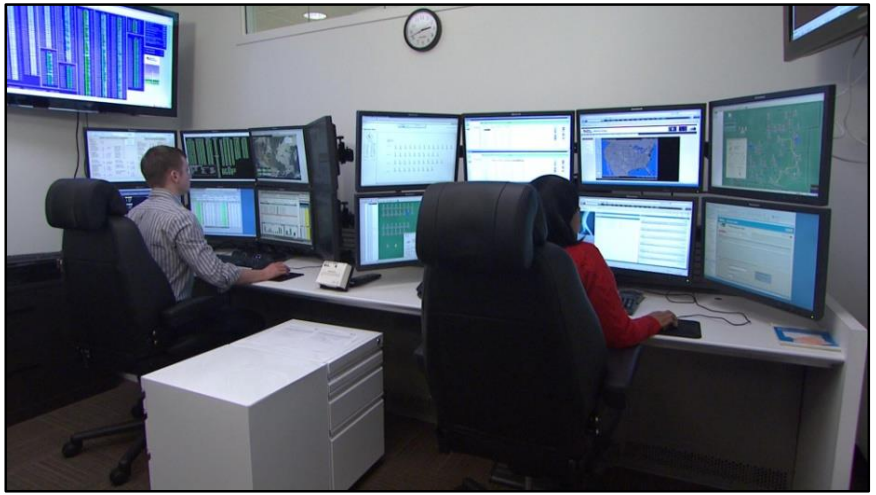
Site Name	Location	# Turbines	Turbine Type	Turbine MW	Site Total MW
North Allegheny	Portage, PA	35	Gamesa	2.00 MW	70.00 MW
Campbell Hill	Glenrock, WY	66	GE	1.50 MW	99.00 MW
Kit Carson	Burlington, CO	34	GE	1.50 MW	51.00 MW
Notrees	Goldsmith, TX	95	GE/ Vestas	1.5/ 1.65 MW	158.00 MW
Top of the World	Casper, WY	110	GE/Siemens	1.5 / 2.3 MW	200.00 MW
Sweetwater (Duke) *	Nolan, TX	346	GE, Mit, Siemens	1.5, 1, 2.3	282.50 MW
Los Vientos 1A & 1B	Brownsville, TX	171	Mitsubishi/ Siemens	2.4/2.3 MW	400 MW
Shirley	Denmark, WI	8	Nordex	2.60 MW	20.80 MW
Cimarron II	Cimarron, KS	57	Siemens	2.30 MW	131.10 MW
Ironwood	Spearville, KS	73	Siemens	2.30 MW	170.00 MW
Laurel Hill	Williamsport, PA	30	Siemens	2.30 MW	69.00 MW
Happy Jack	Cheyenne, WY	14	Suzlon	2.10 MW	29.40 MW
Ocotillo	Forsan, TX	28	Suzlon	2.10 MW	58.80 MW
Silver Sage	Cheyenne, WY	20	Suzlon	2.10 MW	42.00 MW
Third Party Monitoring Only Sites					
Grand Meadow	Dexter, MN	67	GE	1.50 MW	100.50 MW
Nobles	Reading, MN	134	GE	1.50 MW	201.00 MW
Lake Winds Energy Park	Ludington, MI	56	Vestas	1.80 MW	100.80 MW
Cedar Ridge	Eden, WI	41	Vestas	1.65 MW	67.65 MW
Spruce Mountain	Woodstock, ME	11	Gamesa	2.00 MW	22.00 MW
* 50/50 Partnership	**Totals**	**1,396**			**1975.75 MW**

Business Challenge

- Have 37 sites across 13 states
- Multiple OEMs, SCADA and HMI Systems
- OEMs have different tag structures and interfaces
- Need to use a common interface to view and report

Renewable Energy Monitoring Center

- The REMC helps maximize profits for Duke Energy and its contracted site owners by providing world class 24/7 monitoring services through professional communication, consistent processes, reliable reporting, ethical conduct and dedication to safety
- Located in Charlotte, NC
- In operation Since June 2009



PI Applications Used

OSIsoft Products Used

- PI ProcessBook
- PI Datalink
- PI Asset Framework(AF)
- PI Coresight
- PI Notifications
- PI ACE

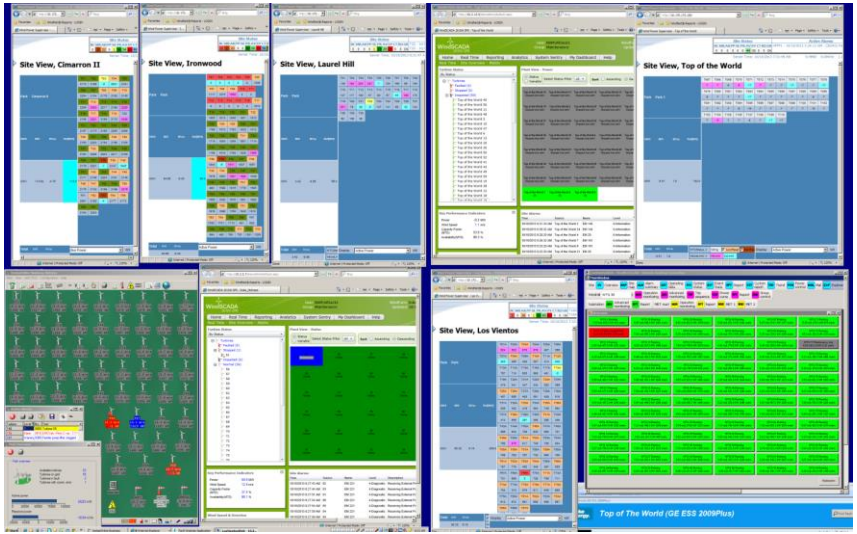
- Utilize Duke Energy PI Team
  - In house group of 10 PI System Experts
- OSIsoft CoE
  - Help to stay updated on new software and ways to improve our operations

PI System Benefits

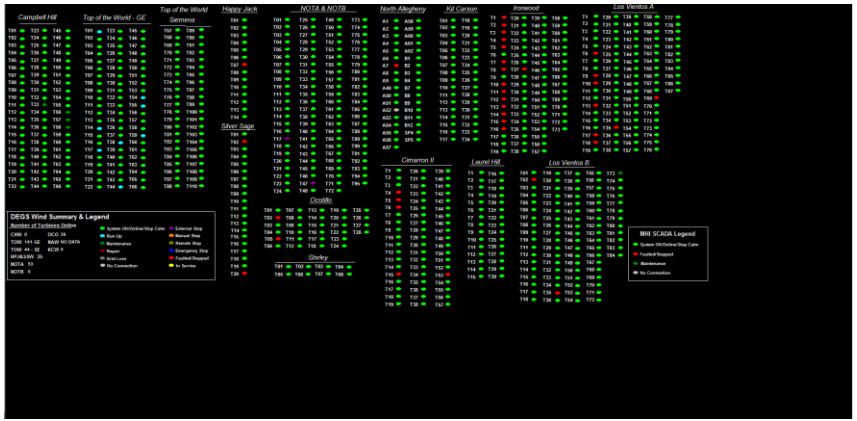
- Visual Uniformity
- Unmodified records of data
- Clear Visual Alerts for operators
- Custom Built Displays
- Real Time Troubleshooting
- Remote Detection at issues unmanned sites
- Efficient Reporting Process

Real Time Monitoring: PI ProcessBook-Wind

Multiple OEM SCADA Systems

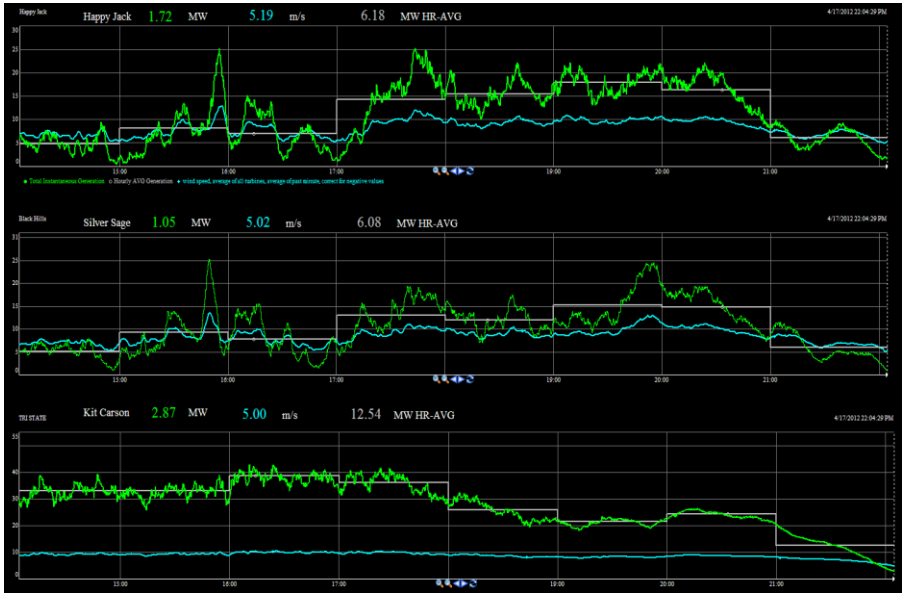


Common Alarm Display using Processbook

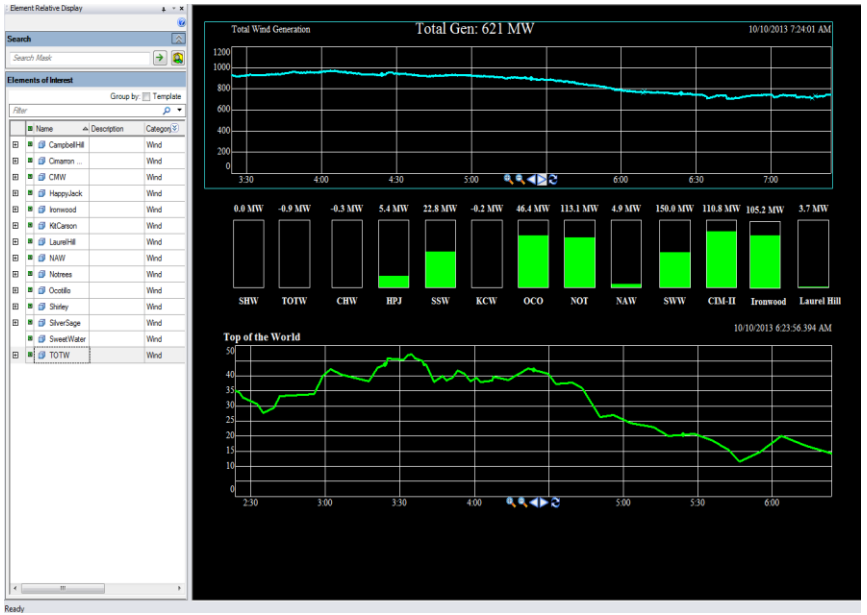


Real Time Monitoring: PI ProcessBook- Wind

Real Time Nominations



Wind Fleet Production



Wind Power Forecasting

Forecast Model Improvements

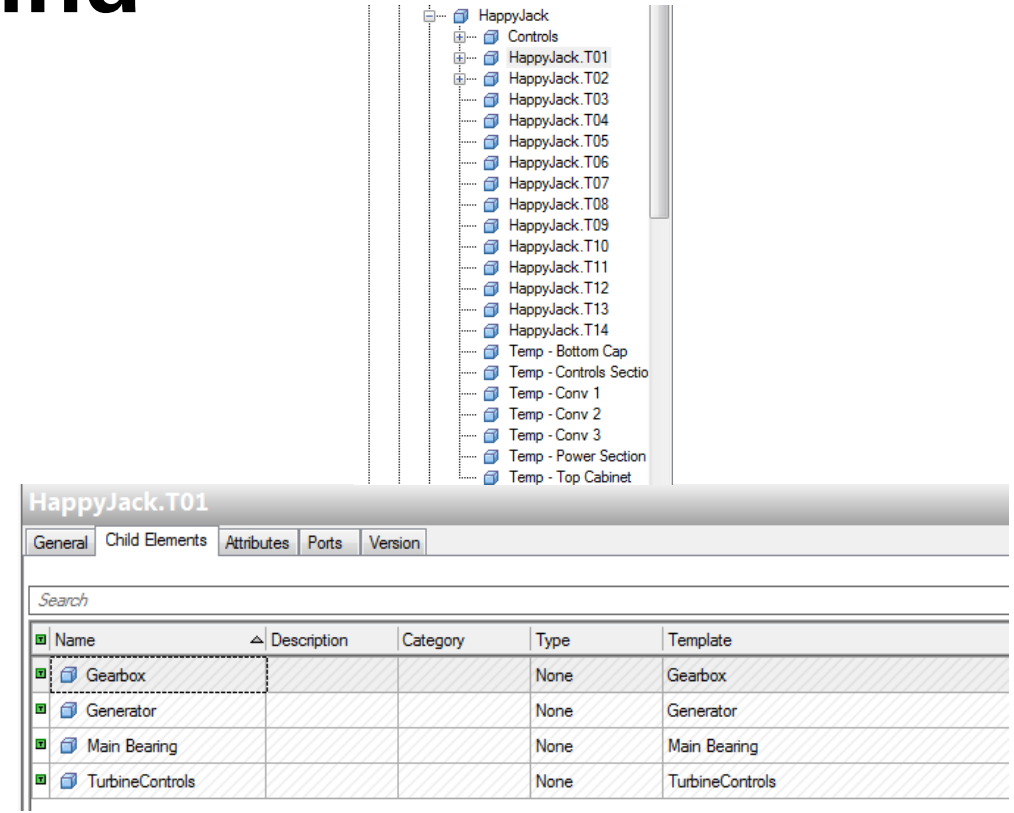
- PI system aided improvements in wind forecast model
- Forecast model obtains real time MET data from PI system
- 1/20/2012: Tag created for 1-min avg m/s of all wind farm WTG nacelles. Integrated into forecast model
- Improved wind forecast projection in both DA & RT by 23%

Online Forecasting Tool

- Streams real-time PI data from MET stations
- Calculates site power based on RT availability and power curve equation
- Provides operator interface for accurate power forecast nominations

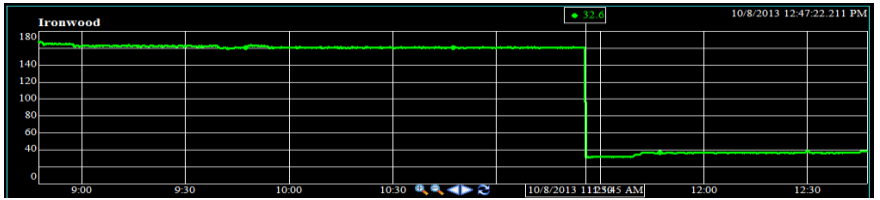
Utilizing AF in Wind

- Able to display wind farms in templates
- Allows quick access to commonly monitored tags
- Provides a uniform tag naming convention across multiple turbine types



PI Notifications

- Provide email alerts to REMC operators during emergency events
  - Equipment communications issues (functional)
  - Substation outages (in development)
  - Solar inverter faults (in development)
- Bring alarms to operator
- Maintain strict tolerance on critical alarms response



Ironwood Substation Alarm Ironwood.SUB.SEL351S.34kV-11F1.Trip: True

"Wind Monitor Group"@duke-energy.com

This message was sent with High importance.

Sent: Tue 10/8/2013 12:26 PM

To: Wind Monitor Group@duke-energy.com;

Site: Ironwood
Received from: PI Notifications
Alarm Received: 10/08/2013 12:25:30
PI Tag: Ironwood.SUB.SEL351S.34kV-11F1.Trip
Status: True
Event Number: 500
Description: Breaker 52-F1 Protective Trip from 11F1 relay.
Response classification and description:
1 = Onsite personnel should be notified immediately - some portion of the farm is offline due to a device trip to protect electrical equipment and/or personnel

Site Manager: **Lance Kohman**
Lead Tech: **James Brownlee**

Acknowledge
Acknowledge With Comment

Solar Monitoring

Challenges

1. Rapid operational turnover of newly constructed sites
2. Multiple SCADA types & equipment manufacturers
3. Screen-space is valuable and limited
4. Sites are unmanned, reliable remote monitoring is critical

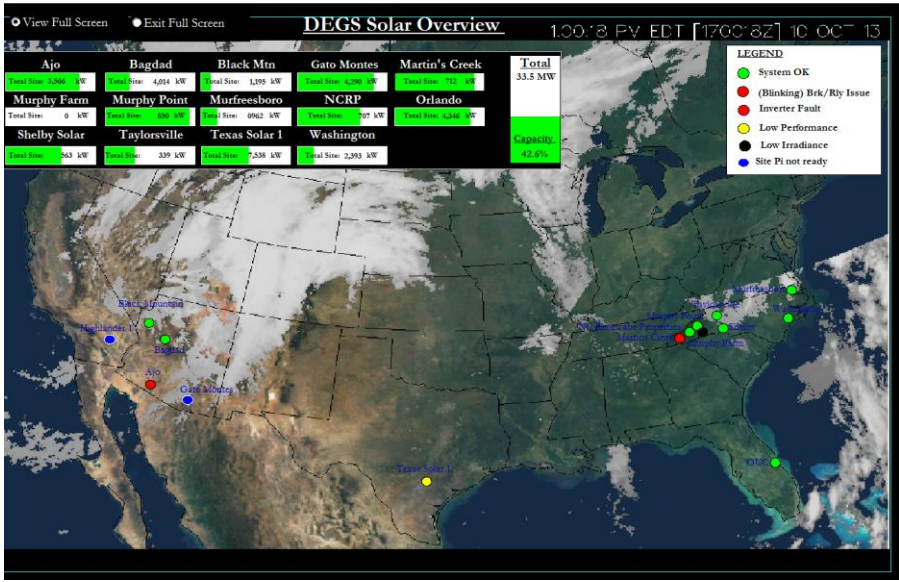
Solution

Standardize solar monitoring with the PI system

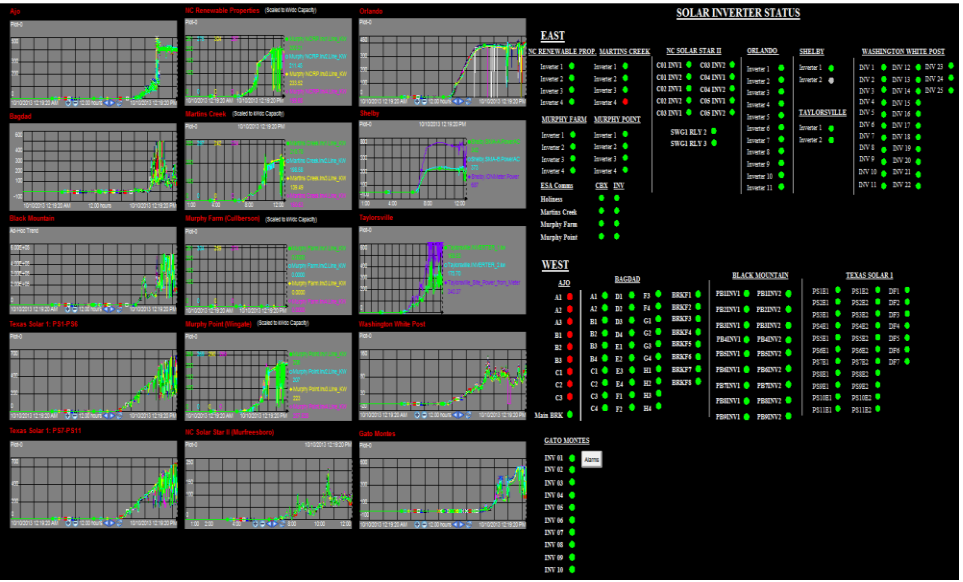
- Collect site data on solar specific PI server
- Create PI tags for operational variables
- Customize performance calculations & metrics
- Design standard monitoring visuals
- Develop alerts for inverter faults & underperformance

Real Time Monitoring: PI ProcessBook- Solar

Solar Overview



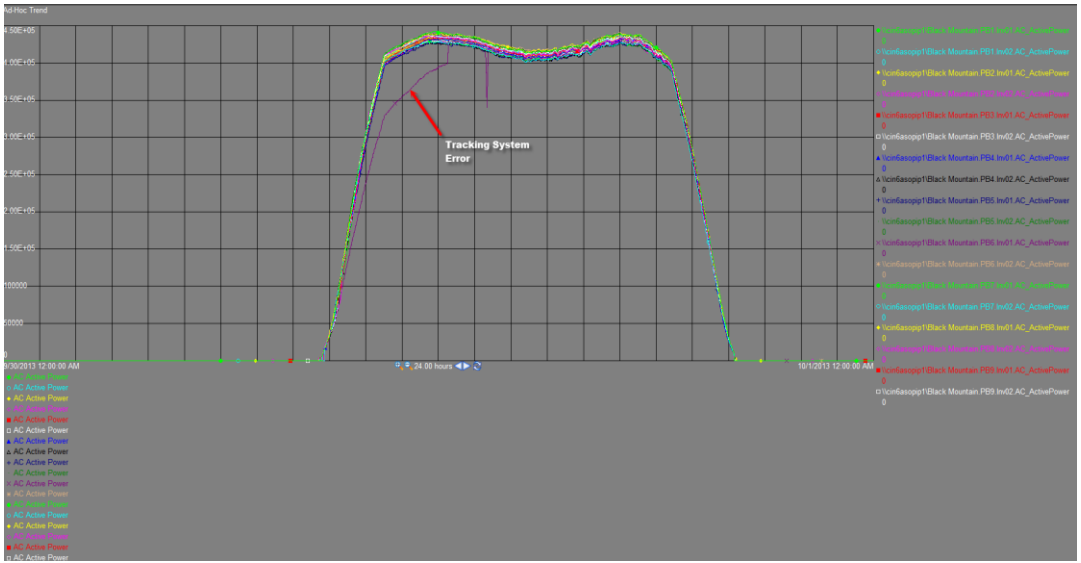
Solar Trends and Inverter Status



Real Time Monitoring: Pi ProcessBook-Solar

Issues detected at solar sites in PI system:

1. Blown fuses
2. Inverter grid faults
3. Communications failures
4. Storm damage to panels
5. Tracker motor errors



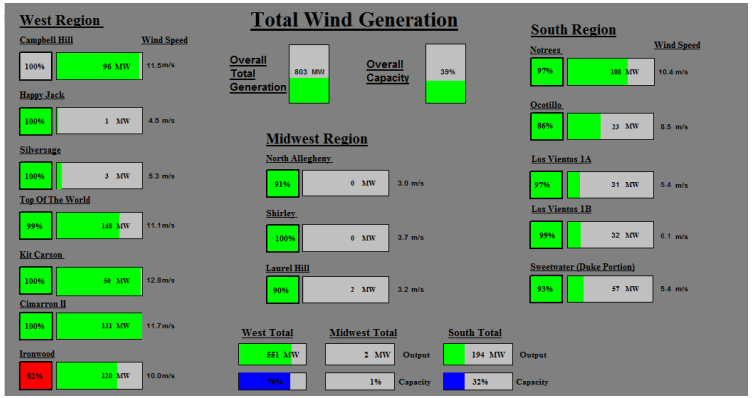
If the issue persisted would have cost $500 a day in lost generation

Renewable Energy Monitoring System

"This [OSI PI System] delivered a highly functional monitoring center interface and saved us the expense of having to use 3rd party programmers."

Greg Wolf

President DE Renewables



Business Challenge

- Need an in-house monitoring scheme for the rapidly growing wind and solar fleet that is uniform, dynamic, and effective.

Solution

✓ Developed overview screens that integrate real-time performance data with a common interface

Results and Benefits

❑ Provides operators with site status at a quick glance

❑ Precedent for future developments in fleet monitoring

Future Developments

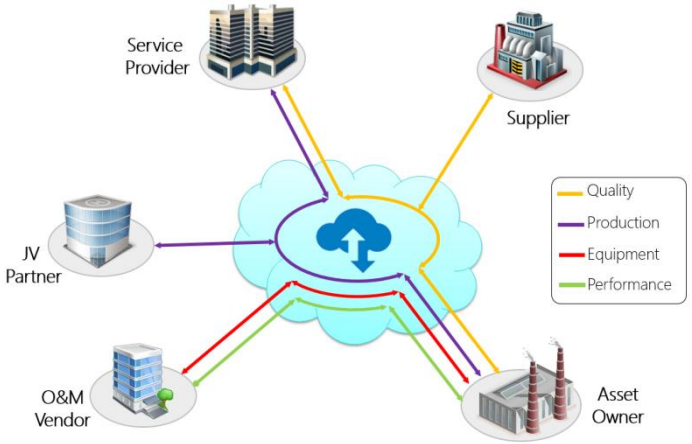
PI Cloud Connect

- Regularly get data requests from Vendors for analytical support
- Be able to publish data and vendors can subscribe and pull data from the cloud when needed
- Save time and resources
- No additional infrastructure needed

PI Future Data

– Ability to model wind forecast in PI

– Predicting equipment impacts due to wind or temperature forecasts, able to adjust schedules to minimize monetary loss



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