



The Journey of the OSIsoft PI System at Xcel Energy

BUSINESS SYSTEMS

TECHNOLOGY • SOLUTIONS • SUPPORT

Think more
strategically.

Maximize
partner value.

Increase
our throughput.

Presented by Kasen Huwa – Application and Operations
Delivery Manager



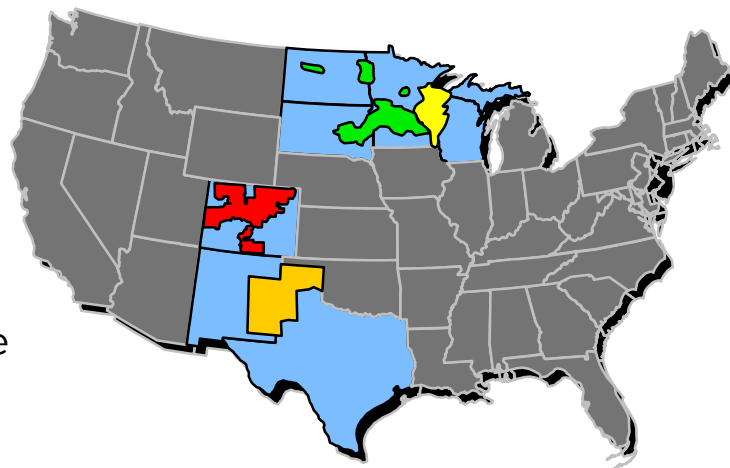
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Xcel Energy: Who We Are

- States Served: Colorado, Michigan, Minnesota, New Mexico, North Dakota, South Dakota, Texas and Wisconsin
- Approximately 3.4 million electric customers and 1.9 million natural gas customers
- \$11.6 billion in revenues (2014)
- Dow Jones Sustainability Index
- 2013 American Wind Energy Association (AWEA) Utility of the Year
- AWEA No. 1 provider of wind energy, 11 years running.
- Solar Energy Power Association (SEPA) Top Ten of US Utilities for amount of solar on our system

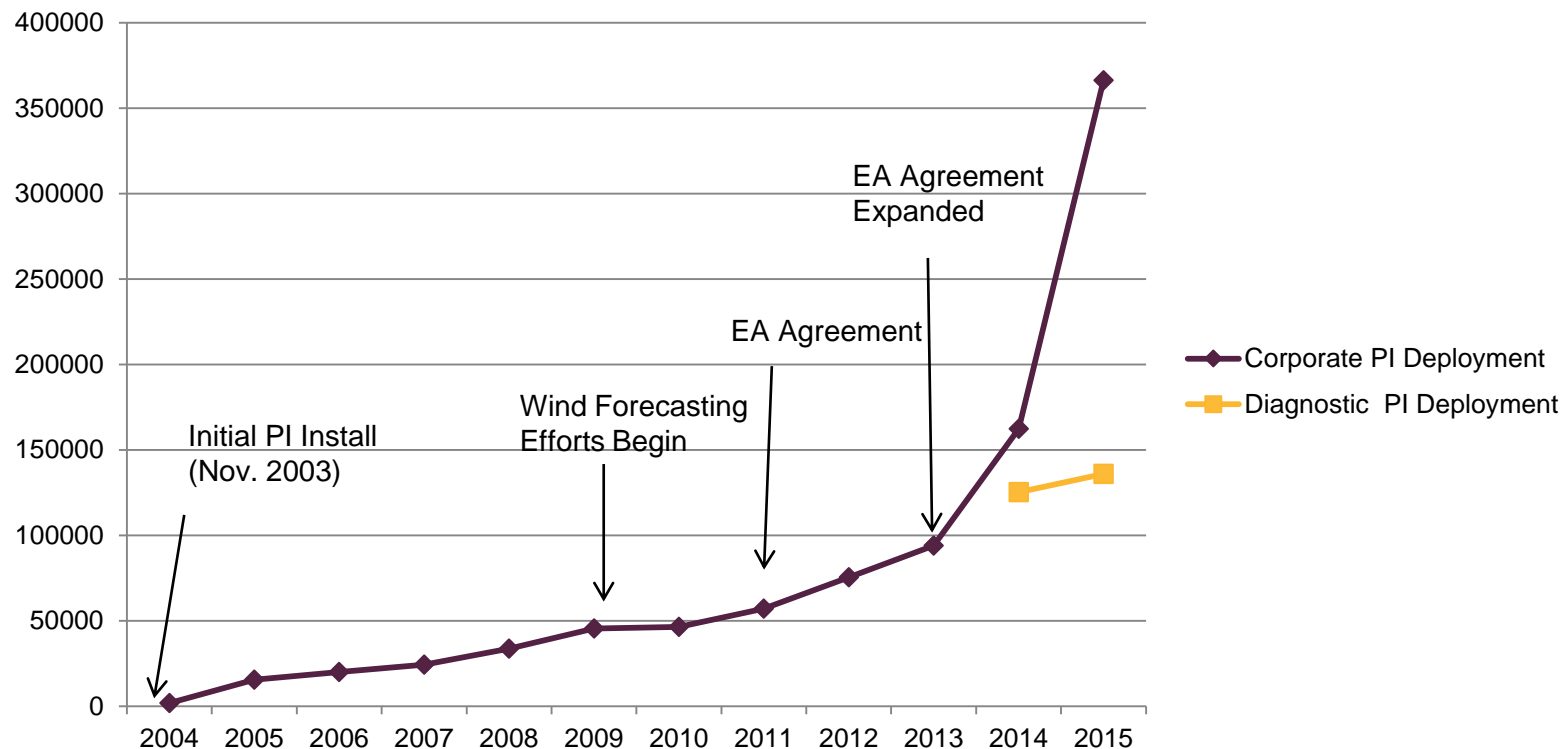


Xcel Energy & OSI PI: The Journey Begins

- 1990's: Four individual plants have separate OSI PI installations
- 2003: First centralized installation in Colorado Transmission Operations, followed by installations in Minnesota and Texas
 - Generation and market pricing data used by Commercial Operations
 - System expanded for new SPP market and MISO Market Changes
- 2008: Wind Forecasting efforts begins
- 2011: Enterprise Agreement (EA) Signed Covering PSCo, SPS and NSP Transmission Operations and Commercial Operations as well as Wind Data Integration
- 2013: EA expanded to cover six coal fired generation facilities on a pilot basis for diagnostic purposes 2013



Xcel Energy PI Point Count Deployment



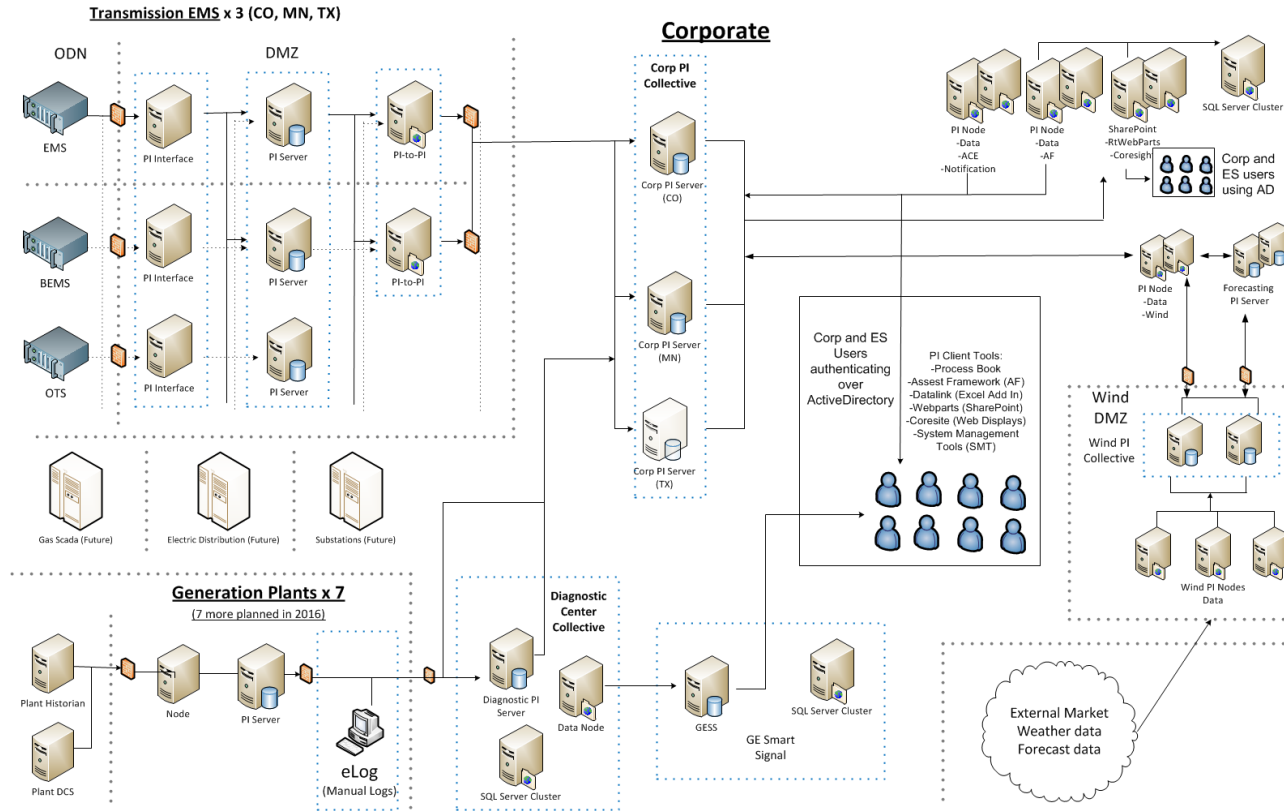
Overview of PI Deployments at Xcel Energy

PI deployments at Xcel Energy include:

- Generation
 - Six coal and one gas fired plant
 - eLog – all 72 generation locations
 - Diagnostic Center
- CORP
 - Commercial Operations
 - Wind and Load Forecast, ISO Data, Internal Apps
 - System Summary Dashboard
- EMS
 - Transmission Operations, all EMS data
 - With limited Gas, Distribution and Substation Data



Architecture – 2003 to Present

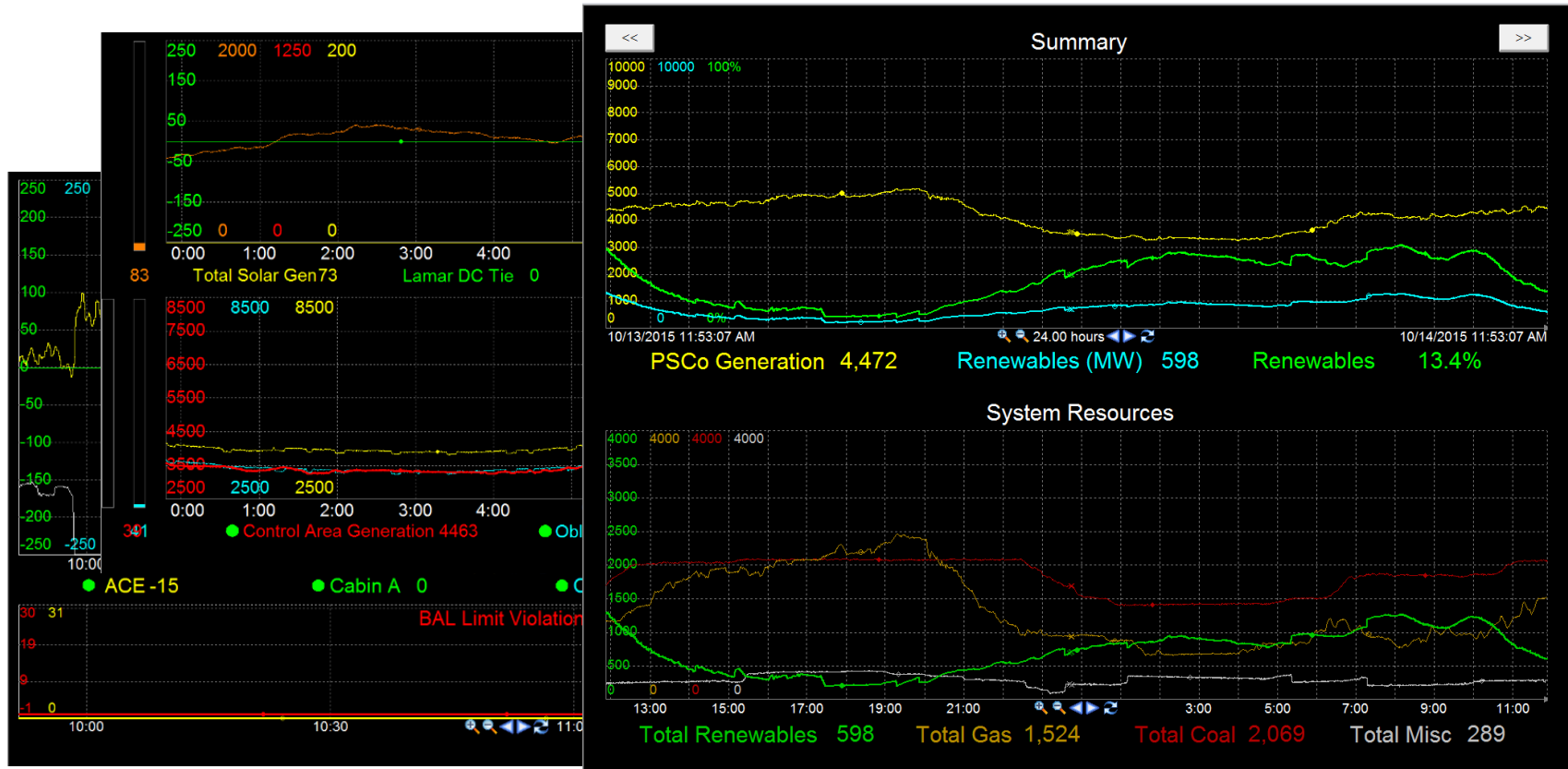


The Journey Continues

- Transmission
- Commercial Operations
- Wind Forecasting
- Monitoring and Diagnostic Center
- Executive Dashboards



Transmission – Operation Displays



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Transmission – AF and Tie Line reports

ALTW Hourly Report

Lock Unlock Export

Last Refr: 10/9/15 12:37 PM

		Total		ADM 852 MTC		ADM TR9		Big Blue		BLE MUNI		Cisco		Jeffers		LAJ 881 NOB		MDE 762		WAM 4592	
		Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received	Delivered	Received
HE01	10/9/15 1:00	138.00	13.00	98.00	0.00	0.00	0.00	26.00	0.00	0.00	0.00	2.00	0.00	9.00		0.00	12.00	2.00	0.00	0.00	1.0
HE02	10/9/15 2:00	102.00	7.00	78.00	0.00	0.00	0.00	14.00	0.00	0.00	0.00	1.00	0.00	7.00		0.00	6.00	1.00	0.00	0.00	1.0
HE03	10/9/15 3:00	105.00	14.00	91.00	0.00	0.00	0.00	6.00	0.00	0.00	0.00	1.00	0.00	5.00		0.00	12.00	1.00	0.00	0.00	2.0
HE04	10/9/15 4:00	93.00	12.00	78.00	0.00	0.00	0.00	9.00	0.00	0.00	0.00	0.00	0.00	5.00		0.00	9.00	0.00	0.00	0.00	3.0
HE05	10/9/15 5:00	134.00	20.00	113.00	0.00	0.00	0.00	16.00	0.00	0.00	0.00	0.00	0.00	4.00		0.00	18.00	0.00	0.00	0.00	2.0
HE06	10/9/15 6:00	123.00	24.00	104.00	0.00	0.00	0.00	14.00	0.00	0.00	0.00	0.00	0.00	3.00		0.00	23.00	0.00	0.00	0.00	1.0
HE07	10/9/15 7:00	72.00	26.00	58.00	0.00	0.00	0.00	7.00	0.00	0.00	0.00	1.00	0.00	3.00		0.00	24.00	0.00	2.00	1.00	0.0
HE08	10/9/15 8:00	63.00	31.00	52.00	0.00	0.00	0.00	3.00	0.00	0.00	0.00	0.00	0.00	4.00		0.00	29.00	0.00	2.00	2.00	0.0
HE09	10/9/15 9:00	64.00	34.00	54.00	0.00	0.00	0.00	2.00	0.00	0.00	0.00	0.00	0.00	4.00		0.00	31.00	0.00	3.00	2.00	0.0
HE10	10/9/15 10:00	35.00	25.00	30.00	0.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	22.00	0.00	3.00	1.00	0.0
HE11	10/9/15 11:00	23.00	26.00	18.00	3.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	19.00	0.00	4.00	1.00	0.0
HE12	10/9/15 12:00	19.00	26.00	14.00	4.00	0.00	0.00	1.00	0.00	0.00	0.00	0.00	0.00	0.00		0.00	18.00	0.00	4.00	1.00	0.0
HE13																					
HE14																					
HE15																					
HE16																					
HE17																					
HE18																					
HE19																					
HE20																					
HE21																					
HE22																					
HE23																					
HE24																					
Total		971.00	258.00	788.00	7.00	0.00	0.00	100.00	0.00	0.00	0.00	5.00	0.00	44.00	0.00	0.00	223.00	4.00	18.00	8.00	10.0
Off Peak Total		695.00	90.00	562.00	0.00	0.00	0.00	85.00	0.00	0.00	0.00	4.00	0.00	33.00	0.00	0.00	80.00	4.00	0.00	0.00	10.0
On Peak Total		276.00	168.00	226.00	7.00	0.00	0.00	15.00	0.00	0.00	0.00	1.00	0.00	11.00	0.00	0.00	143.00	0.00	18.00	8.00	0.0

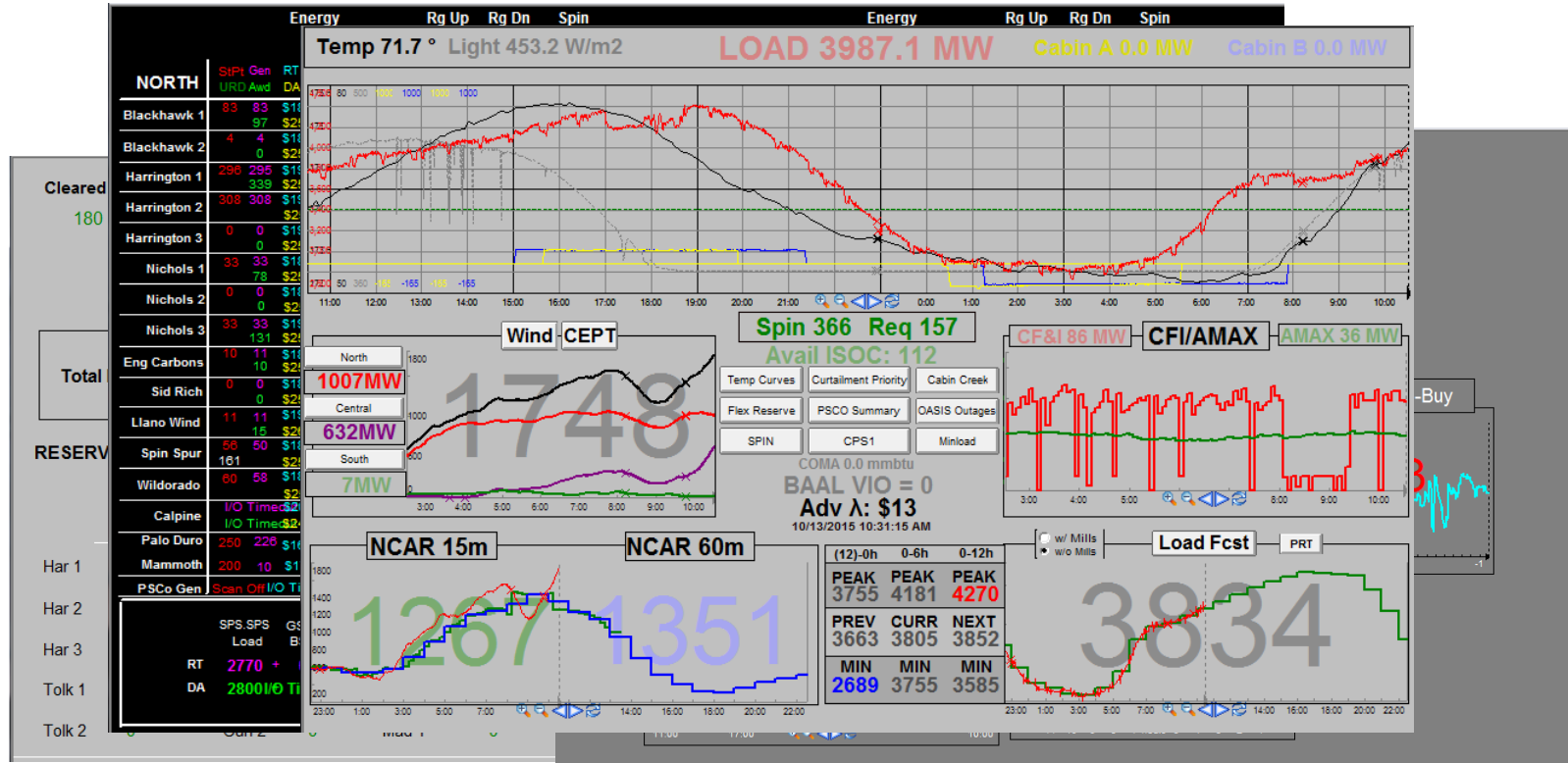


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Commercial Operations - Operational Displays



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Commercial Operations - Offline Supplemental deployment report using AF Event Frame Analysis

General

Child Elements

Attributes

Ports

Analyses

Version

Name

CMODE Compare

Offline supplemental deployment

Name

Expression

Variable1if('CMODE from MISO'='CMODE to MISO')

Name

CMODE Compare

Start Time

7/1/2015

End Time

10/31/2015

Search for Offline Supplemental Deployments for Given Time Range

Pass

Fail

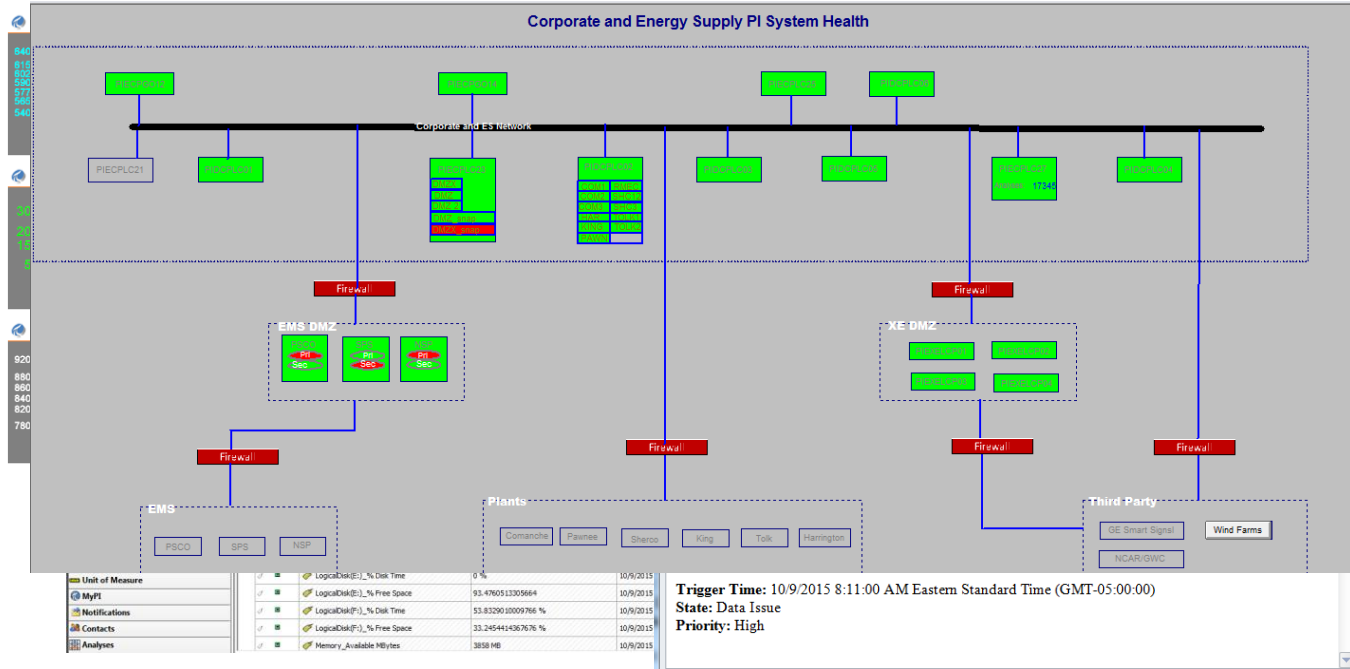
Event name	Start time	End time	Duration	Event template	Primary element	Offline Supplemental Cleared	Offline Supplemental Deployment	RT Net Generation	RT Net Generation plus 10m	Supp MCP	PASS / FAIL
Plant1_1_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 14:55:09	0 0:29:44	Offline Supplemental Plant1	Plant1	4.00	8	-4.88281E-05	0.00	3.960000038	FAIL
Plant1_6_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 15:07:46	0 0:42:21	Offline Supplemental Plant1	Plant1	7.95	8	-4.88281E-05	0.00	3.960000038	FAIL
Plant1_2_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 14:55:09	0 0:29:44	Offline Supplemental Plant1	Plant1	4.00	8	-4.88281E-05	0.00	3.960000038	FAIL
Plant12_4_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 14:50:21	0 0:24:56	Offline Supplemental Plant12	Plant12	8.00	8	0	0.60	3.960000038	FAIL
Plant12_2_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 14:50:21	0 0:24:56	Offline Supplemental Plant12	Plant12	8.00	8	0	0.00	3.960000038	FAIL
Plant12_3_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 14:50:21	0 0:24:56	Offline Supplemental Plant12	Plant12	3.97	8	0	0.37	3.960000038	FAIL
Plant12_1_2015-07-12 15:25:25.421	12-Jul-15 14:25:25	12-Jul-15 14:50:21	0 0:24:56	Offline Supplemental Plant12	Plant12	3.97	8	0	0.72	3.960000038	FAIL
Plant12_2_2015-07-12 16:00:17.421	12-Jul-15 15:00:17	12-Jul-15 15:03:05	0 0:02:48	Offline Supplemental Plant12	Plant12	0.00	8	9.91885376	10.07	3.029999971	Pass
Plant1_1_2015-07-14 14:36:43.593	14-Jul-15 13:36:44	14-Jul-15 13:55:20	0 0:18:36	Offline Supplemental Plant1	Plant1	0.00	45	-4.88281E-05	0.90	8	FAIL
Plant1_1_2015-07-15 13:29:26.937	15-Jul-15 12:29:27	15-Jul-15 12:41:27	0 0:12:00	Offline Supplemental Plant1	Plant1	0.00	45	-4.88281E-05	11.02	2	FAIL
Plant1_1_2015-07-15 13:58:58.953	15-Jul-15 12:58:59	15-Jul-15 13:12:23	0 0:13:24	Offline Supplemental Plant1	Plant1	0.00	47	0.220227093	8.73	8	FAIL
Plant12_2_2015-07-15 14:30:06.953	15-Jul-15 13:30:07	15-Jul-15 13:41:39	0 0:11:32	Offline Supplemental Plant12	Plant12	0.00	56	0	9.91	1.779999971	FAIL
Plant12_4_2015-07-15 14:44:34.953	15-Jul-15 13:44:35	15-Jul-15 13:56:59	0 0:12:24	Offline Supplemental Plant12	Plant12	0.00	47	0.35866794	10.14	1.779999971	FAIL
Plant1_1_2015-07-17 13:45:07.187	17-Jul-15 12:45:07	17-Jul-15 12:58:07	0 0:13:00	Offline Supplemental Plant1	Plant1	0.00	8	0	10.12	2.509999999	Pass
Plant12_3_2015-07-17 14:00:07.187	17-Jul-15 13:00:07	17-Jul-15 13:22:15	0 0:22:08	Offline Supplemental Plant12	Plant12	0.00	8	0	15.60	2.509999999	Pass
Plant1_1_2015-07-17 15:16:43.187	17-Jul-15 14:16:43	17-Jul-15 14:21:43	0 0:05:00	Offline Supplemental Plant1	Plant1	8.00	8	-4.88281E-05	0.00	8.140000343	FAIL
Plant1_6_2015-07-17 15:22:15.187	17-Jul-15 14:22:15	17-Jul-15 14:32:11	0 0:09:56	Offline Supplemental Plant1	Plant1	0.00	8	-4.88281E-05	10.07	2.230000019	Pass
Plant1_1_2015-08-12 12:51:11.500	12-Aug-15 11:51:11	12-Aug-15 12:03:55	0 0:12:44	Offline Supplemental Plant1	Plant1	5.00	8	-4.88281E-05	3.98	0.25	FAIL
Plant1_1_2015-08-12 16:15:23.531	12-Aug-15 15:15:24	12-Aug-15 15:43:08	0 0:27:44	Offline Supplemental Plant1	Plant1	8.00	8	-4.88281E-05	2.68	0.970000029	FAIL
Plant1_2_2015-08-12 16:15:23.531	12-Aug-15 15:15:24	12-Aug-15 15:38:00	0 0:22:36	Offline Supplemental Plant1	Plant1	8.00	8	-4.88281E-05	4.83	0.970000029	FAIL
Plant12_2_2015-08-12 16:15:23.531	12-Aug-15 15:15:24	12-Aug-15 15:43:08	0 0:27:44	Offline Supplemental Plant12	Plant12	8.00	8	0	1.38	0.970000029	FAIL

Commercial Operations - Wind Generation data quality – AF Analysis

Xcel Energy																			
					Update					Waiting for action									
Last Updated: 10/8/2015 12:08:29 PM										Scheduled outage									
										Notify ComOps 1st									

IT Monitoring

System Monitoring/ Alerts on System states/ Data quality monitoring

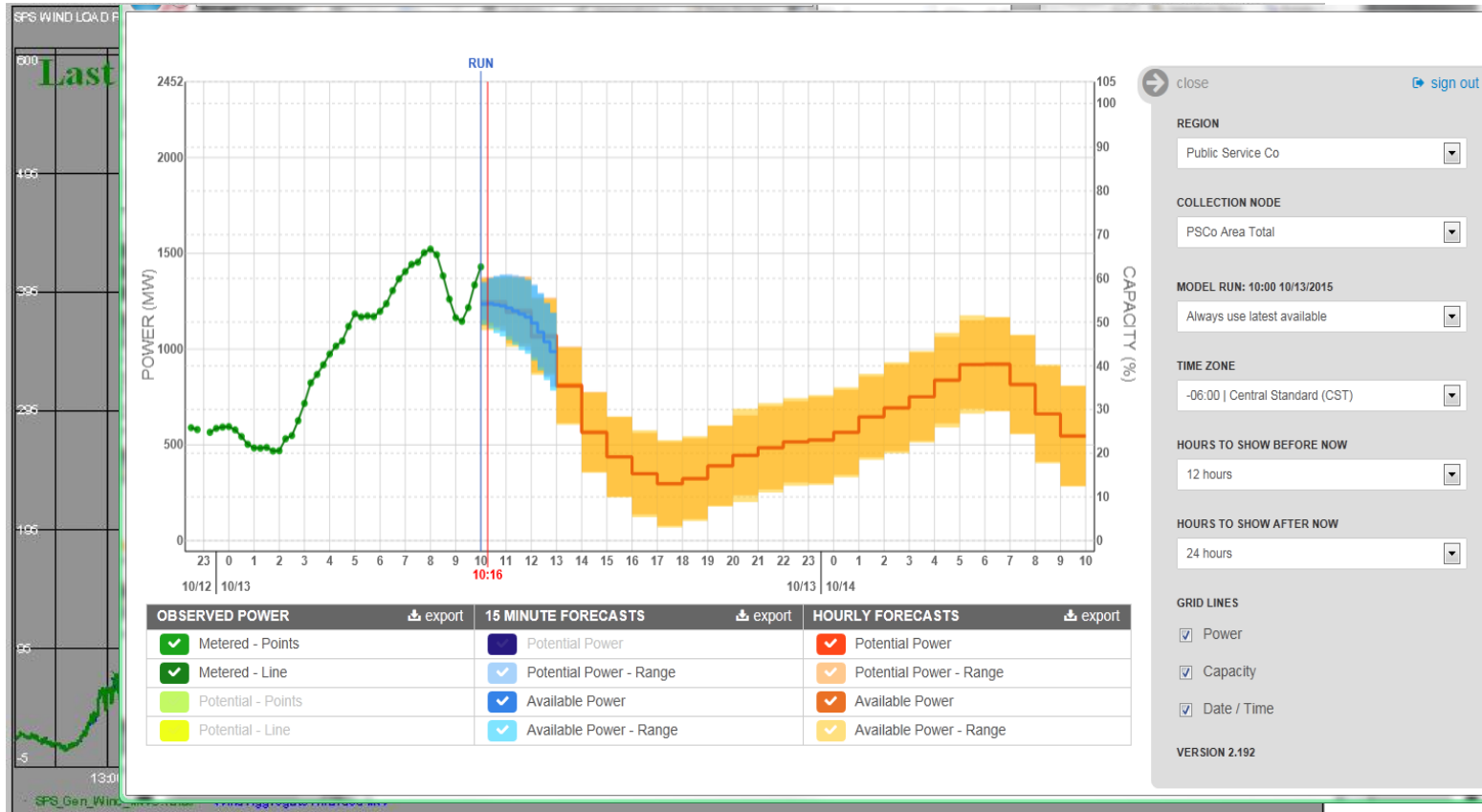


Overview of Wind Forecasting

- Started in 2008 and continues with ongoing improvements
- Partnered with NCAR and NREL
- Now hosted by GWC
- Benefits
 - Reduced error by 38%
 - Savings/Efficiencies of \$46M over six years
 - More Efficient and Maintenance minded operation of Fossil Fuel Plants
 - Finalist for 2015 Minnesota High Tech Association (MHTA) Tekne Award in the Energy and Clean Tech category (awards in mid November 2015)



Wind Forecasting



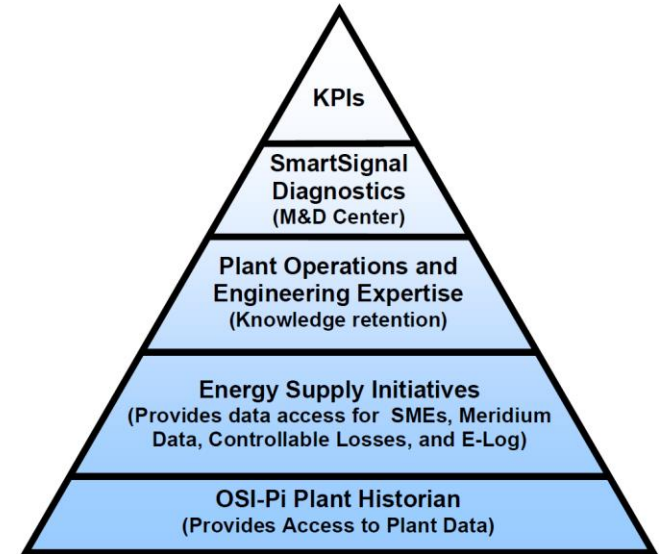
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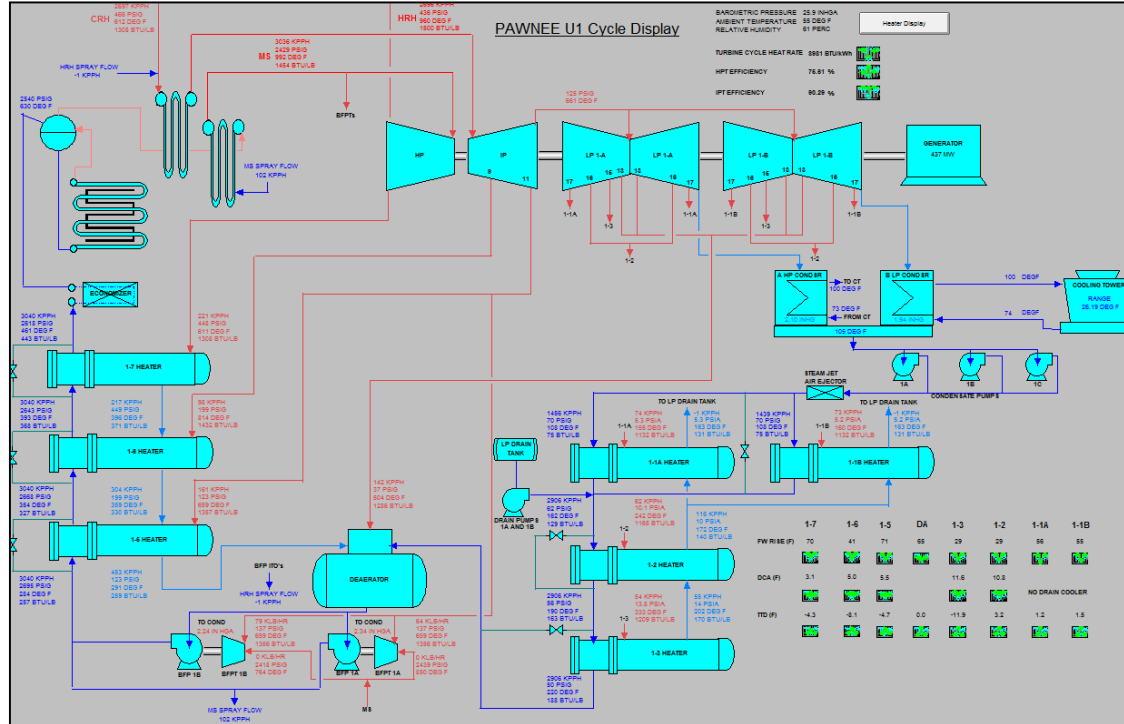
Monitoring and Diagnostic Center

- OSI-PI provides primary data to M&D center and is the foundation for many applications including Predictive Analytics, Process Screens, Controllable Parameters and On-line Heat Rate Monitoring.
- Currently OSI PI's are at six major coal plants and one Combined Cycle
- Plans are in place to expand to all major plants under an EA agreement
- OSI-PI allows secure NON-DCS data access to corporate SMEs for assistance in troubleshooting and analysis.
- OSI-PI will be an enabler for the following:
 - Meridium
 - Smart Signal
 - Vibration Analysis
 - Executive Operating Report - "150z"
 - E-Log
 - Emissions Tracking
 - Near Real time Dispatch Curves


















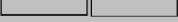








Monitoring and Diagnostic Center

Stream Data and Calculations into cycle monitoring sheets and provides embedded trend charts



Monitoring and Diagnostic Center

Streams Data and Calculations for Plant Controllable monitoring sheets

Controllable Parameters						Generation	266.89 MW
						Net Generation	242.09 MW
Throttle Conditions	Trend	Units	Actual	Target	Deviation	Heat Rate Change*	Heat Rate Change*
Throttle Pressure		PSIG	2342	2400	-57.58	12.22 BTU/kWh	
Throttle Temperature		DEGF	998	1000	-2.07	4.05 BTU/kWh	
Reheat Temperature		DEGF	940	1000	-59.56	57.51 BTU/kWh	
Cycle Conditions							
Condenser Pressure		INHG	4.56	1.50	3.06	620.76 BTU/kWh	
Final Feedwater Temp		DEGF	456.4	447.2	9.14	-25.82 BTU/kWh	
Boiler Conditions							
SH Spray Flows		KPPH	107.0	0.00	5.98 %*	12.27 BTU/kWh	
RH Spray Flow		KPPH	10.2	0.00	0.62 %*	10.16 BTU/kWh	
Exhaust Gas Temp		DEGF	290.6	246.4	44.22	Unavailable	
Excess O2		%	3.26 %	3.54 %	-0.21	Unavailable	
Miscellaneous							
Aux Steam Flow		KPPH	0	0.00	0.00	Unavailable	
Aux Power		MW	24.8	24.3	0.5	21.95 BTU/kWh	
Net Unit Heat Rate		BTU/kWh	11040	10346	694.5		
* Spray deviation is a percentage of MS and HRH flow							
* Note a decrease in Heat Rate is an improvement							



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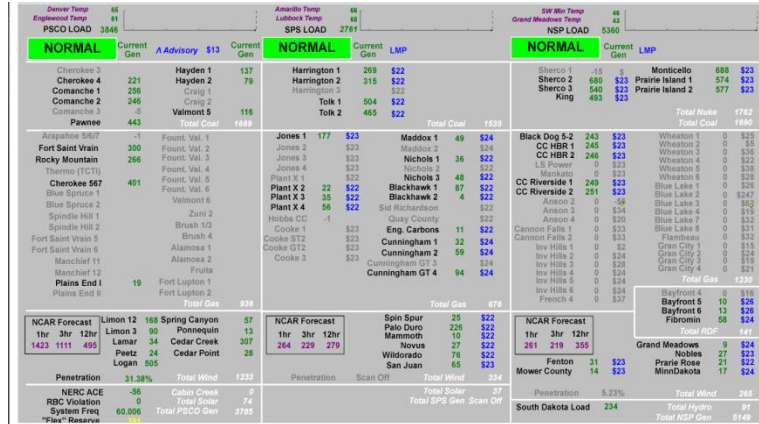
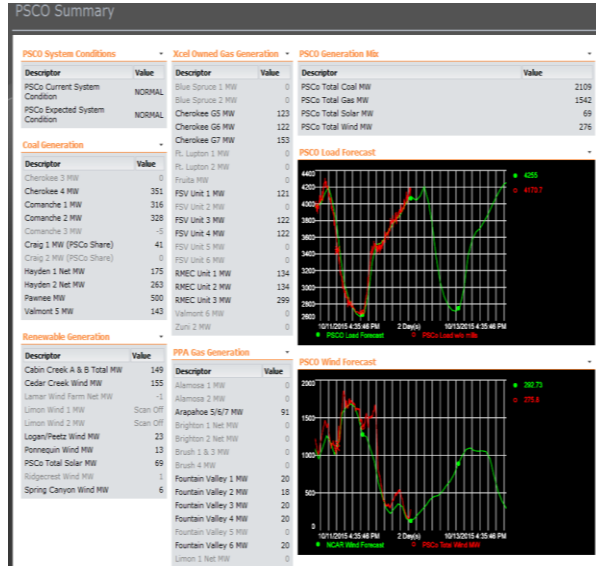
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Executive Summary Dashboard

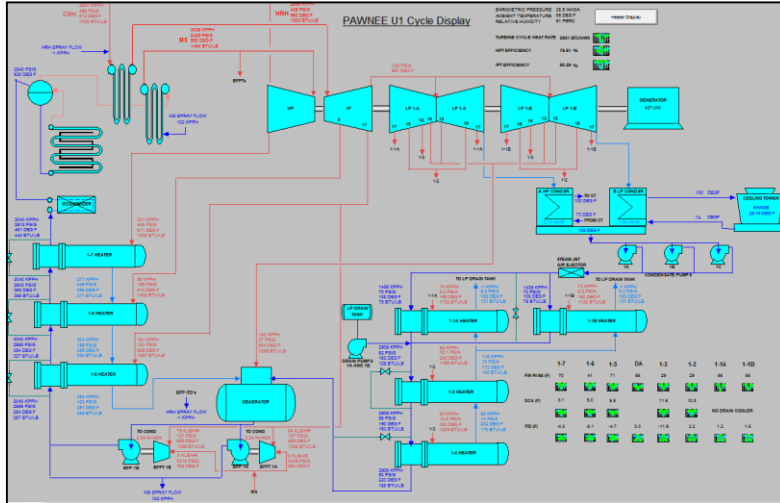
- Commercial Operations & Generation
 - PSCo, SPS, NSP, All Systems
- SPS Plant Gas
- Energy Supply
 - Controllable Parameters, Steam Cycles
- Transmission
 - PSCo, SPS, NSP
- Executive Summary



Generation



Energy Supply



Controllable Parameters

Generation 266.89 MW
Net Generation 242.09 MW

Throttle Conditions	Trend	Units	Actual	Target	Deviation	Heat Rate Change*	Heat Rate Change*
Throttle Pressure		PSIG	2342	2400	-57.58	12.22 BTU/kWh	
Throttle Temperature		DEGF	998	1000	-2.07	4.05 BTU/kWh	
Reheat Temperature		DEGF	940	1000	-59.56	57.51 BTU/kWh	
Cycle Conditions							
Condenser Pressure		INHG	4.56	1.50	3.06	620.76 BTU/kWh	
Final Feedwater Temp		DEGF	456.4	447.2	9.14	-25.02 BTU/kWh	
Boiler Conditions							
SH Spray Flows		KPPH	107.0	0.00	5.98 %*	12.27 BTU/kWh	
RH Spray Flow		KPPH	10.2	0.00	0.62 %*	10.16 BTU/kWh	
Exhaust Gas Temp		DEGF	290.6	246.4	44.22	Unavailable	
Excess O2		%	3.26 %	3.54 %	-0.21	Unavailable	
Miscellaneous							
Aux Steam Flow		KPPH	0	0.00	0.00	Unavailable	
Aux Power		MW	24.8	24.3	0.5	21.95 BTU/kWh	
Net Unit Heat Rate		BTU/kWh	11040	10346	694.5		

* Spray deviation is a percentage of MS and HRH flow

* Note a decrease in Heat Rate is an improvement

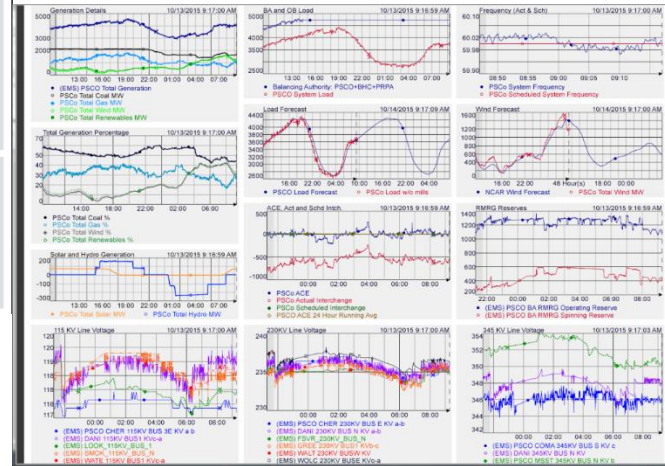
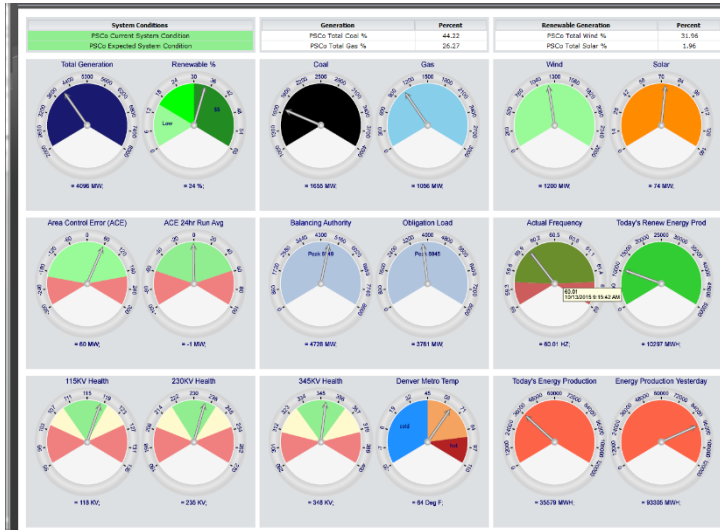


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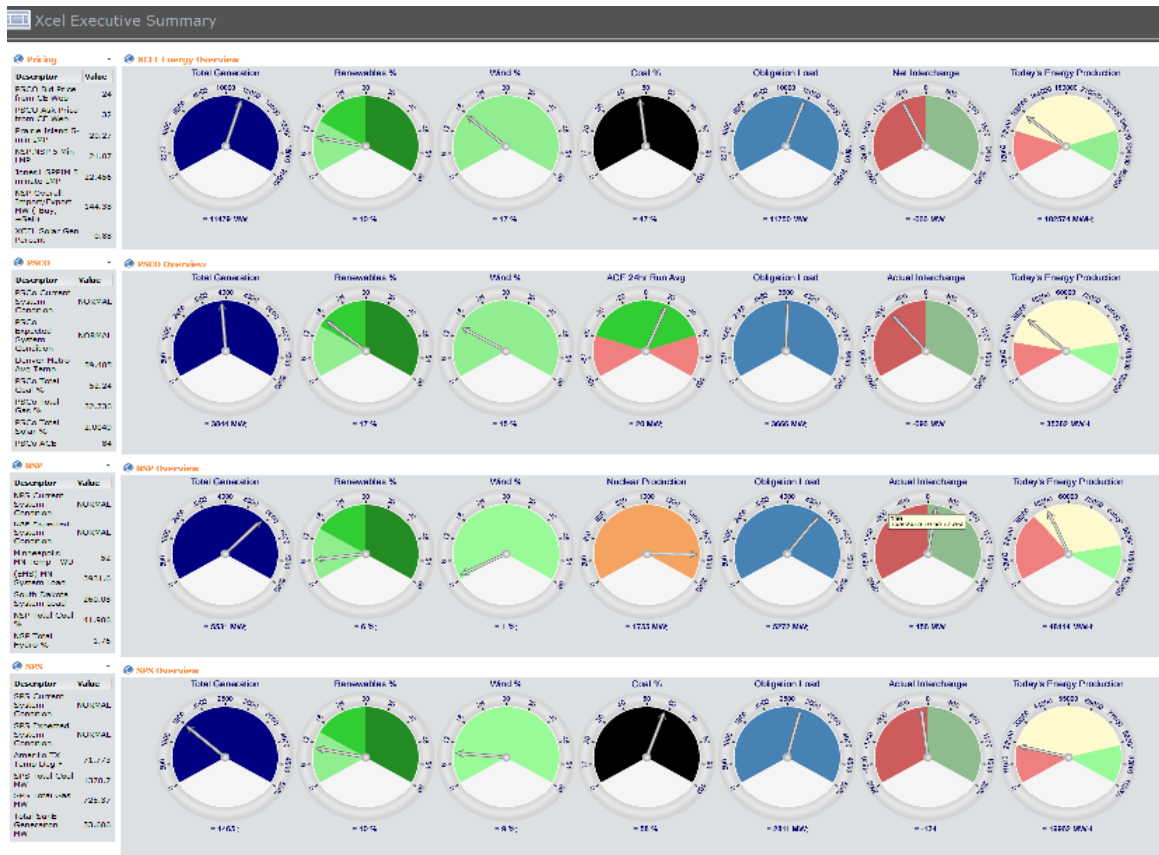
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Transmission



Executive Summary Dashboard



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The Journey Looking Forward

- Gas Distribution
- Gas Transmission
- Emissions
- Electric Distribution
- Substations
- Distributed Generation
- Smart Meters
- Anything the Business can dream of



Questions?



Thank You

Kasen Huwa

Xcel Energy | Responsible By Nature

Senior Business Manager

Kasen.R.Huwa@XcelEnergy.com

XCELENERGY.COM



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