

SmartSignal in Wind Power Generation

OSI User's Conference
Renewables Day
April 26, 2010

Generate Clean, Reliable Power for Your Clients/Markets

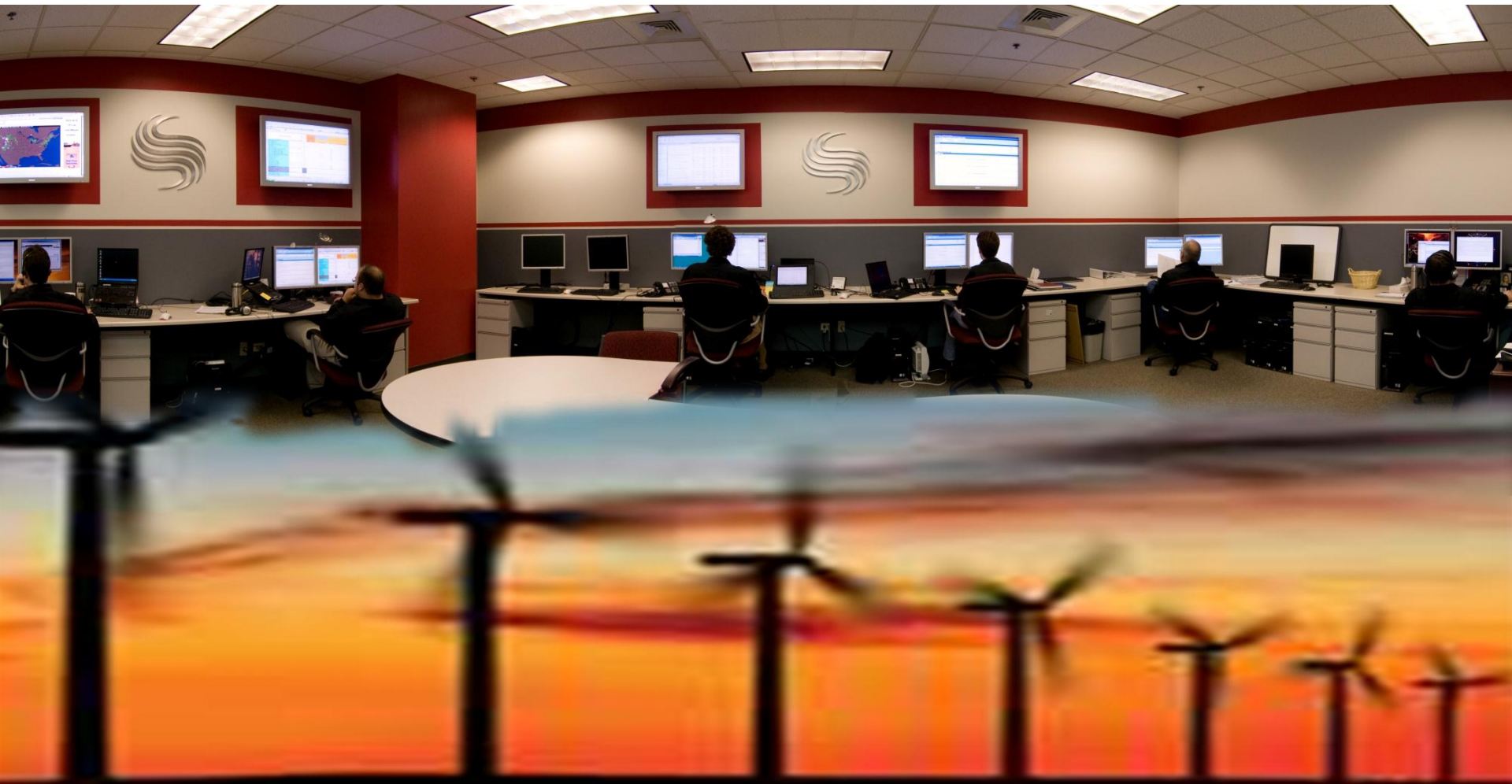


Requires Reliable Wind Turbines



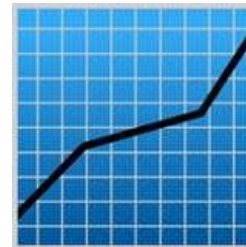
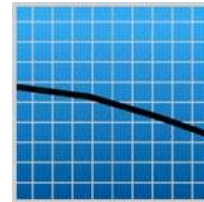
**The turbines must
be available
whenever the
wind blows.**

Avoid Surprises with OSI and SmartSignal




Benefits

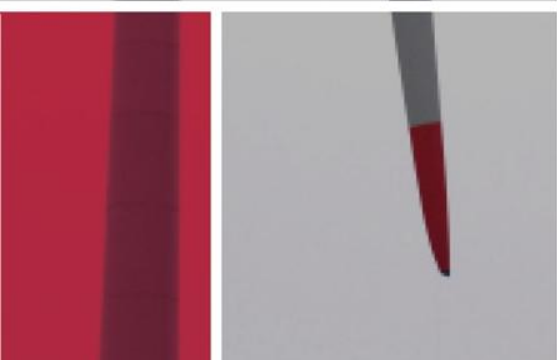
- ☞ Maximize your OSIsoft Return on Investment
- ☞ Optimize maintenance resources
- ☞ Improve reliability
- ☞ Improve revenue
- ☞ Improve safety





Agenda

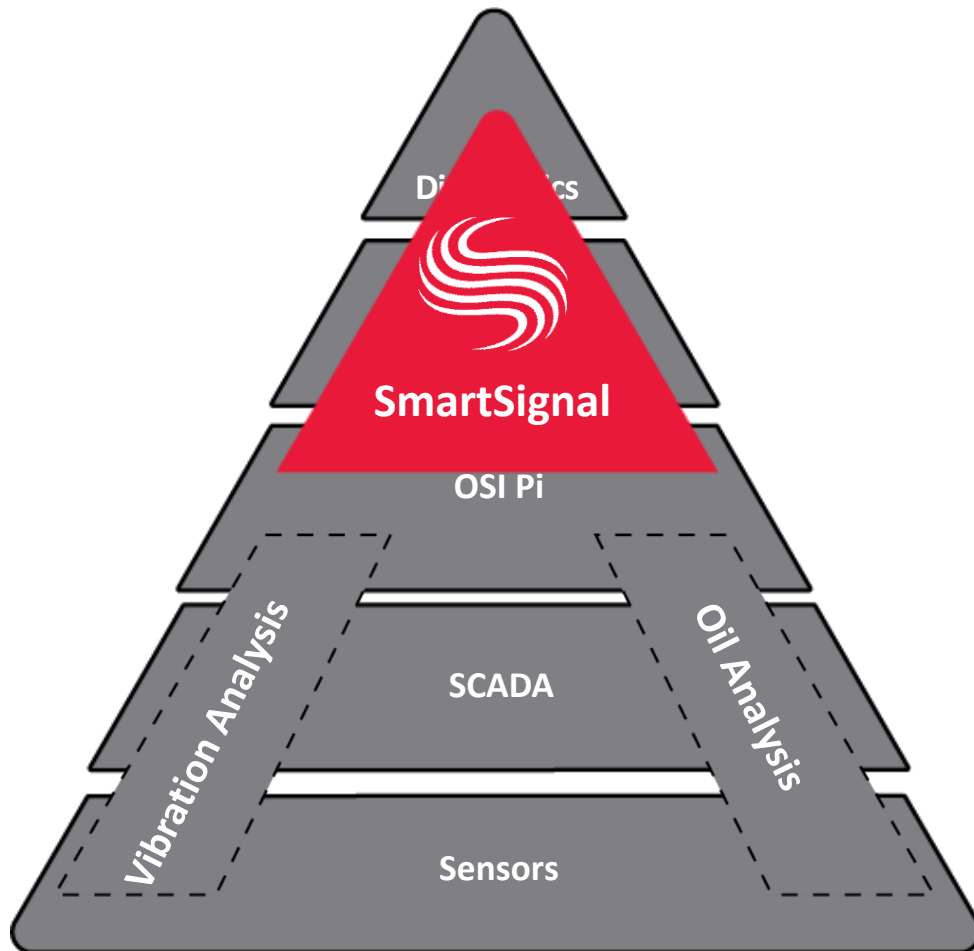
- 
- ☞ Who is SmartSignal?
 - ☞ How SmartSignal is used in Wind Power Generation?
 - ☞ Results



Who is SmartSignal?

OSI User's Conference
Renewables Day

Like You, Our Customers Invested Significantly In Sensors And Technology...Yet Problems Still Persist...Why?



Volume of data and alarms overwhelms:

- Resources
- Analysis capabilities

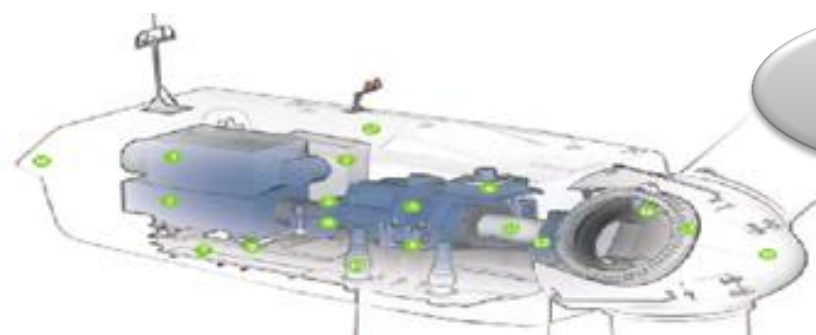
Result:

- Unplanned outages
- Lost availability
- Higher maintenance activity and cost

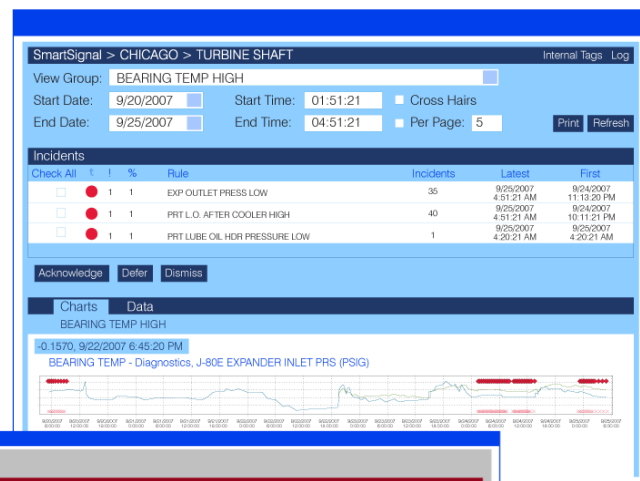
Result:

- Deliver early warning and diagnostic guidance
- Reduce forced losses

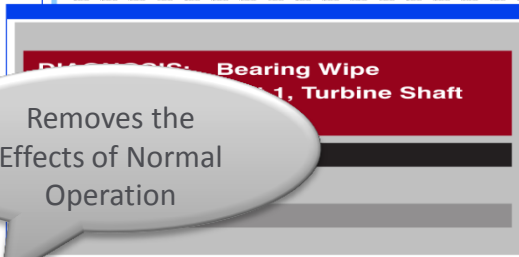
The SmartSignal Solution



Starts with
Data from
Your Equipment



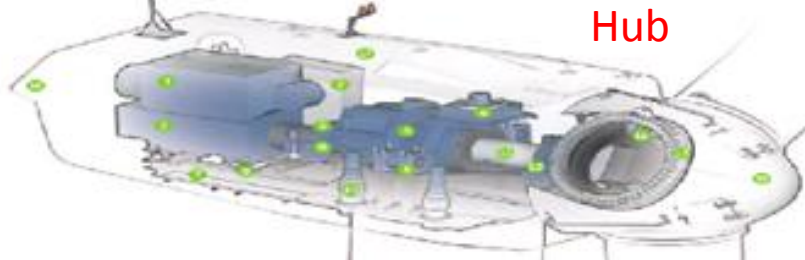
Removes the
Effects of Normal
Operation



Generator

Gearbox

Hub



Personalized Empirical Models

Pulls every 5-10 minutes

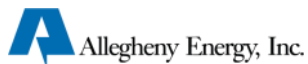


EPI*Center

Posts Emerging Threats
to Incident List

Leader in Predictive Analytics

smartsignal.



Wisconsin Public Service Corporation



Expanding In Wind Power Generation

smart**signal**.



alternativenergy

344 turbines



**IBERDROLA
RENEWABLES**

6,000+ turbines



794 turbines

Invenergy

982 turbines

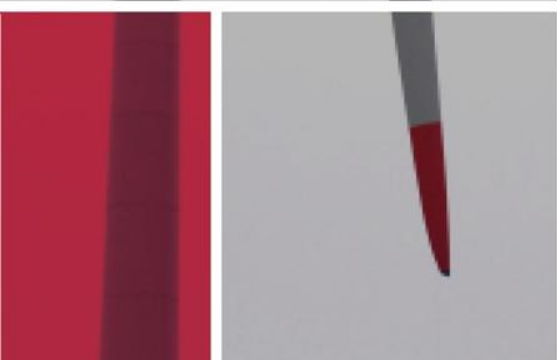


4,000+ turbines



Celebrating 20 years of success!

2,600+ turbines

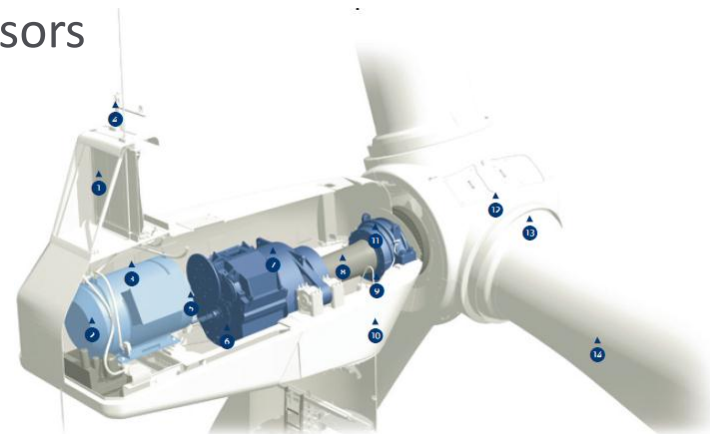


How SmartSignal is used in Wind Power Generation?

OSI User's Conference
Renewables Day

Models Focused On Failure Modes

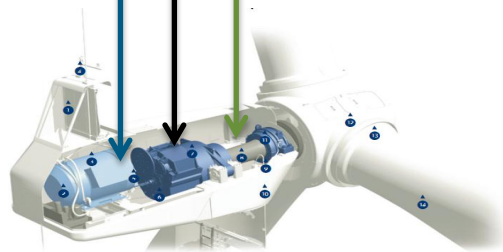
- ☞ Detect Blade Pitch & Yaw Failures:
 - ROTOR model: 17 sensors
- ☞ Detect Gearbox Failures:
 - MECHANICAL/ELECTRICAL model: 20+ sensors
- ☞ Detect Voltage/Current Failures:
 - MECHANICAL/ELECTRICAL model: 20+ sensors
- ☞ Detect Performance Problems
 - For individual WTGs
 - For WTG comparison across a wind plant
- ☞ Wind Plant Models
 - Nacelle position
 - Turbine performance



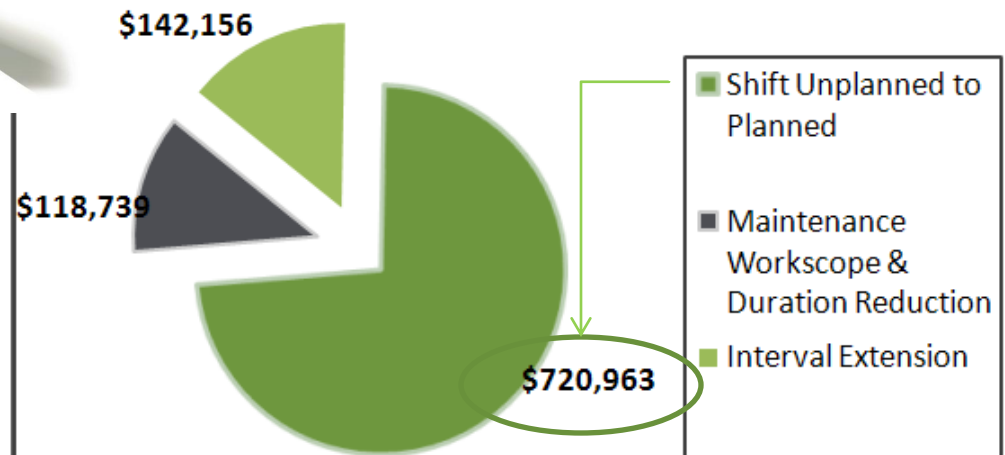
Predictive Analytics – Linked to Value!

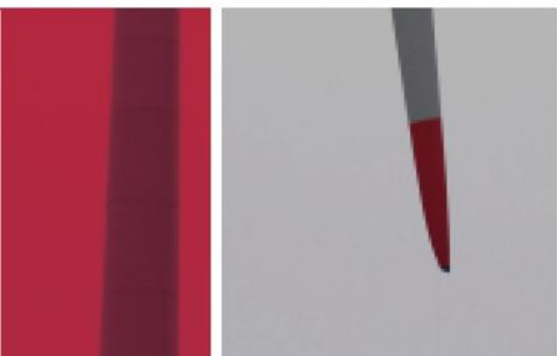


TYPICAL MODEL SET for GE WTGs			
UNIT	Models	Assets per Model	Tags per Model
All GE	ROTOR	1	12
	GEARBOX	1	15
	GENERATOR	1	10
	TOWER_CONTROLS	1	16
	GP_PERFORMANCE	10	50
	Total:	1-10	103



ANNUAL BENEFITS SUMMARY For Fleet





smart**signal**. 

Results

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Real-life Examples

- ☞ Root Cause - High Speed Gen Bearing
- ☞ Failed Equipment - Control Box Temperature Issue
- ☞ Operations - Wrong Control Mode
- ☞ Maintenance - Hydraulic Brake Pressure
- ☞ OEM - Cross Client Maintenance Practices Issue

SmartSignal Monitoring Report

4/7/2010



Availability & Performance Center

022

022

HS GEN BEARING TEMPS HIGH

Status: 02) Under Customer Review

Date of Notification: 3/31/2010 12:00:00 AM

Equipment Tag:

HS SS4 DAT.CL96XX.TUR.020.SS22.GEN1.HS.BEARING.TEMP

DAT.CL96XX.TUR.020.SS22.GEN2.HS.BEARING.TEMP

Category: 02) Mechanical

Description:

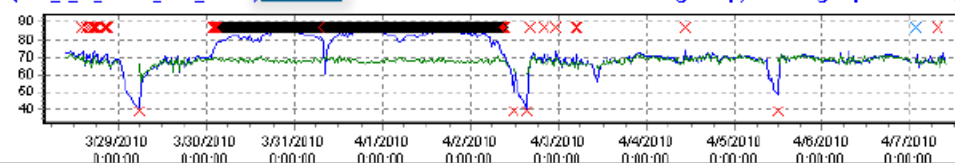
When this turbine came online we noticed a positive residual of 11 DEG C reaching temperatures of 80 DEG C. At the same time we are seeing an increase in gearbox oil temperature (70 DEG C) and tower acceleration (2 m/s²).

Diagnosis:

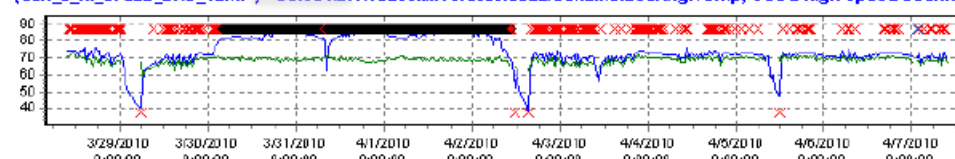
Lubrication, or bearing issue

Customer Response:

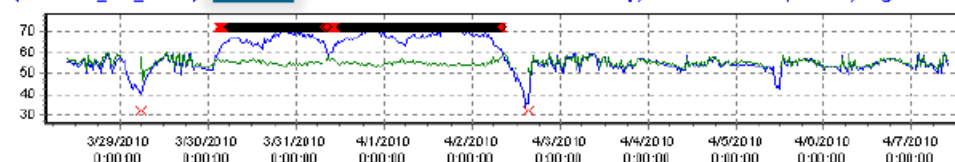
(GEN_1_HI_SPEED_DRG_TEMP) - AT.CL96xx.TUR.020.SS22.Gen1.HS.Bearing.Temp, GCU 1 High Speed Bearing Temp



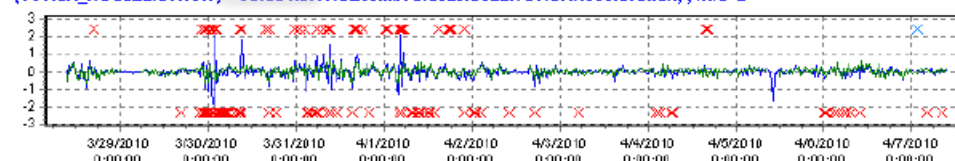
(GEN_2_HI_SPEED_DRG_TEMP) - AT.CL96xx.TUR.020.SS22.Gen2.HS.Bearing.Temp, GCU 2 High Speed Bearing Temp



(GEARBOX_OIL_TEMP) - T.CL96xx.TUR.020.SS22.Gearbox.Oil.Temp, Gearbox Oil Temp - SS22, degC



(TOWER_ACCELERATION) - AT.CL96xx.TUR.020.SS22.Tower.Acceleration, m/s^2



Wind Plant

Turbine_55ar

Several Flatlined tags in the CONTROLS model

Status: 11) Closed - Customer Remediation

Date of Notification:

Equipment Tag: Forward.Turbines.55ar.T_CTRL_BOX_1

.Turbines.55ar.T_CTRL_BOX_2

.Turbines.55ar.T_CTRL_BOX_3

.Turbines.55ar.T_BAT_BOX_1

.Turbines.55ar.T_BAT_BOX_2

.Turbines.55ar.T_BAT_BOX_3

.Turbines.55ar.T_CTRL_BOX

Category: 01) Instrumentation

Description:

sensors have returned highly digital appearing tags

.Turbines.55ar.T_CTRL_BOX_1

.Turbines.55ar.T_CTRL_BOX_2

.Turbines.55ar.T_CTRL_BOX_3

.Turbines.55ar.T_BAT_BOX_1

.Turbines.55ar.T_BAT_BOX_2

.Turbines.55ar.T_BAT_BOX_3

.Turbines.55ar.T_CTRL_BOX

All of the sensors listed above are flat lined with unchanging data. All of the sensors have failed in their normal operating range, so alerts are not being posted. This behavior appears to have started around 7/9 but became more prevalent around 7/20.

Is it possible that either a controller card or multiplexer has failed

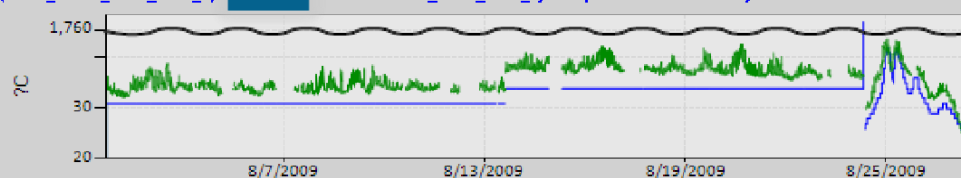
Diagnosis:

Customer Response:

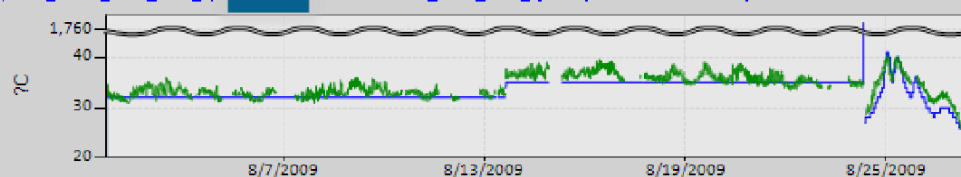
8-27-09: The PLC module was swapped out in WTG55, which I believe cleared up the flat-lined data that you were seeing.

Customer will validate data on their end. I checked and the data is "good quality" but does appear to be flatlined. Site will look into this further.

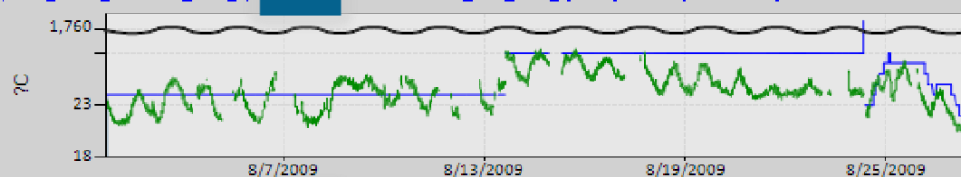
(WTG_TEMP_AXIS_BOX_2) - Turbines.55ar.T_CTRL_BOX_2, Temp. control box axis 2, ?C



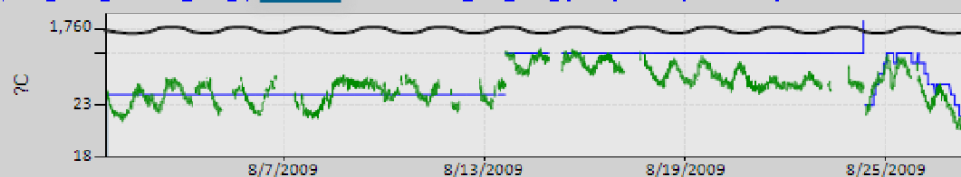
(WTG_TEMP_AXIS_BOX_3) - Turbines.55ar.T_CTRL_BOX_3, Temp. control box axis 3, ?C



(WTG_TEMP_BATTERY_BOX_1) - Turbines.55ar.T_BAT_BOX_1, Temp. battery box axis 1, ?C



(WTG_TEMP_BATTERY_BOX_2) - Turbines.55ar.T_BAT_BOX_2, Temp. battery box axis 2, ?C





Wind Plant

Turbine_47

Low Phase voltage on A,B,C

Status: 11) Closed - Customer Remediation**Date of Notification:****Equipment Tag:** forward.turbines.47,U_A_N, voltage

turbines.47,U_B_N, voltage

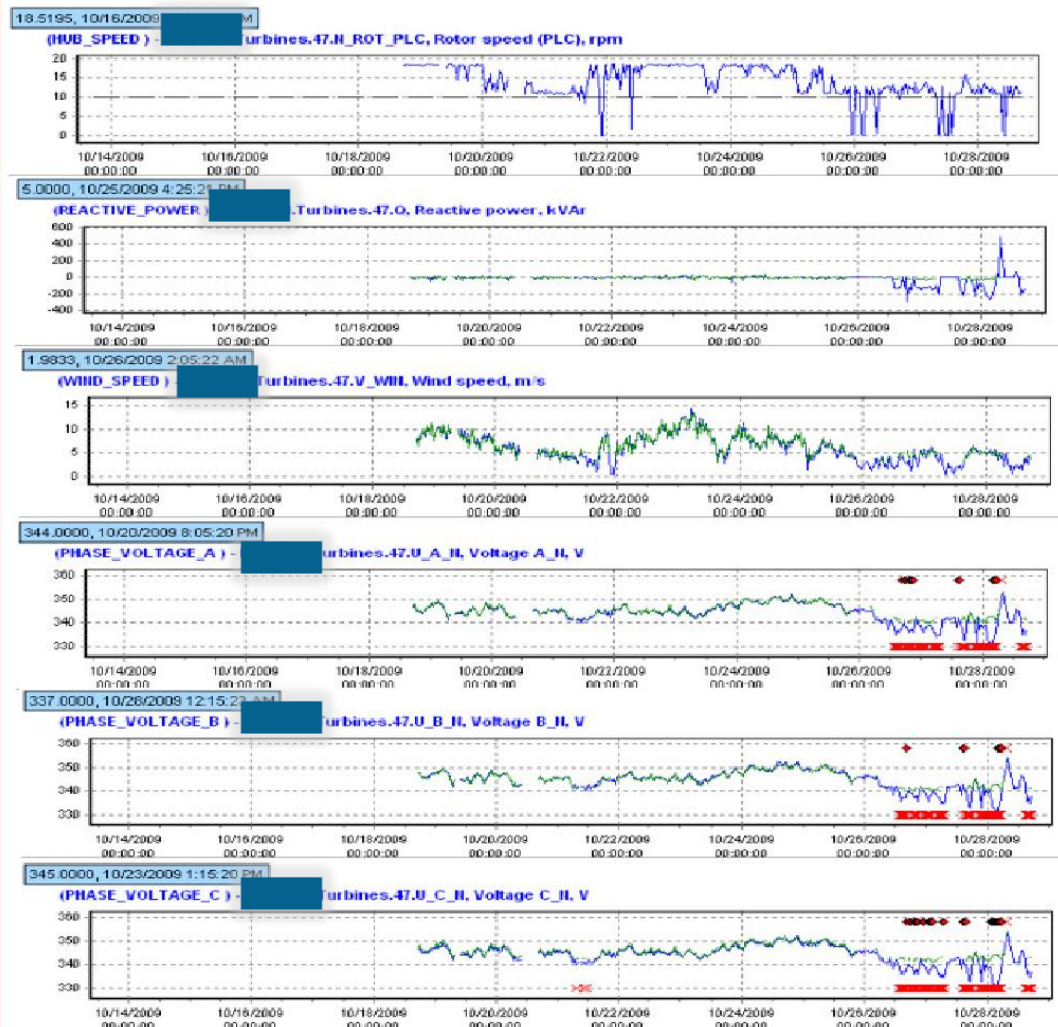
turbines.47,U_C_N, voltage

Category: 02) Mechanical**Description:**

On 10-26-09 we noticed a negative residual on all three phase voltages to almost 13 V. The reactive power is fluctuating lower to -200 kVAR, the hub speed changing between 0-14 RPM frequently. This condition is seen across the farm.

Diagnosis:

Customer Response: The WFMS was enabled, but we were operating in the Power Factor control mode with a power factor setting of 1. We have changed it to the Voltage Control mode and inputted a set point of 141,000V. Apparently, there were some modifications made to the WFMS system yesterday and this got switched. So, we have changed it and should see some improvements.





Wind Plant

Turbine_18

HYDRAULIC

PREPRESSURE ACTUAL

LOW

Status: 11) Closed - Customer Remediation

Date of Notification: 12/2/09

Equipment Tag: I

TURBINE 18.HYD PRES-

HYDRAULIC PREPRESSURE

ACTUAL BELOW 40

Category: 01) Instrumentation

Description:

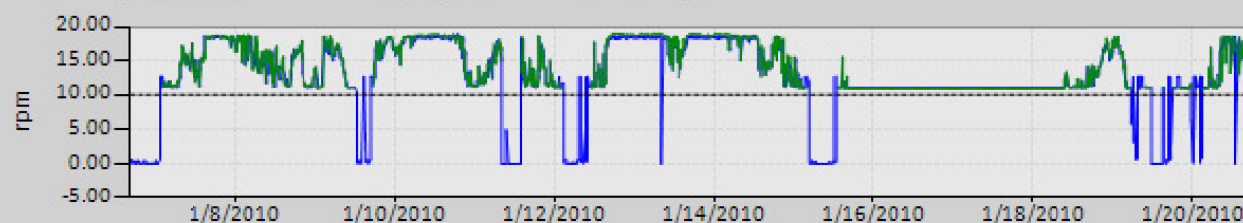
We are starting to see the actual value for the hydraulic prepressure spikes from 67 bar to 0 bar. Is this possible a sensor issue?

Diagnosis:**Customer Response:**

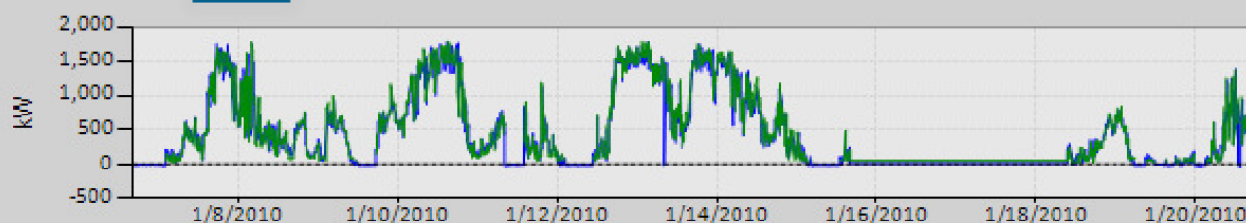
Found brake handle hitting shield of pressure transducer and it was loose. Should be resolved as of yesterday ~2pm. Tracking better now. SSC will close report.

Hydraulic Brake Pressure signal drops to zero value since about NOV 20,

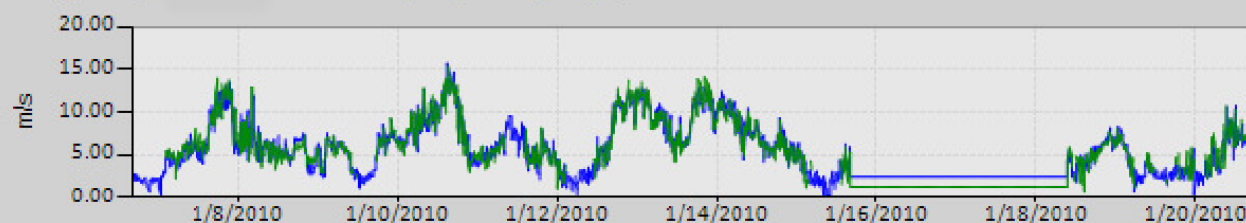
(HUB_SPEED) - Turbines.18.N_ROT_PLG, Rotor speed (PLC), rpm



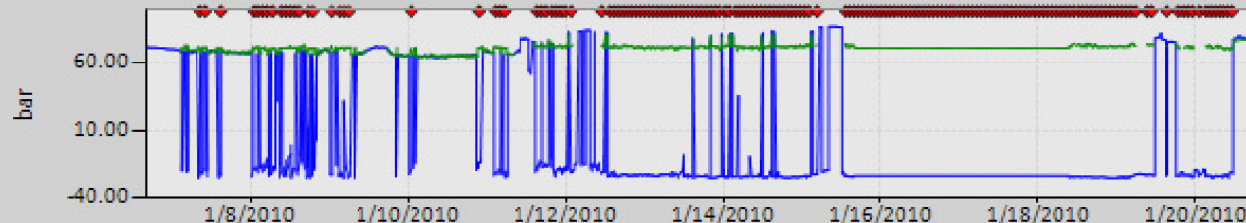
(ACTIVE_POWER) - Turbines.18.P_ACT, Power, kW



(WIND_SPEED) - Turbines.18.V_WIN, Wind speed, m/s



(BLADE_HYDRAULIC_PRESS) - Turbines.18.HYD_PRES, Hydraulic prepressure, bar





TURBINE 76

Slight increase in DE and NDE Generator Bearings

Status: 13) Closed - Other

Date of Notification: 9/24/2009

12:00:00 AM

Equipment Tag:

.T76.T_BEAR_A

.T76.T_BEAR_B

Category:

Description:

On 9/17, when this turbine began to produce power after a brief down period, both the DE and NDE Generator bearings returned with slightly higher values than the estimate was predicting. These bearings came back with temps around 50 deg C, where they typically operate around 30 deg C. This behavior has continued and the bearing temperature has remained consistently about 50 deg C.

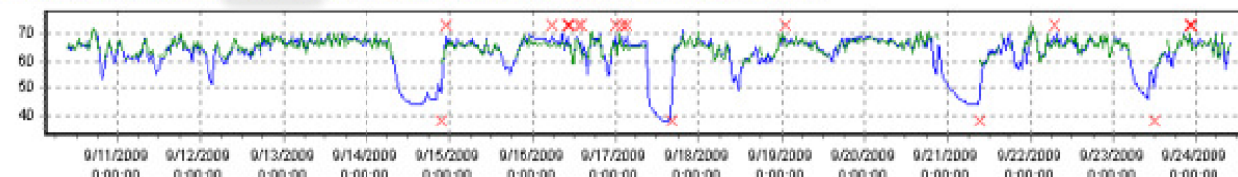
Diagnosis:

Possible loading or lubrication issue.

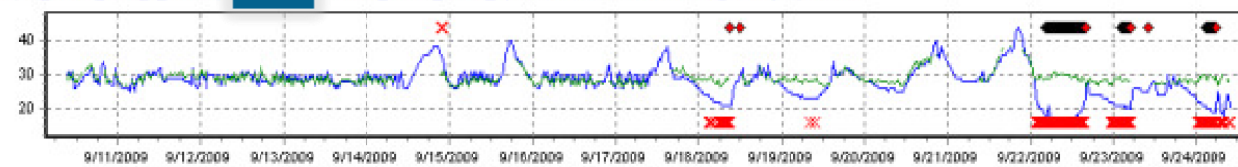
Customer Response:

Continue to monitor

(HS_GEAR_BRG_1_TEMP) - B.T76.T_GEAR_BEAR, Turbine Gearbox Bearing Temp, DEGC

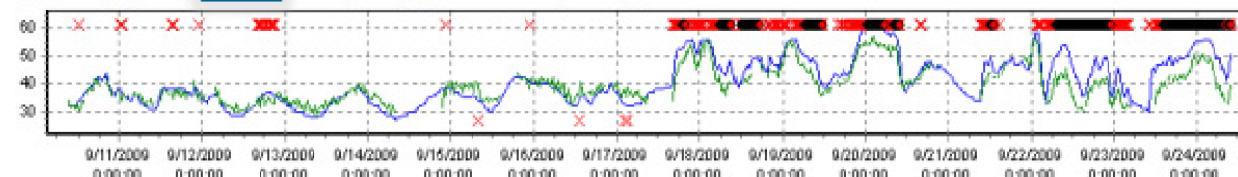


(HS_GEAR_BRG_2_TEMP) - B.T76.T_GEAR_BEAR_B, Turbine Gearbox Bearing Temp B, DEGC



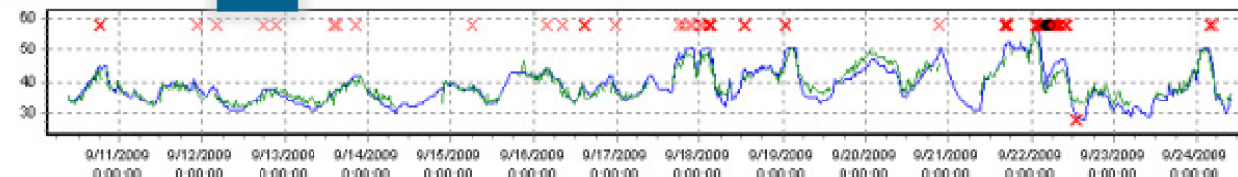
42.0000, 9/15/2009 7:41:40 PM

(GEN_BRG_DE_TEMP) - B.T76.T_BEAR_A, Turbine Bearing A Temp, DEGC

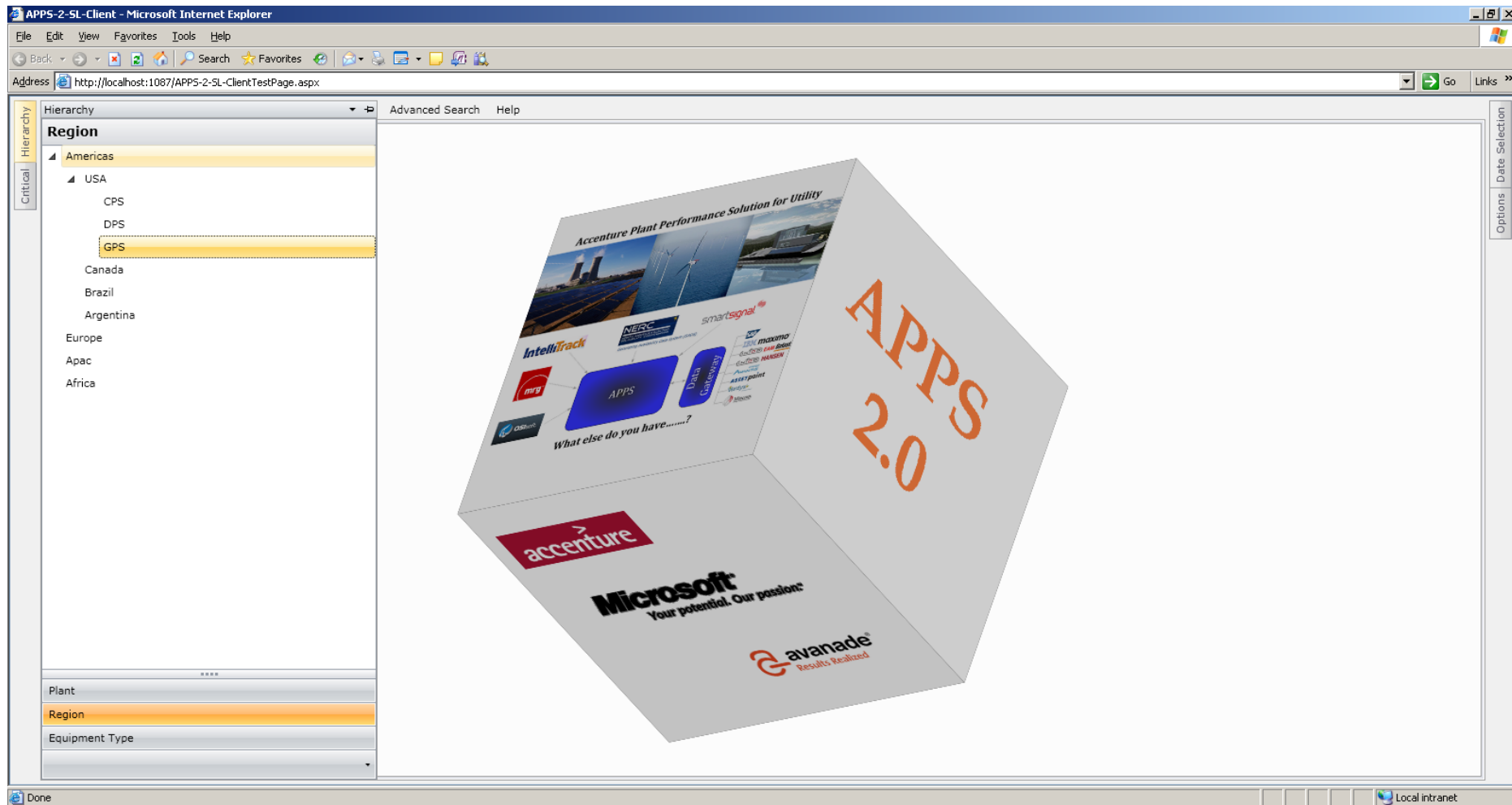


43.0000, 9/15/2009 7:41:40 PM

(GEN_BRG_NDE_TEMP) - B.T76.T_BEAR_B, Turbine Bearing B Temp, DEGC



Integration Into Your Operations



Integration Into Your Operations

Shared Documents - Project Overview - Windows Internet Explorer

http://wafpsmoss01/Windpower/OwnerOperator/Shared%20Documents/Project%20Overview.aspx

File Edit View Favorites Tools Help

Shared Documents - Project Overview

Time Selector

Start Time: 1
End Time: *
Apply

Asset Browser


- OSI Wind Power Division
 - Central Region
 - Black Mesa
 - Buffalo Hill
 - Condor
 - Eagle Mountain
 - Mojave
 - Red Rock
 - Eastern Region
 - Green Rock
 - Gulf Wind
 - Palmer Springs
 - Platte Basin
 - Thunder Ridge
 - Whistling Pines
 - Western Region
 - Coral Wind
 - Fire Mesa
 - Greedo Hill
 - Mountain View
 - Snow Valley
 - Stallion Creek

Contact List

Black Mesa

- Jim Smith
- Pedro Sanchez
- Victor R. Arimando
- Mark Brown
- Troy Carbaugh

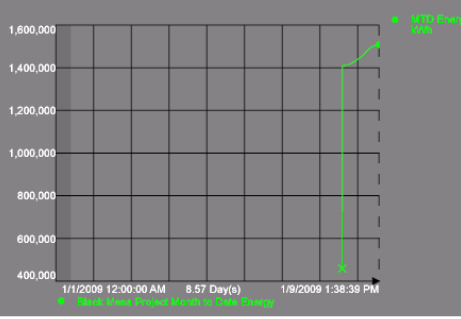
Real-Time Operations



Real-time Operations

Descriptor	Value
Black Mesa Project Capacity	93.288
Black Mesa Project Capacity	23.089
Black Mesa Project Active Power	715.45
Black Mesa Project Wind Speed	4.1294

MTD Generation



WatchList

Status	Priority	Fit	Asset Grp	Asset	Incident	Count	Latest	First
*	1	1	enXco	GE09	GE09_BL1_ACT - GE09...	154	11/6/2... 7:00:00...	10/31/... 6:00:00...
*	1	1	enXco	GE09	GE09_BL2_ACT - GE09...	155	11/6/2... 7:00:00...	10/31/... 5:00:00...
*	1	1	enXco	GE09	GE09_BL3_ACT - GE09...	154	11/6/2... 7:00:00...	10/31/... 6:00:00...
*	1	1	enXco	GE09	GE09_HYD_PRES - GE0...	89	11/6/2... 7:00:00...	11/2/2... 11:00:0...
*	1	1	enXco	GE09	GE09_HYD_PRES - GE0...	80	11/6/2... 7:00:00...	11/3/2... 8:00:00...
*	1	1	enXco	GE06	GE06_kVA - WTG Appa...	83	11/6/2... 4:00:00...	11/3/2... 6:00:00...
*	1	1	enXco	GE13	GE13_HYD_PRES - GE1...	104	11/1/2... 12:00:0...	10/27/... 8:00:00...

Chart View

Active Faults

Unit	Project	FaultType	Manufacturer	LostEnergyCalculation
WTG 02	Black Mesa	Blade Angle Asymetry	GE	73 kWh
WTG 02	Black Mesa	Transformer Oil Level Low	GE	2550 kWh
WTG 01	Black Mesa	Gearbox Filter Dirty	GE	6230 kWh
WTG 01	Black Mesa	Drive Train Vibration	GE	51 kWh

Work Orders

URL	WO#	Person Responsible	General Description	Current status	Manufacturer	Unit	Project	Creation Date
	1324	Jim Smith	High Gearbox Drive Side Temp	Resolved	GE	Gearbox	Black Mesa	10/10/2008 9:23:45 AM
	1325	Bob Walters	High Gearbox Non-Drive Side Temp	Resolved	Clipper	WTG 03	Mojave	10/11/2008 10:22:45 AM
	1326	Roger Wilco	High Gearbox Vibration	Resolved	Repower	WTG 06	Green Rock	10/12/2008 3:03:45 AM
	1327	Jim Smith	Generator Fan Failure	Resolved	GE	Gearbox	Black Mesa	10/12/2008 2:34:09 PM
	1328	Sandra Fisher	Gearbox Oil Level Low	Resolved	GE	WTG 03	Gulf Wind	10/12/2008 4:02:03 PM

Showing 1 to 5 of 30

Knowledge Repository

Type	Name	Modified	Modified By
Project	Project_Description_GEWE1 !NEW	1/8/2009 5:14 PM	Jku Sohanlal

Add new document

Done

Start Desktop Shared Documents - ...

Trusted sites 100% 4:38 PM

Integration Into Your Operations



accenture Owner / Operator

Windpower Monitoring Central > Asset Management > Dashboards > Operations > Owner / Operator Site A

Windpower Monitoring Central > Owner / Operator > Shared Documents > Turbine Overview

Turbine View

Time Range Selector

Start Time: 11/1/2008

End Time: 12/1/2008

Apply

Asset Browser

- OSI Wind Power Division
 - Central Region
 - Black Mesa
 - WTG01
 - Gearbox
 - WTG 02
 - WTG 03
 - WTG 04
 - WTG 05
 - WTG 06
 - WTG 07
 - WTG 08
 - WTG 09
 - WTG 10
 - Buffalo Hill
 - Condor
 - Eagle Mountain
 - Mojave
 - Red Rock
 - Eastern Region
 - Western Region

Turbine

- Heat exchanger
- Control panel
- Generator
- Oil cooler
- Coupling
- Hydraulic parking brake
- Iron frame
- Impact noise insulation
- Gearbox
- Yaw drive
- Rotor shaft
- Gearing housing
- Rotor hub
- Pitch drive
- Brake cone
- Ventilation
- Nacelle

Turbine Curve Analysis

Open Update

	A	C	D	F
2				
3	Turbine:	WTG 01		
4	Start Time:	11/1/2008		
5	End Time:	12/1/2008		
8	Price per kilowatthour (\$)	\$0.09		
9				
10	Average Output	778.45 kW		
11	Avg. Exp. Output	926.84 kW		
12	Average Offset	-148.40 kW		
14	Actual Generation (kWh)	517477.4275		
15	Expected Generation	543582		
16	Actual Revenues	46572.97		
17	Expected Revenues	48922.37		
18	Over/Under Production Cost	-\$2,349.40		
20				

Power Curve Analysis

Expected/Actual Power

Power Offset

Real Time Values

Descriptor	Value
GE01 Power	-4.9822
GE01 Gear Box Temp.	54.909
GE01 Generator 1 Temp.	45.711
Daily Energy Production	8234.5
WTG Apparent Power - kVA	122.05

Showing 1 to 5 of 6

Active Faults

FaultType	Project	Unit	Manufacturer	LostEnergyCalculation
Gearbox Filter Dirty	Black Mesa	WTG 01	GE	6230 kWh
Drive Train Vibration	Black Mesa	WTG 01	GE	51 kWh

Knowledge Repository

Type	Name	Modified	Modified By
GE Turbine		1/6/2009 3:22 PM	Olut Sohanlal

WatchList

Status	Priority	Fit	Asset Gro	Asset	Incident	Count	Latest	F
+	1	1	Black ...	GE06	GE06 kVA - WTG Ap...	83	11/6/... 11:40:00:0...	11:40:00:0...

Chart View

425.7219, 11/26/2008 02:00:00

(Active_Power) - GE06_P_ACT, GE06 Power, kW

Conclusion



The turbines must be available whenever the wind blows.

