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ELIMINATE FAILURE_

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





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Who is SmartSignal?

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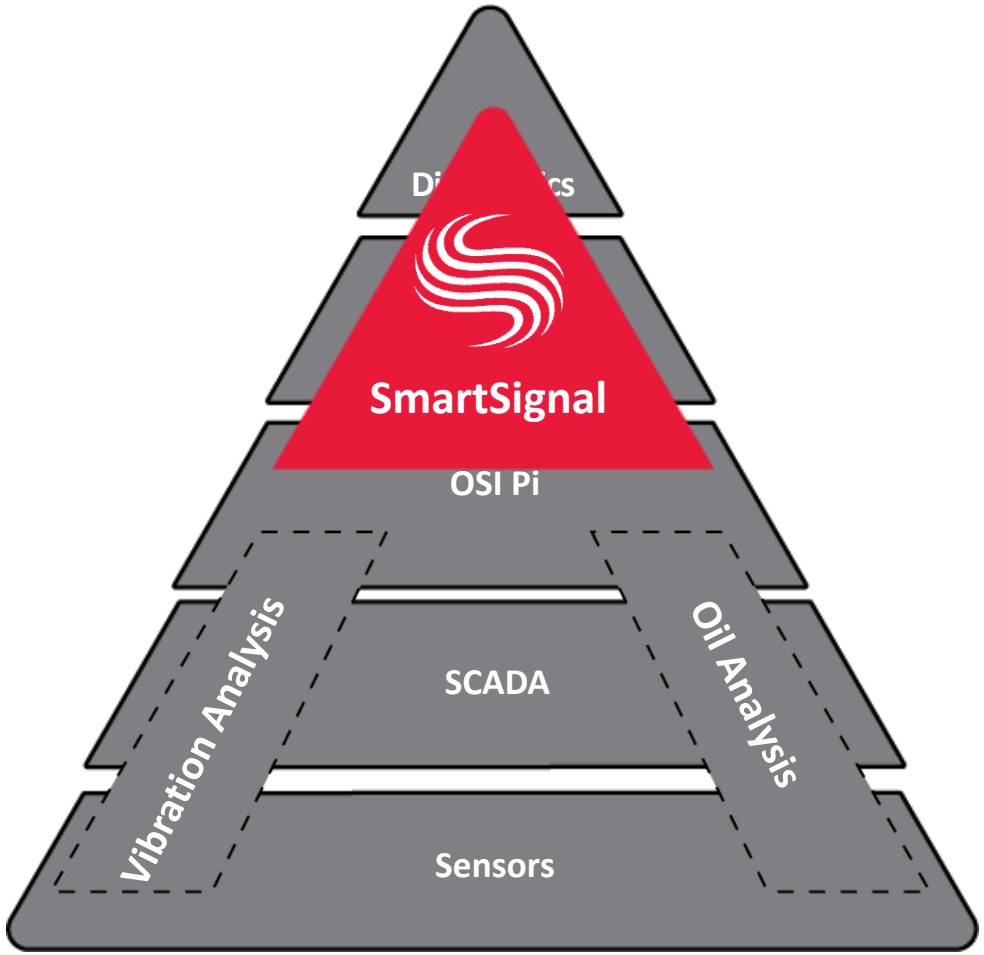
Like You, Our Customers Invested Significantly In Sensors And Technology…Yet Problems Still Persist…Why?



Volume of data and alarms overwhelms:

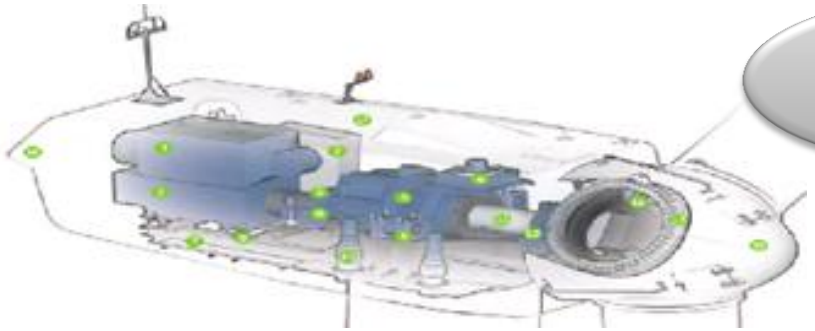
- Resources
- Analysis capabilities

Result:

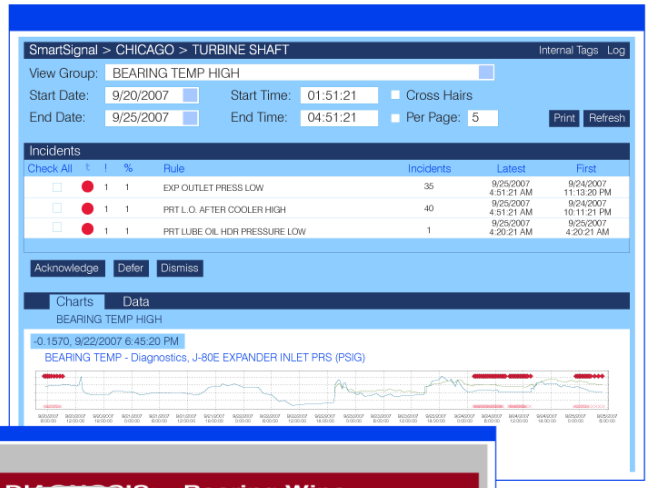
- Unplanned outages
- Lost availability
- Higher maintenance activity and cost
- Deliver early warning and diagnostic guidance
- Reduce forced losses

8

The SmartSignal Solution



Starts with Data from Your Equipment

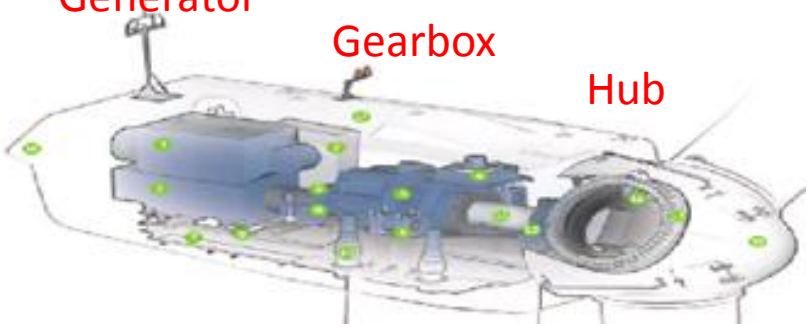


Removes the Effects of Normal Operation

Generator

Gearbox

Hub



Personalized Empirical Models

Pulls every 5-10 minutes

EPI*Center

Posts Emerging Threats to Incident List

Leader in Predictive Analytics

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Expanding In Wind Power Generation

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bp alternativenergy
344 turbines

IBERDROLA RENEWABLES
6,000+ turbines

Duke Energy
794 turbines

Invenergy
982 turbines

NDA
4,000+ turbines

enXco An EDF EN Company
Celebrating 20 years of success!
2,600+ turbines





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How SmartSignal is used in Wind Power Generation?

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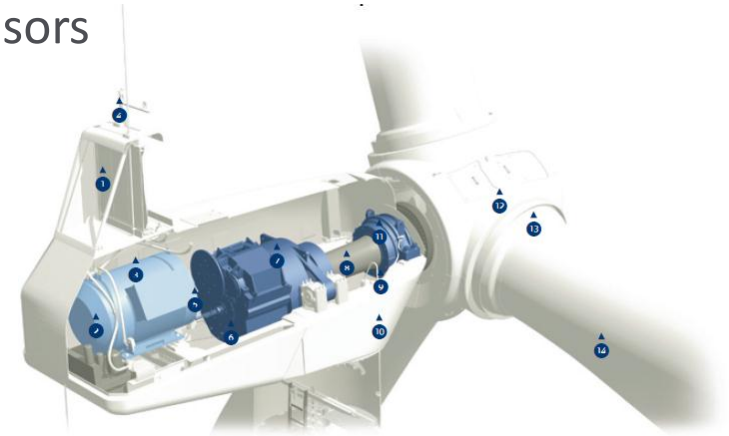
Models Focused On Failure Modes

- 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!

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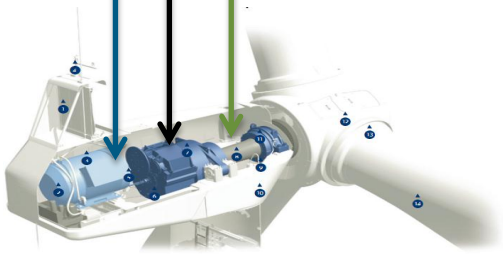
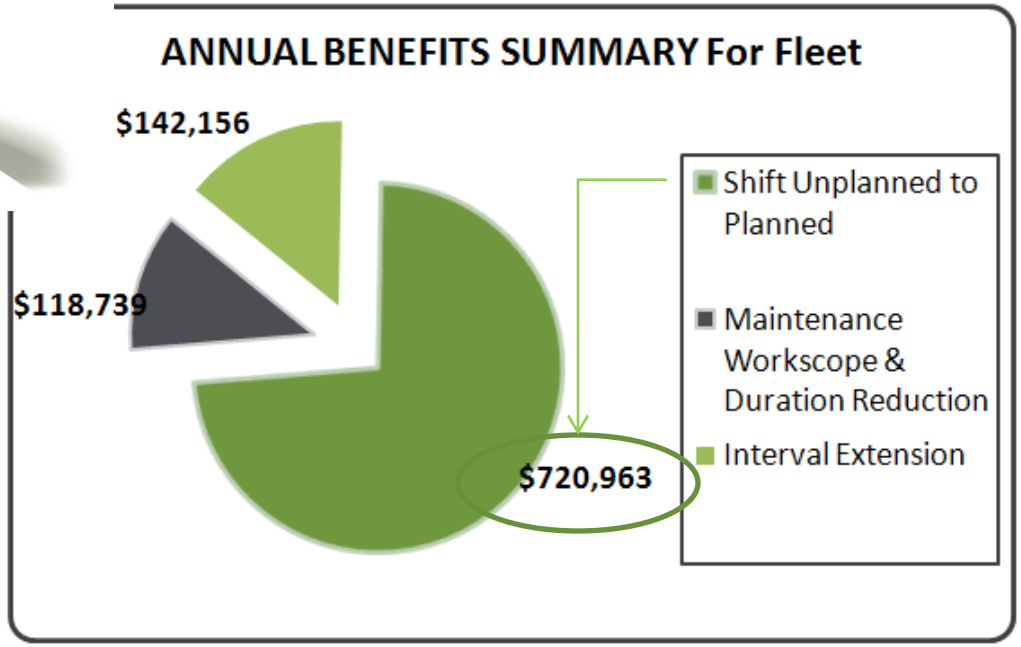
TYPICAL MODEL SET for GE WTGs			
UNIT	Models	Assets per Model	Tags per Model
All GE	ROTOR	1	12
	GEARBOX	1	15
	GENERATOR	1	10
	TOWER_CONTROLS	1	16
	GP_PERFORMANCE	10	50
	Total:	**1-10**	**103**









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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

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Availability & Performance Center

022
022

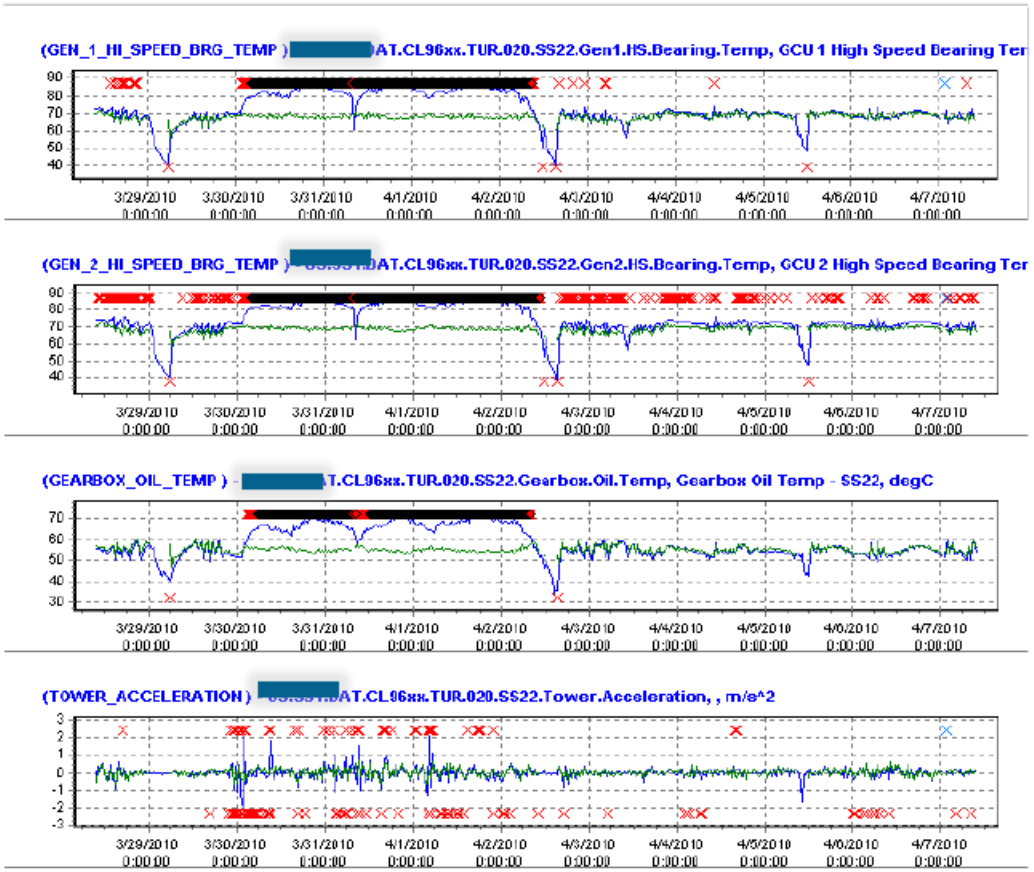
HS GEN BEARING TEMPS HIGH

Status: 02) Under Customer Review
Date of Notification: 3/31/2010 12:00:00 AM
Equipment Tag:
[redacted] DAT.CL96XX.TUR.020.SS22.GEN1.HS.BEARING.TEMP
[redacted] DAT.CL96XX.TUR.020.SS22.GEN2.HS.BEARING.TEMP
Category: 02) Mechanical

Description:
When this turbine came online we noticed a poisitve 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:



Mind Plant
bine_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
urbines.55ar.T_CTRL_BOX_2
urbines.55ar.T_CTRL_BOX_3
urbines.55ar.T_BAT_BOX_1
urbines.55ar.T_BAT_BOX_2
urbines.55ar.T_BAT_BOX_3
urbines.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.

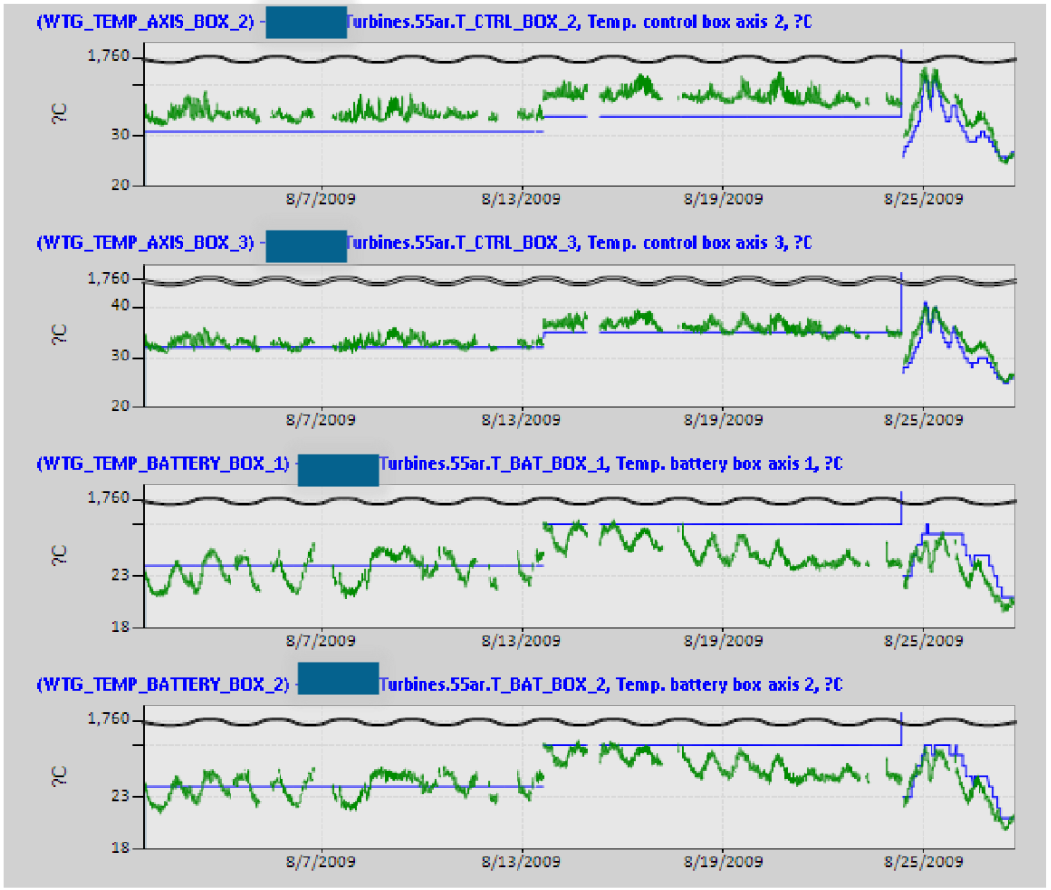
Is it possible that either a controller card or multiplexer has failed

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.



SmartSignal Monitoring Report

2/3/2010

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Availability & Performance Center

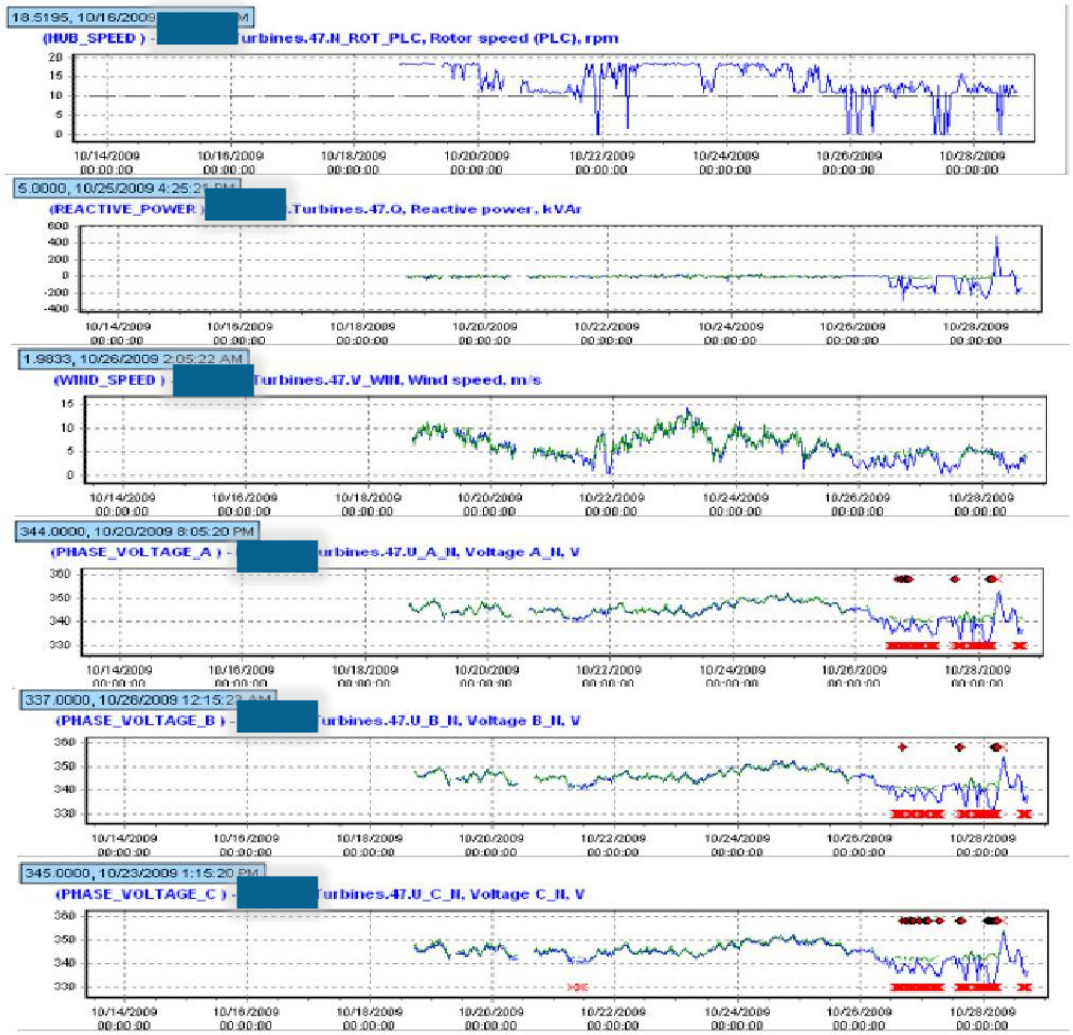
'ind Plant
Turbine_47
Low Phase voltage on A,B,C

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



SmartSignal Monitoring Report

2/3/2010

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Availability & Performance Center

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,

SmartSignal Monitoring Report

2/3/2010

Availability & Performance Center

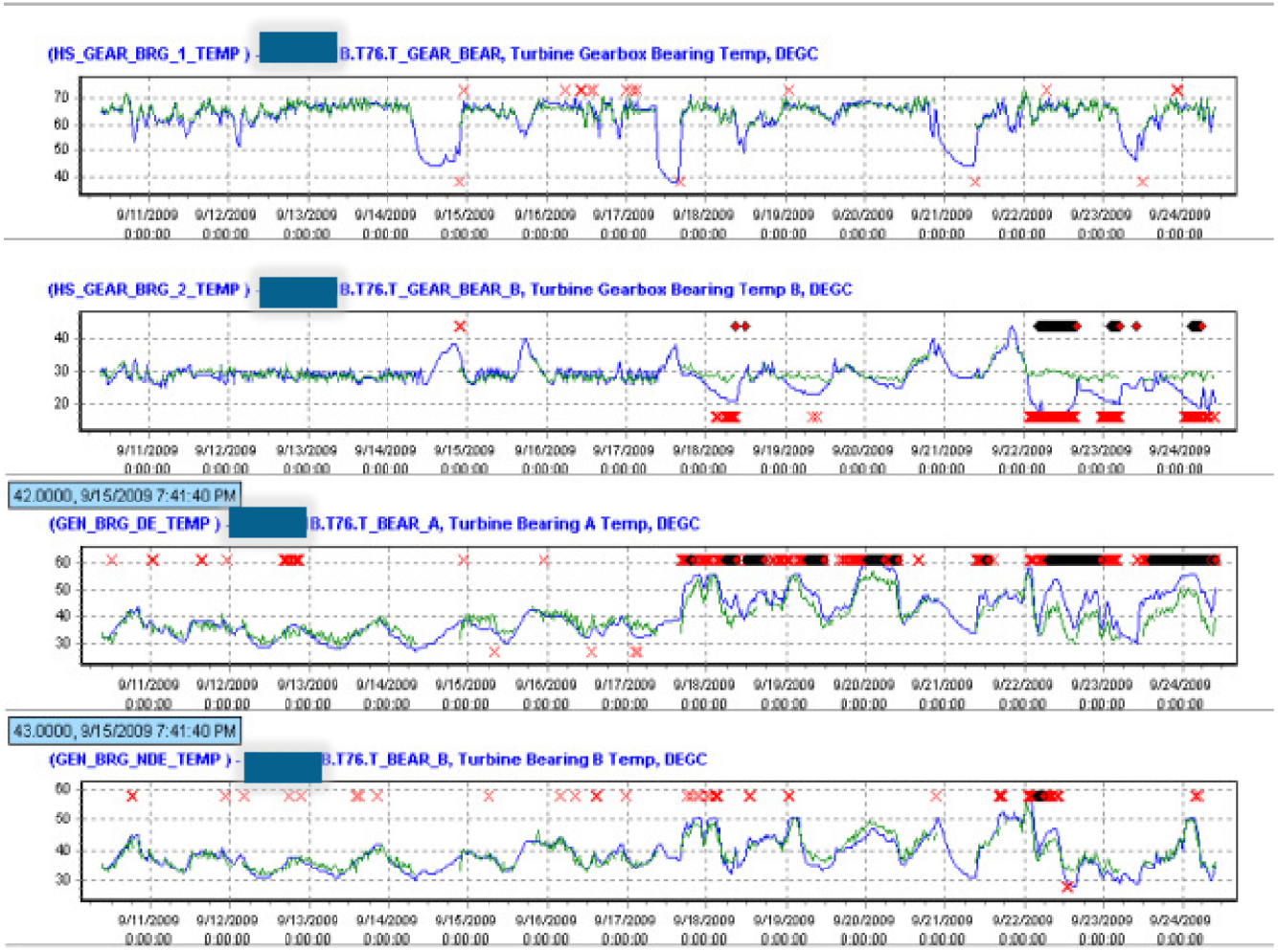
TURBINE 76
Slight increase in DE and NDE Generator Bearings

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:

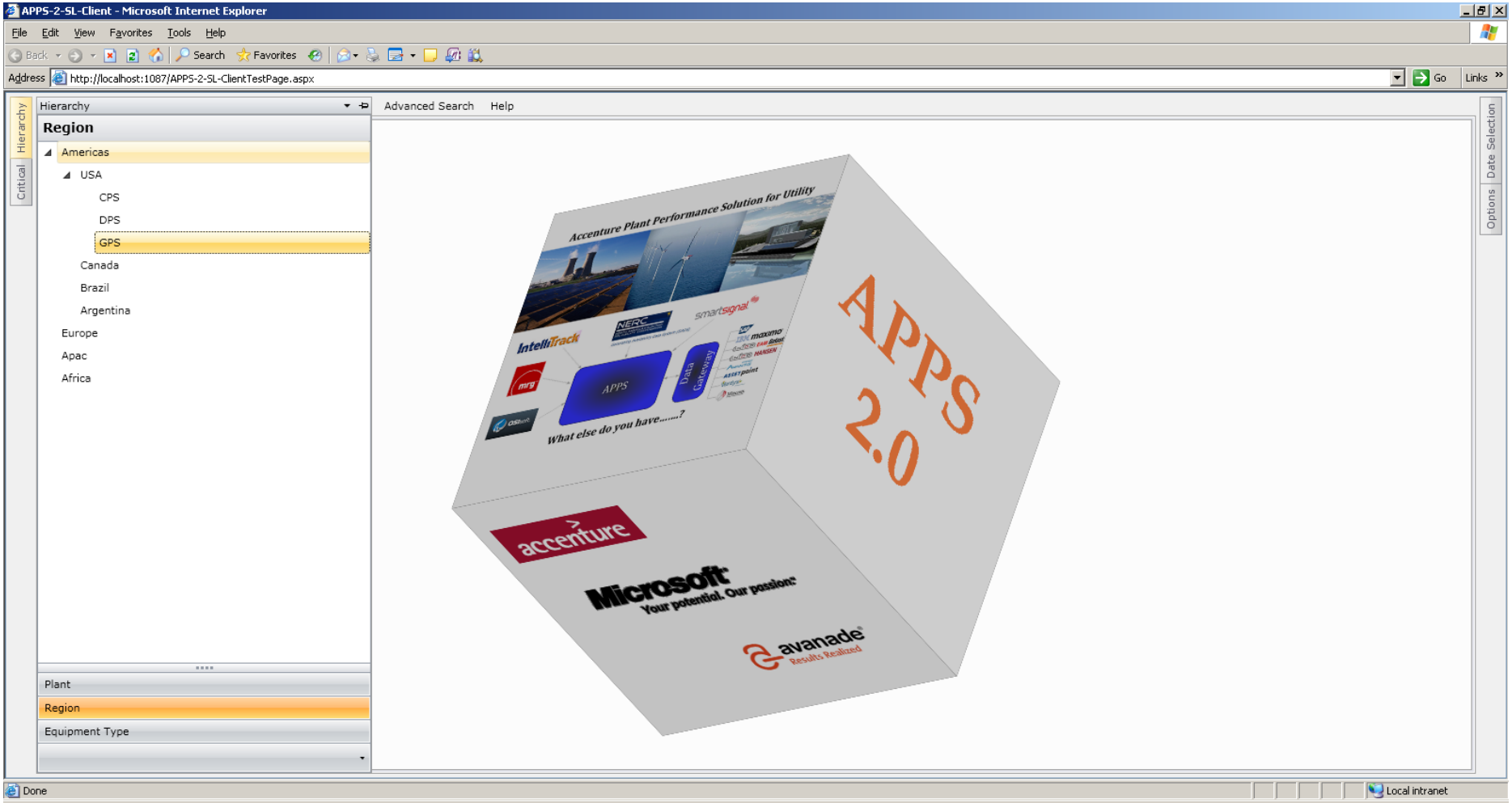
Description:
On 9/17, when this turbine began to produce power after a brief down period, both the DE and NDE Generator bearings returned with slightly higher values than the estimate was predicting. These bearings came back with temps around 50 deg C, where they typically operate around 30 deg C. This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



Integration Into Your Operations



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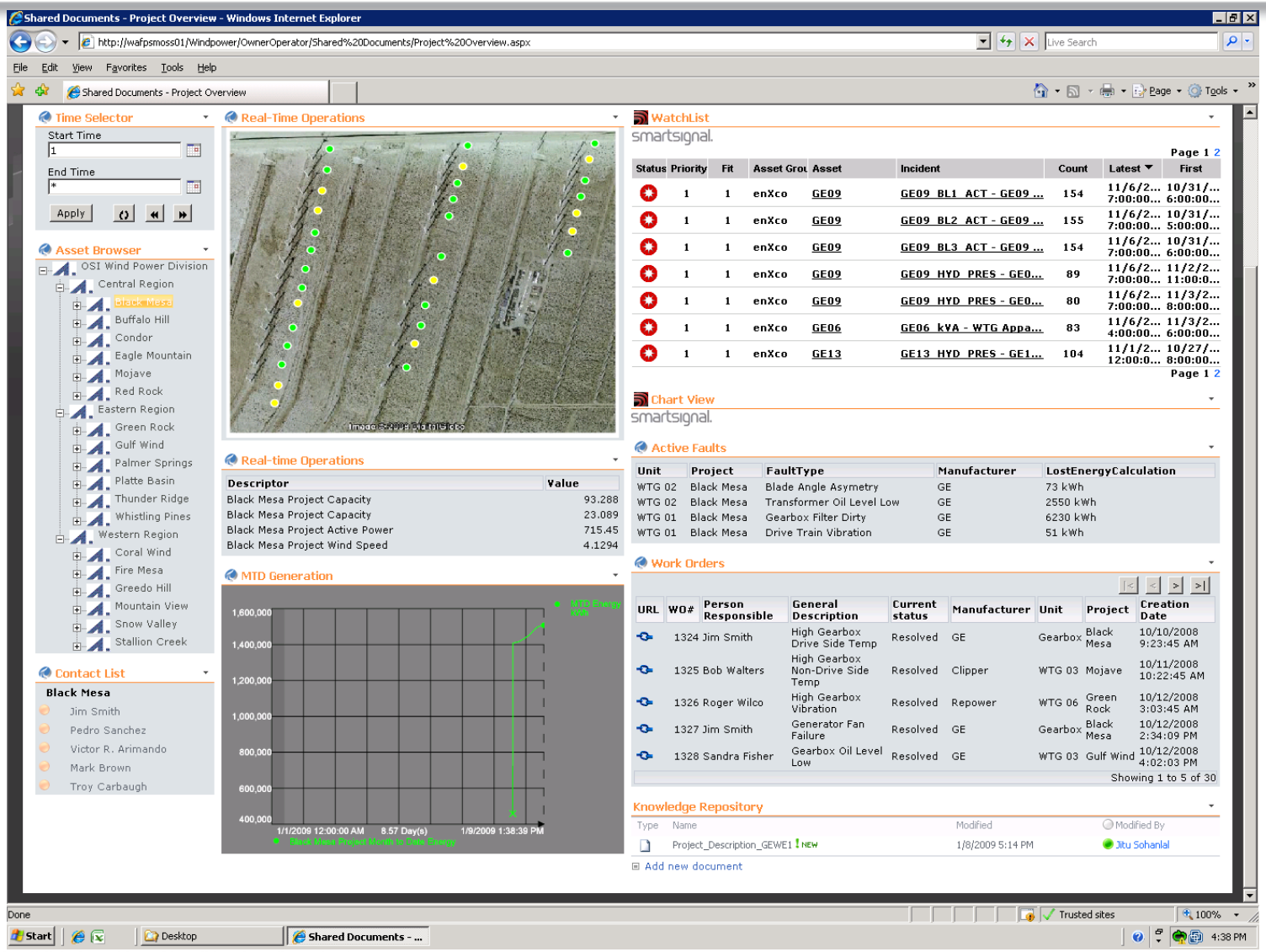

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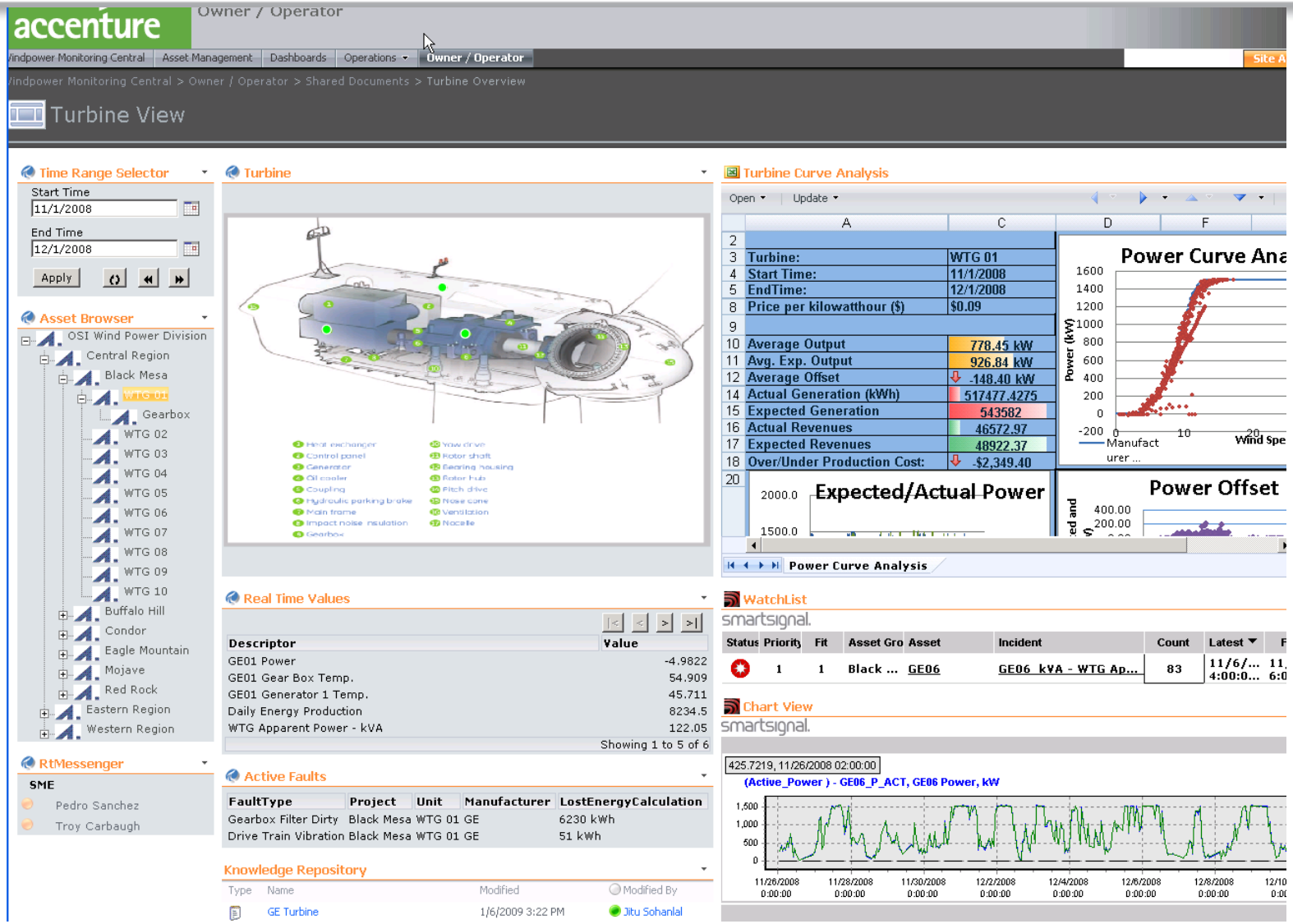

Conclusion

The turbines must be available whenever the wind blows.