

OSIsoft®

# SEMINÁRIO REGIONAL

2014

The Power of Data

L A T A M

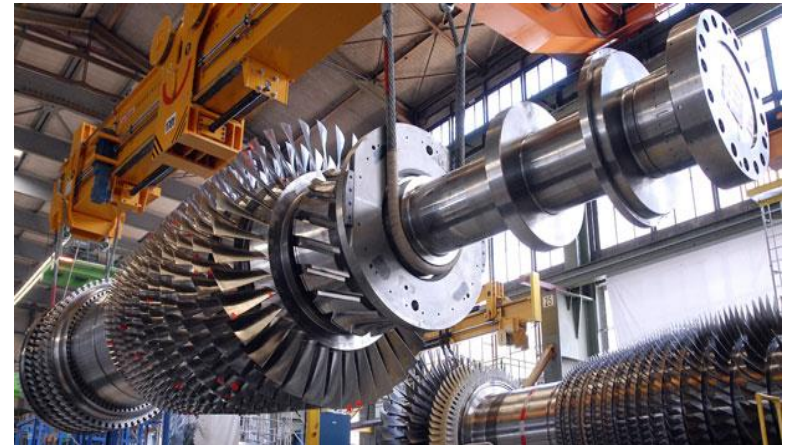
DECISION READY IN REAL-TIME

# BIO / Experience

David Thomason has 29 years experience in applying information technology to the requirements of the electrical utility & power generation industry.

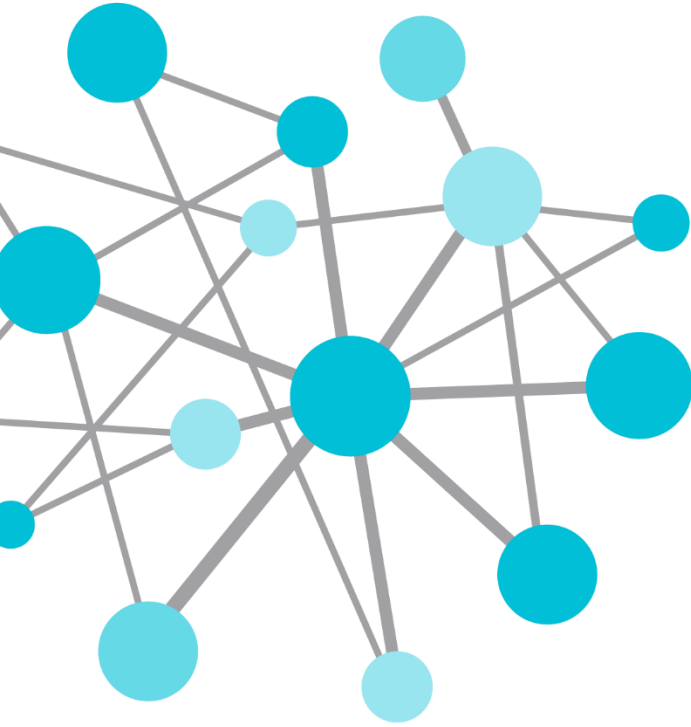
An active advocate in the use of advanced analytics and technologies to enhance value. David's experience at a fuel diverse 30K MW competitive power company includes multi-market EMS, Plant Analytics systems, SAP Work and Material Management, custom SW development & Support teams.

He joined OSIsoft in February 2011 in Business Development focusing on global power generation.



*One foot in the business and one in IT! ☺*

# The Power of Data in Power Generation



Presented by

David Thomason – Industry Principal Global Power Generation







**Data is the currency of the Future...**

**Data is currency NOW!**











# Sustainable Generation Mix of Tomorrow Today



## Spanning the Power Generation Spectrum

# De facto Standard in Power and Utilities

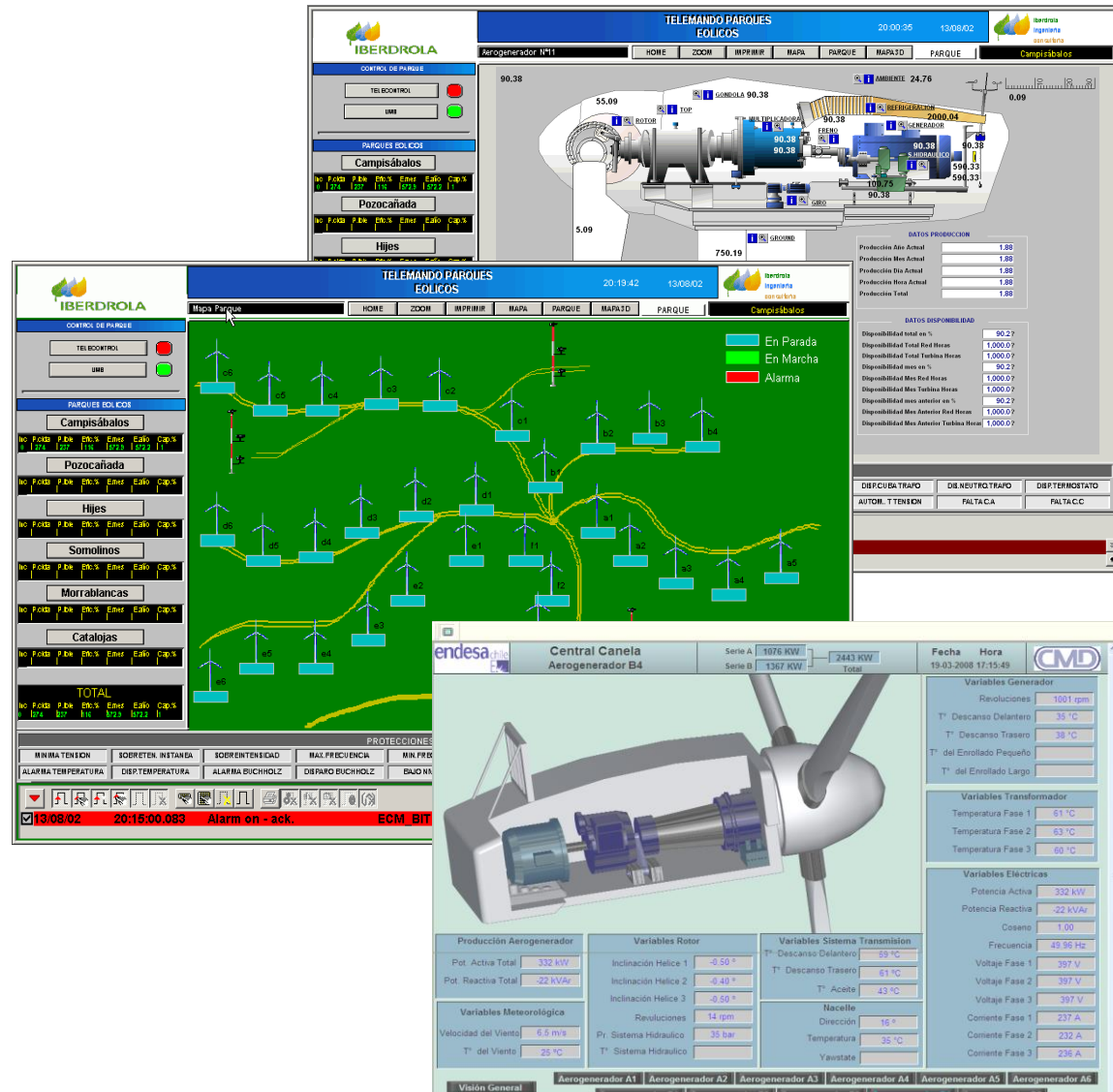




# Renewable Power - Wind



- 13 of the top 15 wind generating producers in the world
- 19.5GW of total 23 GW USA wind generation
- Renewable Integration by ISOs



# Renewable Power - Solar



- PI System in over 50% of the Concentrated Solar Plants (CSPs)
- Many large PV / CPV solar sites utilize the PI System (SunPower, EDF-EN, E.ON, Iberdrola, EGP, Abengoa Solar, Sempra)
- NRG's Ivanpah 377MW CSP
- Central M&D
  - SunPower
  - OCISolar
  - Power Factors, INC

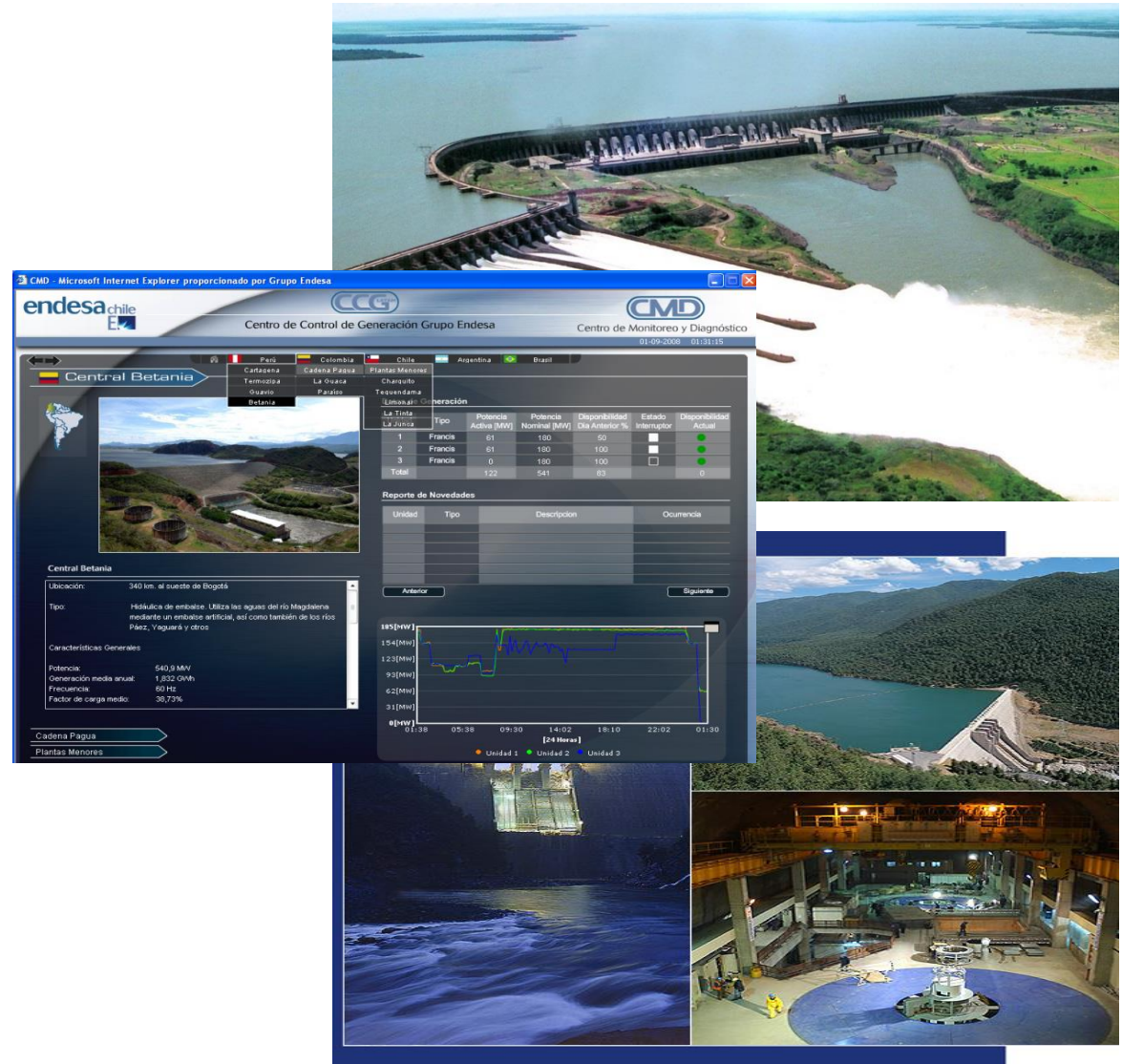




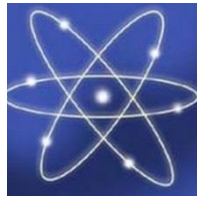
# Hydro Electric Power



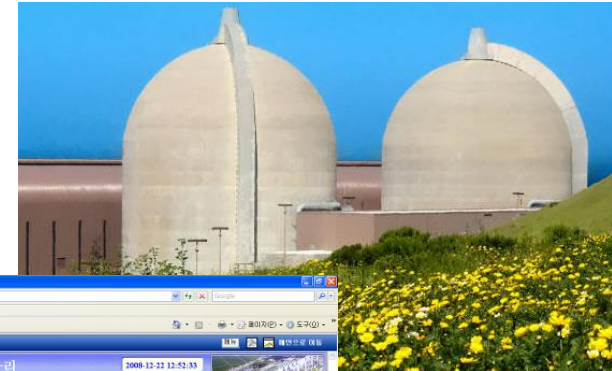
- Hydro Generation success with PI
- Hydro Quebec
- PGE Hydro
- Endesa
- Itaipu (14K MWs)
- BC Hydro
- KenGen
- EDF Hydro



# Nuclear Power



- 76% of USA nuclear plants and growing
- Nearly 100% of nuclear in Canada, UK and Korea
- Emergency preparedness and response, including the US Nuclear Regulatory Commission
- In nuclear mining, fuel conversion, fuel enrichment, fuel fabrication and waste processing
- Securely providing access to critical data and information





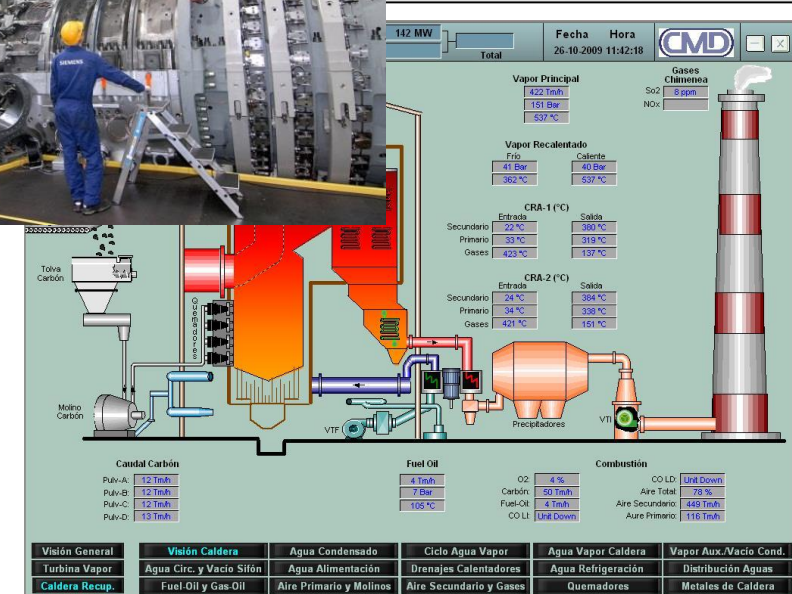
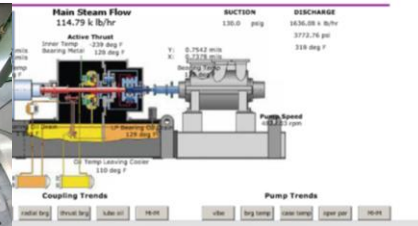
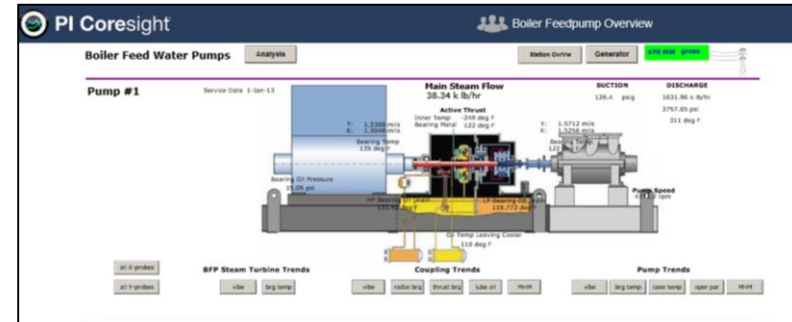
# Fleet Monitoring and ISO

- 100% of the ISOs/RTOs in the North America
- PI System for Fleet Management
  - PJM
  - CAISO
  - Entergy
  - DTE
  - NRG
  - Endesa
  - Iberdrola



# Thermal Power

- Leader in thermal Generation (Gas, Coal, Oil...)
- Approximate market share
  - 60% of USA
  - 30% EMEA
  - 24% APAC
- CCGT, GTs, Steam,...
- Critical Equipment and Systems Condition
- Efficiencies
- Operations Excellence
- Condition Based Maintenance





# Power & Utility Industry Challenges

- Competitive **Market Pricing**
- Limited **Power Reserves**
- Lower capital **ROI**
- Plant and T&D **life extensions** / modernization
- Dynamic **Environmental** requirements
- Optimize use of **renewable** and **distributed** energy sources
- Need for higher **availability**, **reliability**, and **flexibility**
- Plants operating **outside of design**
- High Demand for Real-Time Situational Awareness
  - Market / Grid conditions (Power, Fuel, Ancillary Services...)
  - Current and Forecasted Capability
  - Weather
  - Environmental Compliance
  - Security
- Need to respond and make **decisions in real-time**

# Driving Factors for PI Infrastructure

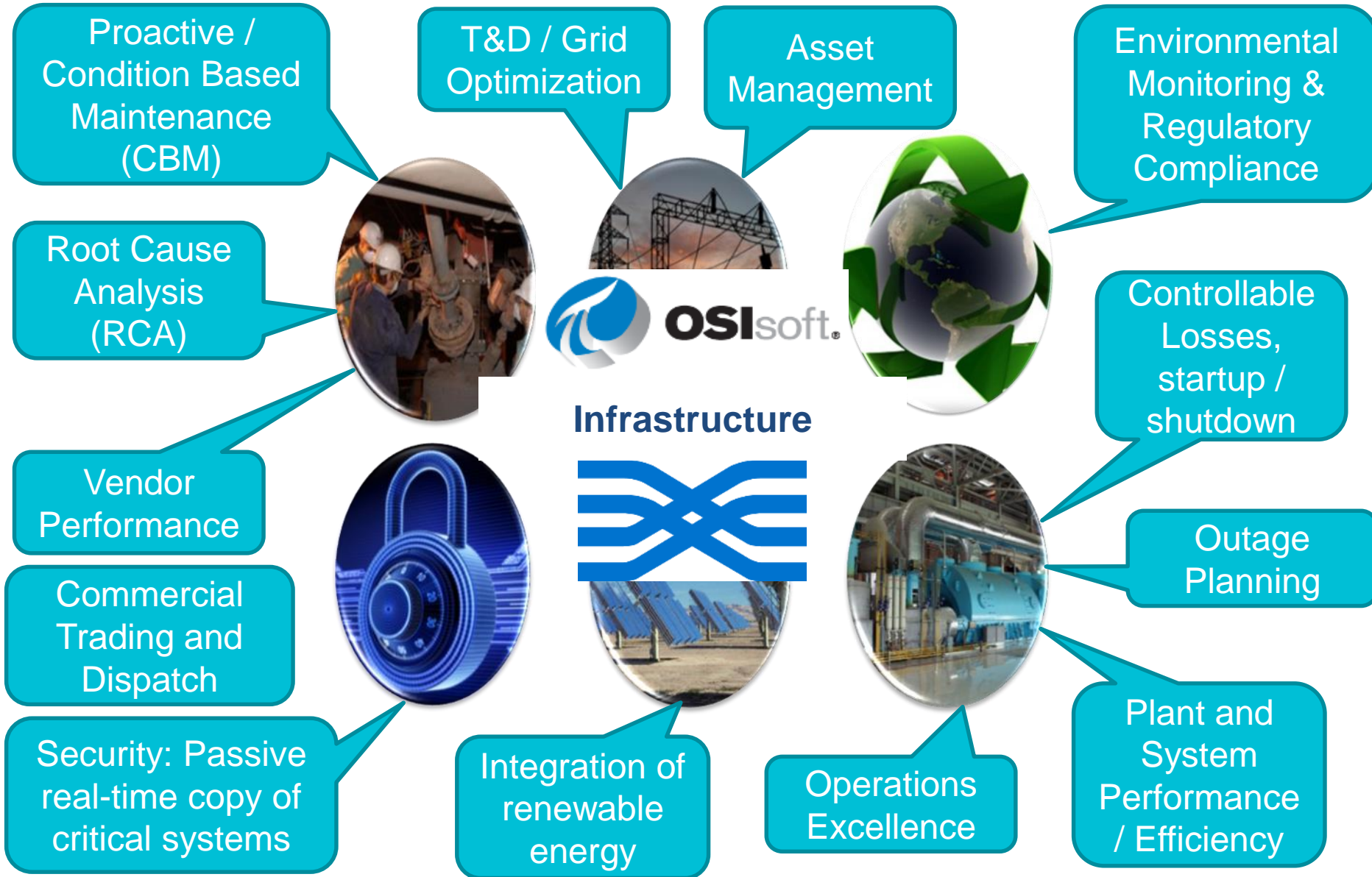


- Problem: Many disparate systems
  - DCS, PLC, CEMS, Analyzers...
  - Various timestamps
  - Data accessibility & integrity
- Solution: OSIsoft Data Infrastructure
  - Common real-time data and events
  - Common visualization and analytic toolset
  - Common platform for notifications, development and advanced analytics
  - Leverage SMEs (Central, Plant, Vendors)
  - Remote Monitoring & Diagnostics

*Increase availability, lower lost margin*



# Supports Key Power & Utility Processes



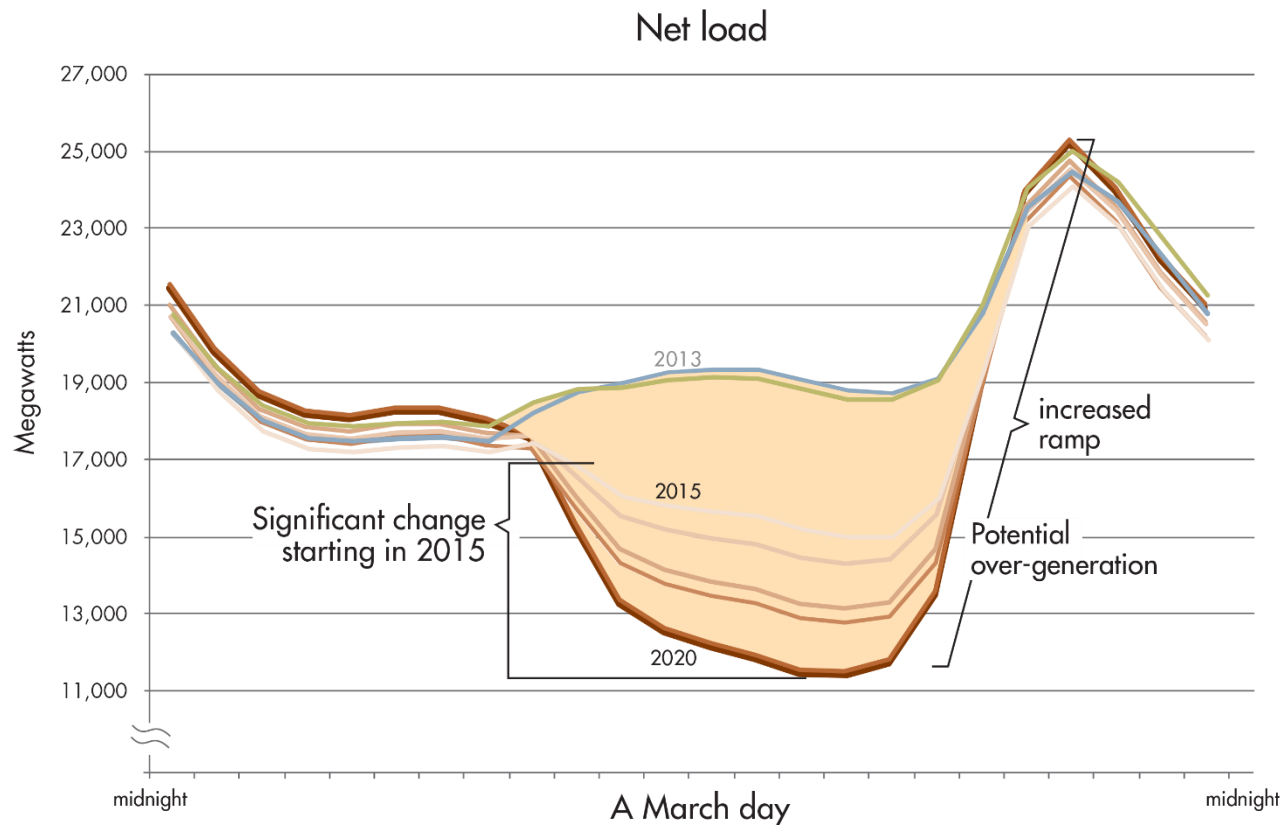
# Power Industry Trends

- Renewables to Account for More than 20% of Brazil's Generation Capacity by 2030
- High efficiency Combined Cycle Power Plants
  - Availability of LNG / Natural Gas
  - Flexibility, units designed for market response
- Plant modernization / modification
  - Implementing Environmental BACT (Scrubbers / SCRs)
  - Carbon Capture (Still a work in progress)
  - Modifications to Base load plants
    - Intermediate / load following / spinning reserve
    - Multiple startups = additional stress / wear on equipment
- Renewables
  - Many Renewables coming to end of warranty period
  - Companies taking on maintenance of wind turbines – need data
  - Growth in solar
  - Investment in storage capabilities



# Effects of Distributed Solar Generation:

Operational needs are significantly changing between 2013 and 2020 the “Duck” Curve - Brian Cummins – Manager, CAISO



# Power Industry Technology Trends

## *From:*

- Static / periodic equipment condition assessments
- Many disparate data systems
- Limited employee use beyond assigned facility
- Multiple projects to address singular issues
- Reactive & Preventive Maintenance
- Aggregating and assessing post situation

## *To:*



- **Dynamic real-time** online condition information



- **Single source** of all plant and enterprise information



- Leverage **all experts** throughout the company for all assets



- Information **infrastructure** that can provide many solutions



- **Proactive & Predictive** Maintenance

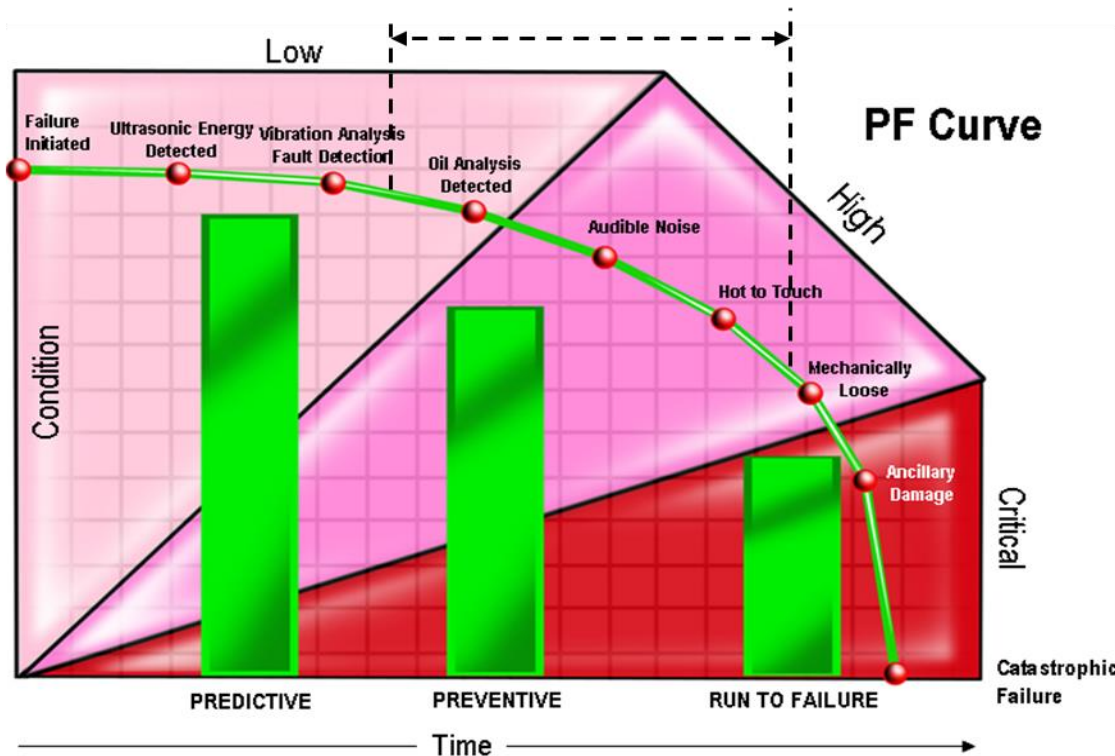


- Real-time situational awareness and enable **market** predictability

# CBM / Proactive Maintenance P-F Curve

The P-F curve is to show the behavior of equipment as it approaches failure.

- The P on the curve is the first possible point when equipment degrades or changes can be detected.
- The F is the point of equipment or system failure.
- The time between is your “opportunity” to avoid unplanned events



## P-F Interval

**Time frame to rectify impending equipment failure  
(Planning / Scheduling / Execution Window)**

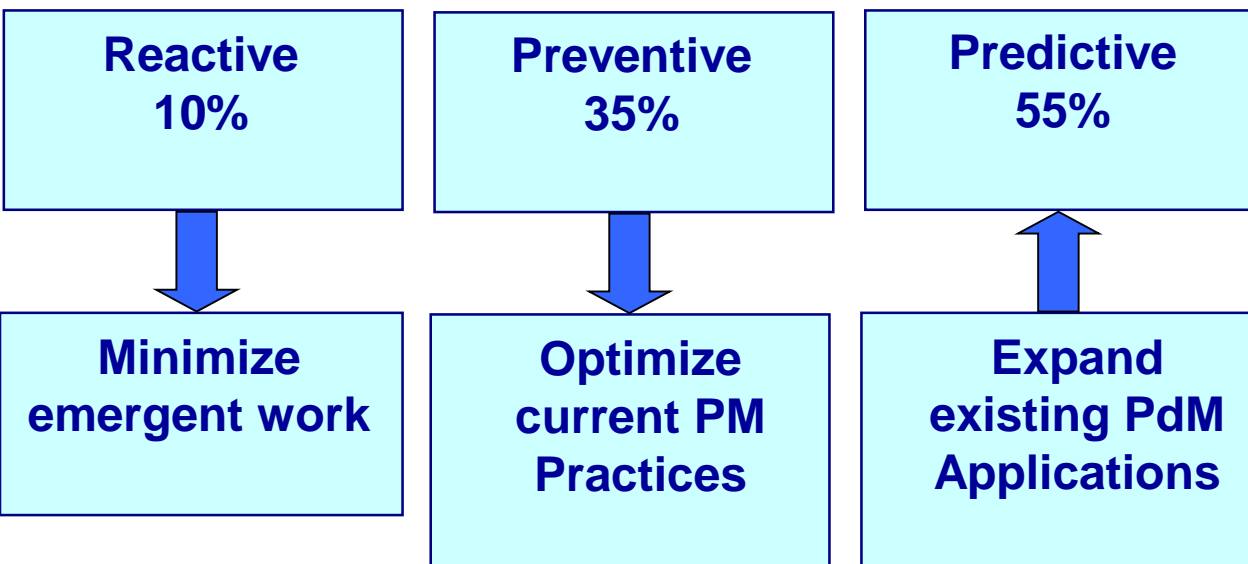
**Earliest detection provides the greatest opportunity time**

*Source: Allied Reliability*



# CBM / Proactive Maintenance

- Proactive Maintenance is a strategy in which Corrective, Preventive, and Predictive processes complement one another.
- The average industrial plant performs more than 55% Reactive maintenance work. **Reactive is the highest cost!**
- The top industrial plants perform less than 10% Reactive maintenance work. An industry “best practice” target goal maintenance mix



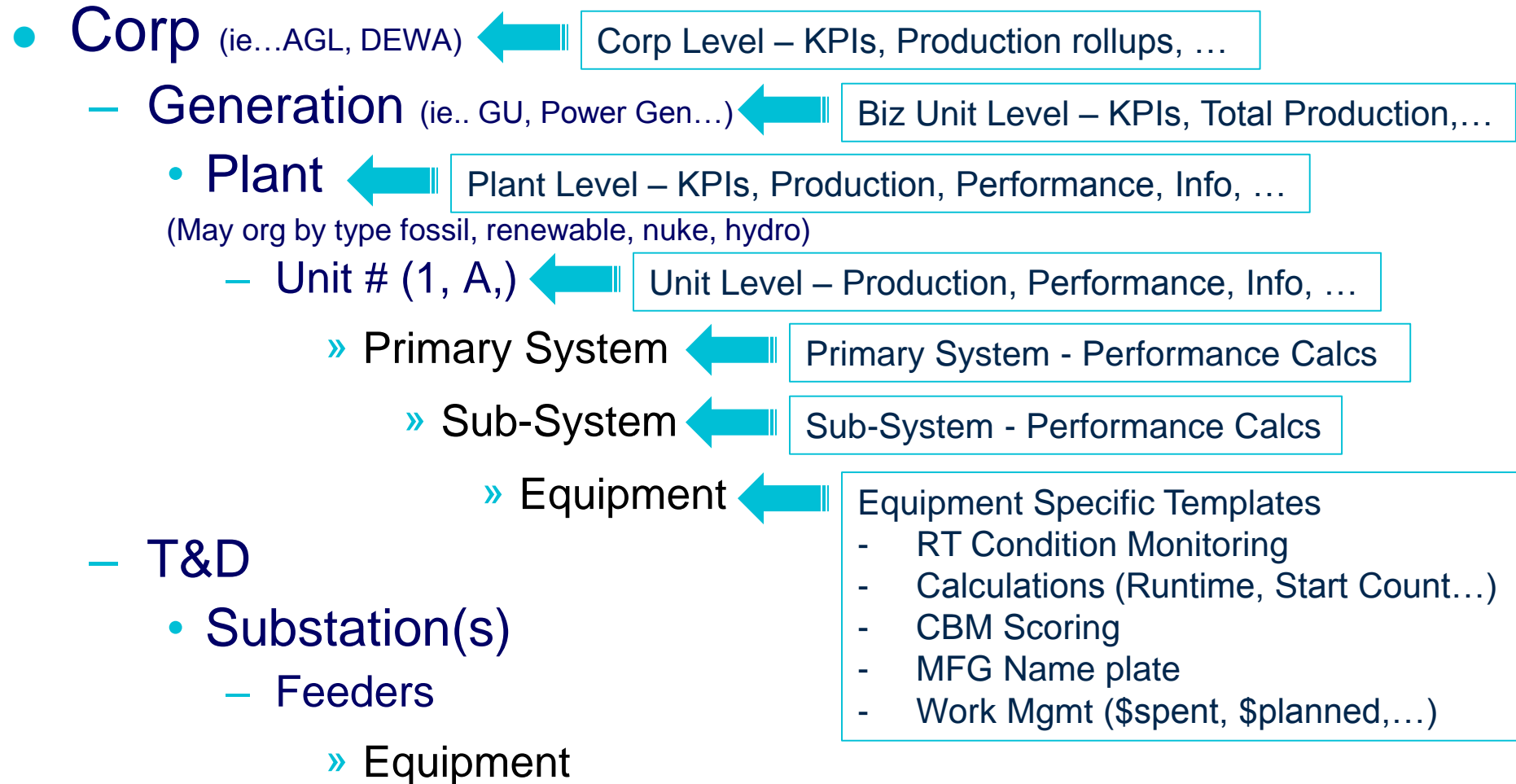
*- Strategy: enhance & expand the use of real time, historical data and analytics systems*

# CBM / Proactive Maintenance

- Screens and information with Maintenance in mind
- Focus on critical equipment, parameters for condition
  - Vibrations (rotating equipment, motors, pumps, turbine...)
  - Temperatures (bearings, oil, metal, motors...)
  - Amps
- Transform data and use in a new, valuable way
- Use out of the box, PI System functionality
  - Totalizers for run time counters, compare / balance usage, schedule maintenance, measure accumulative damage
  - Multi-state graphics
  - Notifications
- Increase speed and accuracy of decisions

# AF Structures & Templates

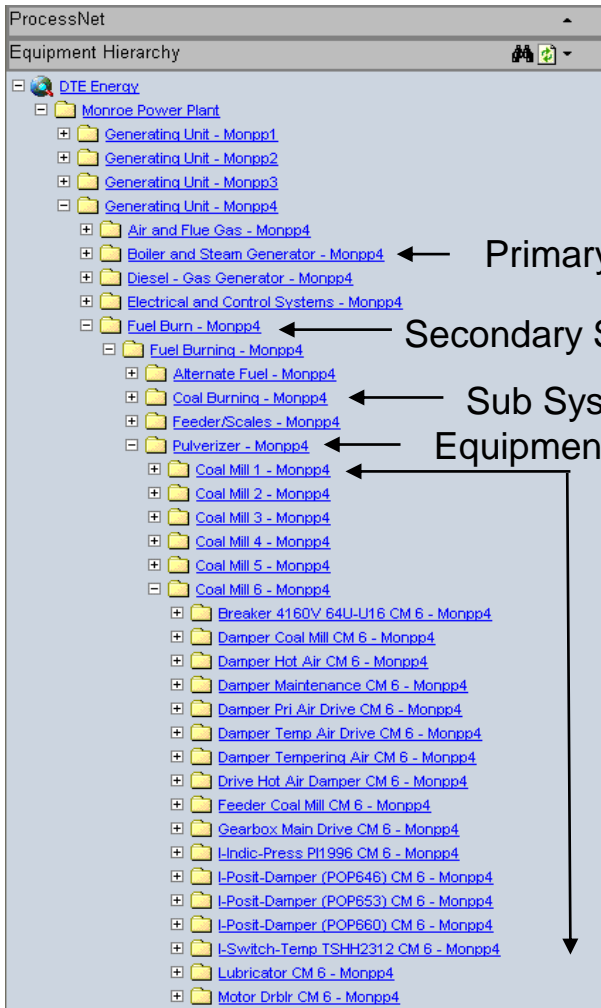
## Example AF for Power & Utilities:



*Each level templates w/ Calcs, notifications, element relative displays...*

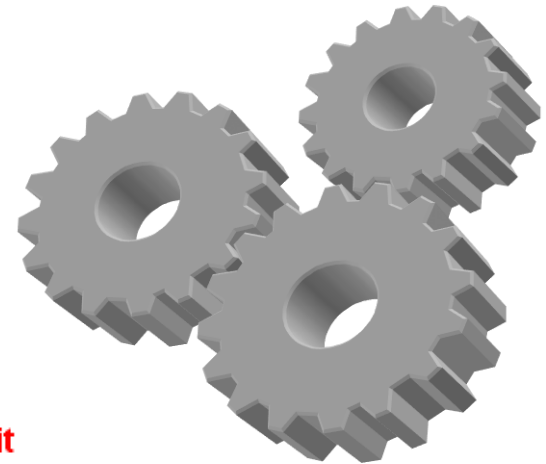


# Common Thread Equipment Hierarchy



## Equipment Hierarchy

- Hierarchical System Index (HSI)
- Work Breakdown Structure (WBS)



Sub Equipment

**DTE Energy – Business Unit**

**Monroe Power Plant – Plant**

**Generating Unit - Monpp4 – Unit**

**Fuel Burn - Monpp4 – Primary System**

**Fuel Burn - Monpp4 – Secondary System**

**Pulverizer - Monpp4 – Sub System**

**Coal Mill 1 - Monpp4 – Equipment / Sub Equip**

Breaker 4160V 64U-U16 CM 1 - Monpp4

Damper Coal Mill CM 1 - Monpp4

Damper Hot Air CM 1 - Monpp4

Damper Maintenance CM 1 - Monpp4

Damper Pri Air Drive CM 1 - Monpp4

# Equipment Template Details

- Electric Motor
- PI Condition data
- ERP Nameplate information
- Calculations
  - In PI Server
  - In AF
- Table reference
  - Docs
  - Test results
  - WM &MM
- CBM Score

| Meas. Point                       | Parameters                             | Parameter Units        |
|-----------------------------------|--|------------------------|
| <b>Operational Data</b>           | MOTOR CURRENT                          | Amps                   |
| Calculated Values                 | VOLTAGE                                | Volts                  |
|                                   | <i>Run-Time Hours (since Overhaul)</i> | <i>Hours</i>           |
|                                   | <i>Starts Count</i>                    | <i>Count</i>           |
| <b>Stator Temperature Data</b>    | MTR WINDING TEMP 1                     | deg. C                 |
|                                   | MTR WINDING TEMP 2                     | deg. C                 |
|                                   | MTR WINDING TEMP 3                     | deg. C                 |
|                                   | MTR WINDING TEMP 4                     | deg. C                 |
| <b>Bearing Temperature Data</b>   | FAN MTR IB BRG TEMP                    | deg. F                 |
|                                   | FAN MTR OB BRG TEMP                    | deg. F                 |
| <b>Vibration Data</b>             | FAN MTR OB BRG VIB                     |                        |
| Real-time Data                    | Inboard X                              | mils                   |
|                                   | Inboard Y                              | mils                   |
|                                   | Inboard X                              | Vdc                    |
|                                   | Inboard Y                              | Vdc                    |
|                                   | FAN MTR IB BRG VIB                     |                        |
|                                   | Outboard X                             | mils                   |
|                                   | Outboard Y                             | mils                   |
|                                   | Outboard X                             | Vdc                    |
|                                   | Outboard Y                             | Vdc                    |
| <b>Oil Analysis Data</b>          | <i>VISCOSITY</i>                       | <i>centistokes ssu</i> |
| Reference Data from other systems | <i>WATER CONTENT</i>                   | <i>ppm water</i>       |
|                                   | <i>PARTICLE COUNT</i>                  | <i>iso count</i>       |
|                                   |  |                        |
|                                   | <i>INFRARED IMAGE</i>                  | <i>(Document)</i>      |
|                                   | <i>SPOT TEMPERATURE</i>                | <i>Deg. F or C</i>     |

# Event Frames

## Event Types

0

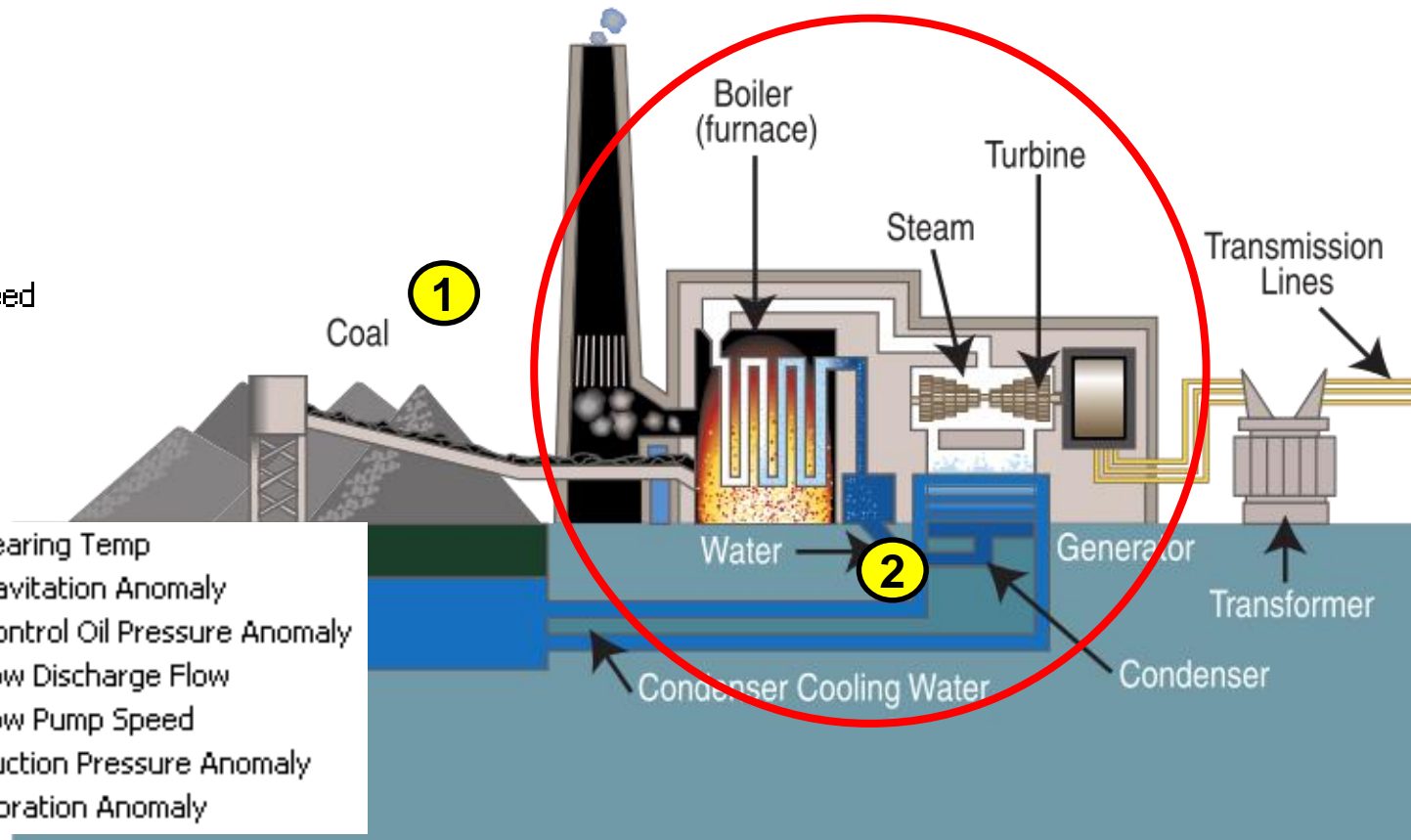
- Unit Shutdown
- Unit TIME.Day
- Unit TIME.Hour
- Unit Trip

1

- Mill Low Feeder Speed

2

- Boiler Feed Pump Bearing Temp
- Boiler Feed Pump Cavitation Anomaly
- Boiler Feed Pump Control Oil Pressure Anomaly
- Boiler Feed Pump Low Discharge Flow
- Boiler Feed Pump Low Pump Speed
- Boiler Feed Pump Suction Pressure Anomaly
- Boiler Feed Pump Vibration Anomaly





# PI AF – Structure and Attributes

The screenshot displays the OSIsoft PI Asset Framework (AF) interface. The left pane shows the 'Elements' tree, which is organized into a hierarchical structure. The main pane shows the 'Attributes' tab for a selected element, displaying a table of attributes grouped by category. The right pane shows the 'Settings' dialog for the selected element, which includes fields for 'Categories', 'Default UOM', 'Value Type', 'Value', and 'Data Reference'.

**AF – Asset Framework**

**Categories for Attribute Groupings**

**Attribute alias elements normalizes diverse tag / point names**

**Element Template**

| Category                       | Attribute                      | Value                    |
|--------------------------------|--------------------------------|--------------------------|
| Category: <None>               | In Service Date                | 1-Jan-13                 |
|                                | Last Service Date              | 8-Nov-13                 |
|                                | Manufacturer                   | GE                       |
|                                | Serial Number                  | 1B395                    |
| Category: Bearing Temperatures | Inboard Bearing Temperature    | 135.0065007 deg F        |
|                                | Outboard Bearing Temperature   | 127.00983581543 deg F    |
| Category: Flows                | Auxiliary Steam Flow           | 14.8983793258667 lb      |
|                                | Discharge Flow                 | 1634.23645019531 k lb/hr |
|                                | Discharge Flow Total           | 757539.875 lb            |
|                                | EXT Steam Flow Total           | 260660.078125 lb         |
|                                | Flow entering economizer       | 3257.94702148438 k lb/hr |
|                                | Main Steam Flow                | 38.3094062805176 k lb/hr |
| Category: Limits               | Bearing Vibration High Limit   | 2 mils                   |
|                                | Control Oil Pressure Low Limit | 32 psi                   |
|                                | Discharge Flow Low Limit       | 1700 k lb/hr             |
|                                | Suction Pressure High Limit    | 160 psi                  |

45 Attributes

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7:36 AM  
4/30/2014

# PI AF Asset Based Analytics – Event Detection

The screenshot displays the PI AF Asset Based Analytics – Event Detection interface. The main window is titled "Boiler Feed Pump Turbine" and shows the "Analysis Templates" tab. The "Name" field is set to "Boiler Feed Pump Vibration Anomaly", and the "Description" is "Boiler Feed Pump Vibration Anomaly". The "Analysis Type" is set to "Event Frame Generation".

Callouts highlight key features:

- Element Template**: Points to the "Element Template" dropdown menu.
- EF Start Trigger**: Points to the "StartTrigger" field, which contains a complex conditional expression.
- Time True**: Points to the "Time True" field, which is set to "30 Seconds".
- Root Cause Child Events**: Points to the "Generate child root cause event frame before parent event frame starts" checkbox.
- Type = EF Generation**: Points to the "Analysis Type" dropdown menu.
- PE Functions**: Points to the "Functions" list on the right side of the interface.

The "StartTrigger" expression is:

```
if ('Inboard Bearing Vibration X' > 'Bearing Vibration High Limit') Then true else if ('Inboard Bearing Vibration Y' > 'Bearing Vibration High Limit') Then true else if ('Inboard Bearing Vibration Z' > 'Bearing Vibration High Limit') Then true else if ('Outboard Bearing Vibration X' > 'Bearing Vibration High Limit') Then true else if ('Outboard Bearing Vibration Y' > 'Bearing Vibration High Limit') then true else false
```

The "Time True" field is set to "30 Seconds".

The "Generate child root cause event frame before parent event frame starts" checkbox is checked.

The "Functions" list on the right includes:

- Abs
- Acas
- And
- Ascii
- Asin
- Atn
- Atn2
- Avg
- Bat
- Bod
- Bom
- Bonm
- Ceiling
- Char
- Compare
- Concat
- Convert
- Cos
- Cosh
- Cot
- Coth
- Cor

The "Functions" list also includes a description for the "Abs" function:

**Abs(number x)**  
Return the absolute value of an integer or real number.  
Example: Abs(1)

# PI AF Asset Based Analytics – Event Preview

\\UCAFSVR\Power Generation - PI System Explorer

File Edit View Go Tools Help

Database Query Date Back Check In Refresh New Element Search Elements

Elements

- Generation
  - OSISoft Power
    - Big Creek Power Plant
    - Cleveland Power Plant
    - Houston Power Plant
    - Philadelphia Power Plant
    - San Leandro Power Plant
    - Unit 1
      - Air Heater
      - Balance of Plant
        - Feedwater System
          - Boiler Feed Pump #1
          - Boiler Feed Pump #2
        - Generator
        - Mills
        - Turbine
  - Wind Power Generation Fleet
  - Transmission and Distribution
  - Element Searches

Boiler Feed Pump #1

General Child Elements Attributes Ports Analyses Version

Name: Boiler Feed Pump Vibration Anomaly

Description:

Categories:

Analysis Type: ☐ Expression ☐ Rollup ☒ Event Frame Generation

Event Frame Template

Start Time: \*-1w

End Time: \*

| Name   | Duration         | Start time           | End time             |
|--|------------------|----------------------|----------------------|
| - Boiler Feed Pump Vibration Anomaly - 2014.03.28.15 | 01:57:30         | 3/28/2014 3:57:11 PM | 3/28/2014 5:54:41 PM |
| - Boiler Feed Pump Vibration Anomaly - 2014.03.29.15 | 01:57:30         | 3/29/2014 3:57:11 PM | 3/29/2014 5:54:41 PM |
| - Boiler Feed Pump Vibration Anomaly - 2014.04.01.00 | 06:58:18.0144869 | 4/1/2014 12:43:11 AM |                      |

StartTrigger true for: 30 Seconds

☒ Generate child root cause event frame before parent event frame starts

Duration: 1 Days

Name: Root Cause

Category:

Scheduling: ☒ Event-Triggered ☐ Periodic

Trigger on: Any Input

Results Preview

Abs(number x)  
Return the absolute value of an integer or real number.  
Example: Abs(1)

Attributes

Boiler Feed Pump #1 Modified: 3/27/2014 12:29:21 AM. Version: 1/1/1970 12:00:00 AM, Revision 13

Connected to the PI Analysis Service.

7:42 AM  
4/1/2014



# PI AF Asset Based Analytics – Backfilling Events

The screenshot shows the PI AF Asset Based Analytics interface. The main window is titled "PI AF Asset Based Analytics – Backfilling Events". The interface includes a menu bar (File, View, Go, Tools, Help), a toolbar (Database, Query Date, Back, Check In, Refresh), and a sidebar with a tree view of analyses.

The "Analyses" section on the left shows a list of analyses, including "Boiler Feed Pump Turbine\Boiler Feed Pump Cavitation Anomaly (8)", "Boiler Feed Pump Turbine\Boiler Feed Pump Control Oil Pressure Anom", "Boiler Feed Pump Turbine\Boiler Feed Pump High Bearing Temperature", "Boiler Feed Pump Turbine\Boiler Feed Pump Low Discharge Flow Anom", "Boiler Feed Pump Turbine\Boiler Feed Pump Low Pump Speed (8)", "Boiler Feed Pump Turbine\Boiler Feed Pump Suction Pressure Anomaly", "Boiler Feed Pump Turbine\Boiler Feed Pump Vibration Anomaly (8)", "Gas Turbine Template\GTExhaustGasTempDiffP1vP2 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP1vP3 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP1vP4 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP2vP1 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP2vP3 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP2vP4 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP3vP1 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP3vP2 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP3vP4 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP4vP1 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP4vP2 (2)", "Gas Turbine Template\GTExhaustGasTempDiffP4vP3 (2)", "Gas Turbine Template\GTExhaustGasTemperatureAnomaly (2)", "Mill\Mill Low Feeder Speed (16)", "Coal Plant\Plant Generating (4)", "Coal Plant\Plant Not Generating (4)", "Combined Cycle Power Plant Template\PowerPlantShutDown (1)", "Combined Cycle Power Plant Template\PowerPlantStartUp (1)", "Unit\Unit ShutDown (4)", and "Unit\Unit Trip (4)".

The "Analyses" section on the right shows a table of 8 checked analyses. The table has columns for Status, Element, Name, Template, and Backfilling. The first row is "Generation\OSISoft Power\Cleveland Power Plant\Unit 1\Balance of Plant\Feedwater System\Boiler Feed Pump #1" with a status of "Checked" and a backfilling status of "Backfilled".

The "Operations" section on the right shows a list of operations, including "Start checked analyses", "Stop checked analyses", and "Backfill checked analyses".

The "Analysis details" section at the bottom shows the details for the "Boiler Feed Pump Vibration Anomaly configuration". It includes the analysis type, description, element path, template, and schedule. The status section shows the analysis is "Enabled" and "Running".

A callout bubble points to the "Backfill Events into History" button, which is located in the "Operations" section.

Backfill  
Events into  
History

Pending Operations  
No pending operations

# PI DataLink 2014 – Pump Relative Report

Search Start: 1/10/2014 00:00  
 Search End: \*  
 Site Name: San Leandro Power Plant  
 Unit Name: Unit 1  
 Pump Name: Boiler Feed Pump #2

Now  
looking  
at BFP2

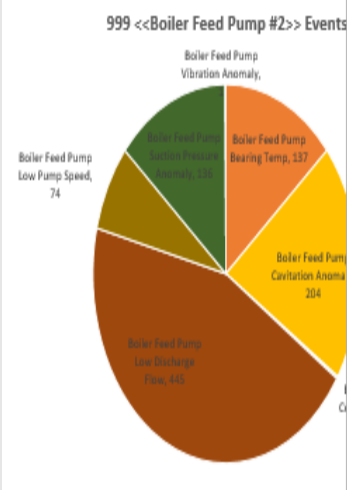
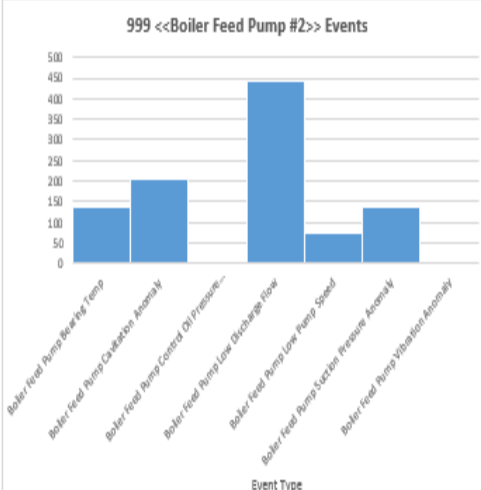
## Pump Information [PI AF]

| VIBRATION DATA                     |                             |                              |                              | PRESS                |                      |                    |                  | BEARING TEMPERATURE         |                              | UOM                                |
|------------------------------------|-----------------------------|------------------------------|------------------------------|----------------------|----------------------|--------------------|------------------|-----------------------------|------------------------------|------------------------------------|
| Inboard Bearing Vibration X        | Inboard Bearing Vibration Y | Outboard Bearing Vibration X | Outboard Bearing Vibration Y | Bearing Oil Pressure | Control Oil Pressure | Discharge Pressure | Suction Pressure | Inboard Bearing Temperature | Outboard Bearing Temperature |                                    |
| UOM                                | mils                        | mils                         | mils                         | psi                  | psi                  | psi                | psi              | deg F                       | deg F                        |                                    |
| Value at Start: 10-Jan-14 00:00:00 | 1.02                        | 0.95                         | 0.74                         | 14.80                | 35.76                | 3689.14            | 115.66           | 147.31                      | 125.44                       | Value at Start: 10-Jan-14 00:00:00 |
| Value at End: 29-Apr-14 06:40:12   | 0.97                        | 0.87                         | 0.75                         | 14.78                | 35.75                | 3776.16            | 129.87           | 147.36                      | 125.25                       | Value at End: 29-Apr-14 06:40:12   |
| Minimum                            | 0.05                        | 0.04                         | 0.03                         | 14.71                | 35.46                | 38.58              | 6.60             | 71.83                       | 73.63                        | Minimum                            |
| Average                            | 0.85                        | 0.89                         | 0.62                         | 15.61                | 37.00                | 2628.75            | 111.23           | 128.93                      | 116.20                       | Average                            |
| Maximum                            | 2.72                        | 1.86                         | 3.68                         | 19.98                | 46.90                | 4099.07            | 207.40           | 155.31                      | 135.38                       | Maximum                            |
| StdDev                             | 0.53                        | 0.54                         | 0.30                         | 0.78                 | 1.47                 | 1698.24            | 50.97            | 29.67                       | 19.54                        | StdDev                             |

## Pump Events [PI EF] (999)

| EVENT NAME |           | EVENT CATEGORY |         | EVENT TEMPLATE         |  |
|------------|-----------|----------------|---------|------------------------|--|
| ✖          |           | ✖              |         | ✖                      |  |
| Minimum    | 0.00126   | Minimum        | 1.4     | 999 <<Boiler Feed Pump |  |
| Average    | 0.164243  | Average        | 1003.3  |                        |  |
| StdDev     | 2.120659  | StdDev         | 3607.8  |                        |  |
| Maximum    | 3113.0301 | Maximum        | 45423.0 |                        |  |

| Event name                               | Start time         | End time           | Duration    | Event template                      | Duration Minutes |
|--|--------------------|--------------------|-------------|-------------------------------------|------------------|
| Boiler Feed Pump #2 - Boiler Feed Pump L | 10-Jan-14 00:00:00 | 11-Jan-14 06:40:00 | 16:40:00    | Boiler Feed Pump Low Discharge Flow | 1840.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump L | 10-Jan-14 00:00:00 | 11-Jan-14 06:40:00 | 16:40:00    | Boiler Feed Pump Low Discharge Flow | 1840.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump E | 10-Jan-14 00:00:00 | 12-Jan-14 21:05:00 | 2 21:05:00  | Boiler Feed Pump Bearing Temp       | 4145.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump E | 10-Jan-14 00:00:00 | 10-Jan-14 05:20:00 | 0 5:20:00   | Boiler Feed Pump Bearing Temp       | 320.0            |
| Boiler Feed Pump #2 - Boiler Feed Pump E | 10-Jan-14 00:00:00 | 12-Jan-14 21:05:00 | 2 21:05:00  | Boiler Feed Pump Bearing Temp       | 4145.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump E | 10-Jan-14 00:00:00 | 10-Jan-14 05:20:00 | 0 5:20:00   | Boiler Feed Pump Bearing Temp       | 320.0            |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 10-Jan-14 00:00:00 | 12-Jan-14 18:40:00 | 2 18:40:00  | Boiler Feed Pump Cavitation Anomaly | 4000.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 10-Jan-14 00:00:00 | 12-Jan-14 18:40:00 | 2 18:40:00  | Boiler Feed Pump Cavitation Anomaly | 4000.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 11-Jan-14 00:30:00 | 24-Jan-14 21:05:00 | 13 20:35:00 | Boiler Feed Pump Bearing Temp       | 19355.0          |
| Boiler Feed Pump #2 - Boiler Feed Pump E | 11-Jan-14 00:30:00 | 24-Jan-14 21:05:00 | 13 20:35:00 | Boiler Feed Pump Bearing Temp       | 19355.0          |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 11-Jan-14 07:10:00 | 11-Jan-14 16:00:00 | 0 8:50:00   | Boiler Feed Pump Cavitation Anomaly | 530.0            |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 11-Jan-14 07:10:00 | 11-Jan-14 16:00:00 | 0 8:50:00   | Boiler Feed Pump Cavitation Anomaly | 530.0            |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 12-Jan-14 16:00:00 | 13-Jan-14 10:45:00 | 0 18:45:00  | Boiler Feed Pump Cavitation Anomaly | 1125.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 12-Jan-14 16:00:00 | 13-Jan-14 10:45:00 | 0 18:45:00  | Boiler Feed Pump Cavitation Anomaly | 1125.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump L | 12-Jan-14 18:55:00 | 12-Jan-14 19:55:00 | 0 1:00:00   | Boiler Feed Pump Low Discharge Flow | 60.0             |
| Boiler Feed Pump #2 - Boiler Feed Pump L | 12-Jan-14 18:55:00 | 12-Jan-14 19:55:00 | 0 1:00:00   | Boiler Feed Pump Low Discharge Flow | 60.0             |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 12-Jan-14 19:55:00 | 12-Jan-14 20:15:00 | 0 0:20:00   | Boiler Feed Pump Cavitation Anomaly | 20.0             |
| Boiler Feed Pump #2 - Boiler Feed Pump C | 12-Jan-14 19:55:00 | 12-Jan-14 20:15:00 | 0 0:20:00   | Boiler Feed Pump Cavitation Anomaly | 20.0             |
| Boiler Feed Pump #2 - Boiler Feed Pump L | 12-Jan-14 20:55:00 | 14-Jan-14 08:50:00 | 11:55:00    | Boiler Feed Pump Low Discharge Flow | 2155.0           |
| Boiler Feed Pump #2 - Boiler Feed Pump L | 12-Jan-14 20:55:00 | 14-Jan-14 08:50:00 | 11:55:00    | Boiler Feed Pump Low Discharge Flow | 2155.0           |



# Excel Charting



# PI DataLink 2014 – Daily Events Production Report

Copy of Copy of UC2014 Power Gen Reports - Excel

Todd Brown

B21 : (=PIEFdat(GLOBAL!\$B\$2,'Production Summary Report'!\$C\$3,'Production Summary Report'!\$C\$4,0,'Production Summary Report'!\$F\$4,'Unit TIME.Day','Production Summary Report'!\$F\$3,"","","","","active in range","start time

EF Template Unit Time.Day  
 Search Start 1/10/2014 0:00  
 Search End \*

Site Name San Leandro Power Plant  
 Unit Name Unit 1  
 EF Name \*

Day of Week \*

|    |            |                    |                    |           |                         |                 |             |          |                         | Top 10%                 |                         |                | Bottom 10%   |              |              |              |  |  |
|----|------------|--------------------|--------------------|-----------|-------------------------|-----------------|-------------|----------|-------------------------|-------------------------|-------------------------|----------------|--------------|--------------|--------------|--------------|--|--|
|    |            |                    |                    |           |                         |                 |             |          |                         | AMBIENT TEMPERATURE     |                         |                | GROSS MW     |              |              |              |  |  |
|    | Event name | Start time         | End time           | Duration  | Site Name               | Primary element | Day of Week | Day Type | Ambient Temperature.Min | Ambient Temperature.Avg | Ambient Temperature.Max | Gross MW.Start | Gross MW.End | Gross MW.Min | Gross MW.Avg | Gross MW.Max |  |  |
| 20 | 2014_01_10 | 10-Jan-14 00:00:00 | 11-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | FRIDAY      | WEEKDAY  | 39.38                   | 53.15                   | 62.12                   | 389.42         | 383.05       | 371.63       | 382.90       | 408.00       |  |  |
| 21 | 2014_01_11 | 11-Jan-14 00:00:00 | 12-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SATURDAY    | WEEKEND  | 42.95                   | 51.00                   | 58.65                   | 383.05         | 548.17       | 377.83       | 513.15       | 583.00       |  |  |
| 22 | 2014_01_12 | 12-Jan-14 00:00:00 | 13-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SUNDAY      | WEEKEND  | 36.49                   | 39.77                   | 42.97                   | 548.17         | 557.14       | 532.21       | 554.91       | 564.00       |  |  |
| 23 | 2014_01_13 | 13-Jan-14 00:00:00 | 14-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | MONDAY      | WEEKDAY  | 31.43                   | 34.38                   | 37.44                   | 557.14         | 557.33       | 445.00       | 548.00       | 557.00       |  |  |
| 24 | 2014_01_14 | 14-Jan-14 00:00:00 | 15-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | TUESDAY     | WEEKDAY  | 29.40                   | 36.46                   | 44.59                   | 557.33         | 561.43       | 500.00       | 550.00       | 561.00       |  |  |
| 25 |            | 15-Jan-14 00:00:00 | 16-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | WEDNESDAY   | WEEKDAY  | 36.39                   | 39.39                   | 45.72                   | 561.43         | 483.70       | 445.00       | 548.00       | 557.00       |  |  |
| 26 |            | 16-Jan-14 00:00:00 | 17-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | THURSDAY    | WEEKDAY  | 31.79                   | 33.96                   | 38.39                   | 483.70         | 559.58       | 445.00       | 548.00       | 557.00       |  |  |
| 27 |            | 17-Jan-14 00:00:00 | 18-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | FRIDAY      | WEEKDAY  | 27.75                   | 31.90                   | 36.31                   | 559.58         | 584.55       | 500.00       | 550.00       | 584.00       |  |  |
| 28 |            | 18-Jan-14 00:00:00 | 19-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SATURDAY    | WEEKEND  | 32.18                   | 36.37                   | 41.00                   | 584.55         | 580.75       | 500.00       | 550.00       | 584.00       |  |  |
| 29 |            | 19-Jan-14 00:00:00 | 20-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SUNDAY      | WEEKEND  | 28.63                   | 33.16                   | 40.24                   | 580.75         | 581.87       | 500.00       | 550.00       | 584.00       |  |  |
| 30 |            | 20-Jan-14 00:00:00 | 21-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | MONDAY      | WEEKDAY  | 25.36                   | 30.89                   | 33.64                   | 581.87         | 585.70       | 500.00       | 550.00       | 584.00       |  |  |
| 31 |            | 21-Jan-14 00:00:00 | 22-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | TUESDAY     | WEEKDAY  | 21.31                   | 29.28                   | 36.49                   | 585.70         | 580.75       | 500.00       | 550.00       | 584.00       |  |  |
| 32 | 2014_01_22 | 22-Jan-14 00:00:00 | 23-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | WEDNESDAY   | WEEKDAY  | 31.02                   | 36.55                   | 43.74                   | 586.95         | 582.22       | 543.00       | 574.01       | 583.00       |  |  |
| 33 | 2014_01_23 | 23-Jan-14 00:00:00 | 24-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | THURSDAY    | WEEKDAY  | 30.67                   | 35.83                   | 39.71                   | 582.22         | 584.35       | 550.66       | 582.36       | 583.00       |  |  |
| 34 | 2014_01_24 | 24-Jan-14 00:00:00 | 25-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | FRIDAY      | WEEKDAY  | 34.48                   | 36.28                   | 38.73                   | 584.35         | 1.57         | 1.57         | 497.81       | 630.00       |  |  |
| 35 | 2014_01_25 | 25-Jan-14 00:00:00 | 26-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SATURDAY    | WEEKEND  | 33.30                   | 36.73                   | 40.87                   | 1.57           | 1.41         | 1.35         | 1.52         | 1.52         |  |  |
| 36 | 2014_01_26 | 26-Jan-14 00:00:00 | 27-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SUNDAY      | WEEKEND  | 37.34                   | 41.12                   | 46.49                   | 1.41           | 1.57         | 1.35         | 1.48         | 1.48         |  |  |
| 37 | 2014_01_27 | 27-Jan-14 00:00:00 | 28-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | MONDAY      | WEEKDAY  | 35.64                   | 42.73                   | 50.00                   | 1.57           | 1.51         | 1.51         | 1.57         | 1.57         |  |  |
| 38 | 2014_01_28 | 28-Jan-14 00:00:00 | 29-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | TUESDAY     | WEEKDAY  | 35.96                   | 42.99                   | 50.79                   | 1.51           | 1.51         | 1.35         | 1.50         | 1.50         |  |  |
| 39 | 2014_01_29 | 29-Jan-14 00:00:00 | 30-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | WEDNESDAY   | WEEKDAY  | 37.32                   | 45.35                   | 51.52                   | 1.51           | 1.57         | 1.35         | 1.43         | 1.43         |  |  |
| 40 | 2014_01_30 | 30-Jan-14 00:00:00 | 31-Jan-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | THURSDAY    | WEEKDAY  | 38.37                   | 45.66                   | 53.09                   | 1.57           | 1.57         | 1.35         | 1.50         | 1.50         |  |  |
| 41 | 2014_01_31 | 31-Jan-14 00:00:00 | 01-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | FRIDAY      | WEEKDAY  | 45.71                   | 52.39                   | 61.25                   | 1.57           | 564.46       | 1.57         | 329.83       | 583.00       |  |  |
| 42 | 2014_02_01 | 01-Feb-14 00:00:00 | 02-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SATURDAY    | WEEKEND  | 34.55                   | 41.15                   | 52.62                   | 564.46         | 584.37       | 499.94       | 575.82       | 590.00       |  |  |
| 43 | 2014_02_02 | 02-Feb-14 00:00:00 | 03-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SUNDAY      | WEEKEND  | 29.58                   | 37.42                   | 45.33                   | 584.37         | 502.19       | 502.19       | 581.74       | 583.00       |  |  |
| 44 | 2014_02_03 | 03-Feb-14 00:00:00 | 04-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | MONDAY      | WEEKDAY  | 31.52                   | 38.18                   | 47.16                   | 502.19         | 581.26       | 502.19       | 580.03       | 583.00       |  |  |
| 45 | 2014_02_04 | 04-Feb-14 00:00:00 | 05-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | TUESDAY     | WEEKDAY  | 41.13                   | 41.29                   | 41.45                   | 581.26         | 582.85       | 581.26       | 582.05       | 583.00       |  |  |
| 46 | 2014_02_05 | 05-Feb-14 00:00:00 | 06-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | WEDNESDAY   | WEEKDAY  | 40.82                   | 40.97                   | 41.13                   | 582.85         | 584.43       | 582.85       | 583.64       | 584.00       |  |  |
| 47 | 2014_02_06 | 06-Feb-14 00:00:00 | 07-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | THURSDAY    | WEEKDAY  | 40.68                   | 43.56                   | 53.49                   | 584.43         | 584.13       | 496.15       | 575.45       | 590.00       |  |  |
| 48 | 2014_02_07 | 07-Feb-14 00:00:00 | 08-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | FRIDAY      | WEEKDAY  | 48.62                   | 57.47                   | 60.77                   | 584.13         | 585.30       | 405.41       | 473.67       | 583.00       |  |  |
| 49 | 2014_02_08 | 08-Feb-14 00:00:00 | 09-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SATURDAY    | WEEKEND  | 43.24                   | 51.08                   | 67.00                   | 585.30         | 581.77       | 557.08       | 583.15       | 590.00       |  |  |
| 50 | 2014_02_09 | 09-Feb-14 00:00:00 | 10-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | SUNDAY      | WEEKEND  | 43.60                   | 47.53                   | 54.25                   | 581.77         | 581.77       | 572.93       | 583.79       | 583.00       |  |  |
| 51 | 2014_02_10 | 10-Feb-14 00:00:00 | 11-Feb-14 00:00:00 | 1 0:00:00 | San Leandro Power Plant | Unit 1          | MONDAY      | WEEKDAY  | 42.88                   | 46.16                   | 50.80                   | 581.77         | 583.44       | 472.99       | 578.89       | 583.00       |  |  |

Daily Events

Unit Trip!

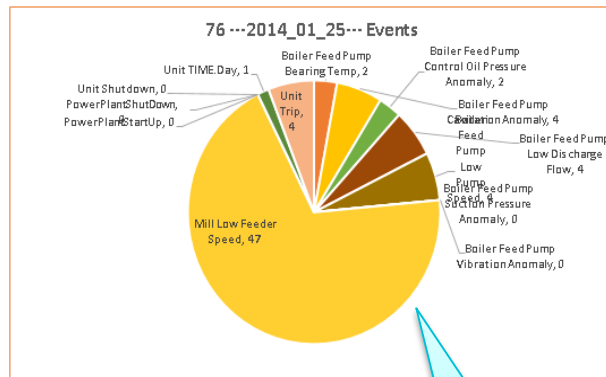
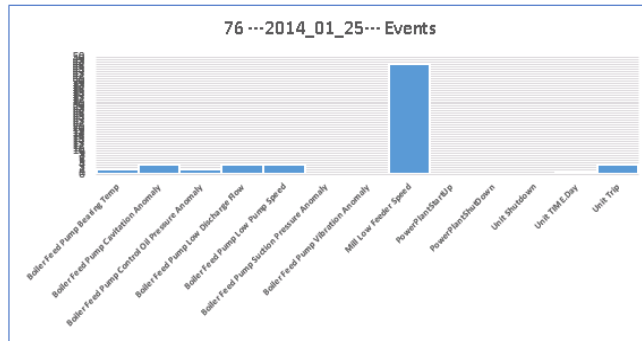
# PI DataLink 2014 – Daily Anomaly Report

Copy of Copy of UC2014 Power Gen Reports - Excel

Todd Brown

Daily Data

(76) Events during DAY ---2014\_01\_25--- on <<Unit 1>>



Excel Charting

Excursion Events

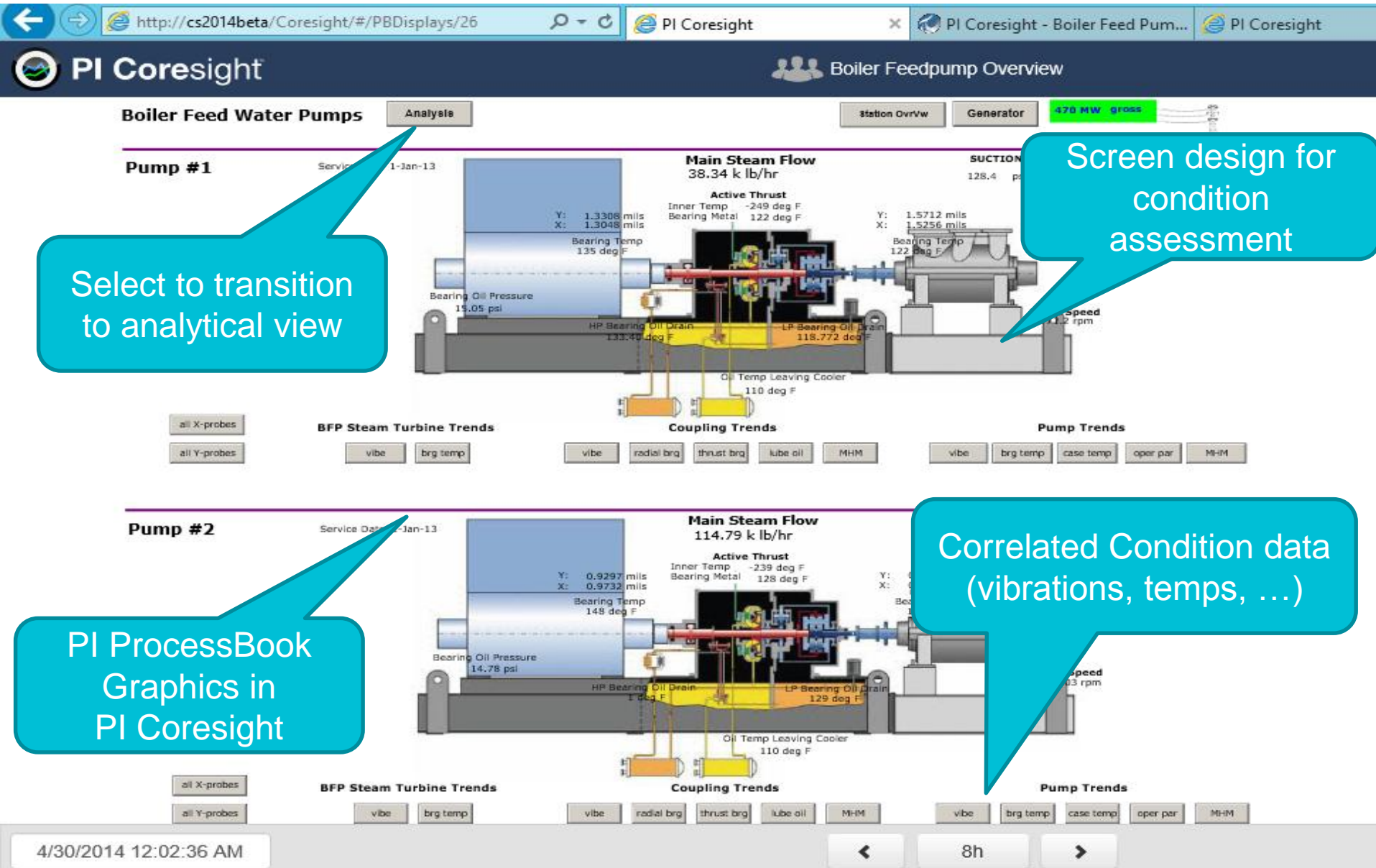
| Relative Time  | Event name  | Start tir          | End tir            | Durati     | Event template                                | Site                    |
|----------------|---|--------------------|--------------------|------------|---|-------------------------|
| 00 -- 05:05:00 | Boiler Feed Pump #1 - Boiler Feed Pump Low Discharge Flo  | 24-Jan-14 18:55:00 | 29-Jan-14 21:55:00 | 5 3:00:00  | Boiler Feed Pump Low Discharge Flow           | San                     |
| 00 -- 04:05:00 | Boiler Feed Pump #1 - Boiler Feed Pump Low Pump Speed -   | 24-Jan-14 19:55:00 | 29-Jan-14 21:55:00 | 5 2:00:00  | Boiler Feed Pump Low Pump Speed               | San                     |
| 00 -- 03:05:00 | Boiler Feed Pump #2 - Boiler Feed Pump Low Discharge Flo  | 24-Jan-14 20:55:00 | 26-Jan-14 08:50:00 | 1 11:55:00 | Boiler Feed Pump Low Discharge Flow           | San                     |
| 00 -- 02:45:00 | Boiler Feed Pump #1 - Boiler Feed Pump Control Oil Pressu | 24-Jan-14 21:15:00 | 25-Jan-14 01:55:00 | 0 4:40:00  | Boiler Feed Pump Control Oil Pressure Anomaly | San                     |
| 00 -- 02:30:00 | Unit 1 - Unit Trip - 2014.01.24.21                        | 24-Jan-14 21:30:00 | 31-Jan-14 05:15:00 | 6 7:45:00  | Unit Trip                                     | Unit 1 San              |
| 00 -- 01:15:00 | Boiler Feed Pump #2 - Boiler Feed Pump Low Pump Speed -   | 24-Jan-14 22:45:00 | 26-Jan-14 09:15:00 | 1 10:30:00 | Boiler Feed Pump Low Pump Speed               | Boiler Feed Pump #2 San |
| 00 -- 00:06:40 | Mill 2 - Mill Low Feeder Speed - 2014.01.25.00            | 24-Jan-14 23:53:20 | 25-Jan-14 00:01:00 | 0 0:07:40  | Mill Low Feeder Speed                         | Mill 2 San              |
| 00 -- 00:00:00 | 2014_01_25  | 25-Jan-14 00:00:00 | 26-Jan-14 00:00:00 | 1 0:00:00  | Unit TIME.Day                                 | Unit 1 San              |
| 00 -- 00:32:30 | Mill 4 - Mill Low Feeder Speed - 2014.01.25.00            | 25-Jan-14 00:32:30 | 25-Jan-14 00:42:00 | 0 0:09:30  | Mill Low Feeder Speed                         | Mill 4 San              |
| 00 -- 00:06:40 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.00            | 25-Jan-14 00:32:50 | 25-Jan-14 01:36:30 | 0 1:03:40  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 00:34:00 | Mill 2 - Mill Low Feeder Speed - 2014.01.25.00            | 25-Jan-14 00:34:00 | 25-Jan-14 01:41:20 | 0 1:07:20  | Mill Low Feeder Speed                         | Mill 2 San              |
| 00 -- 01:40:20 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.01            | 25-Jan-14 01:40:20 | 25-Jan-14 02:22:00 | 0 0:41:40  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 04:20:20 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.04            | 25-Jan-14 04:20:20 | 25-Jan-14 04:32:30 | 0 0:12:10  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 04:34:00 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.04            | 25-Jan-14 04:34:00 | 25-Jan-14 04:38:30 | 0 0:04:30  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 04:40:50 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.04            | 25-Jan-14 04:40:50 | 25-Jan-14 08:03:30 | 3 3:22:40  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 08:14:00 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.08            | 25-Jan-14 08:14:00 | 25-Jan-14 08:40:00 | 0 0:26:00  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 08:46:40 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.08            | 25-Jan-14 08:46:40 | 25-Jan-14 08:53:50 | 0 0:07:10  | Mill Low Feeder Speed                         | Mill 1 San              |
| 00 -- 09:09:00 | Mill 1 - Mill Low Feeder Speed - 2014.01.25.09            | 25-Jan-14 09:09:00 | 25-Jan-14 09:14:20 | 0 0:05:20  | Mill Low Feeder Speed                         | Mill 1 San              |

Hourly Report

GLOBAL DAY Data

7:28 AM  
4/1/2014

# CBM / Proactive Maintenance Monitoring





# CBM / Proactive Maintenance Monitoring



# Condition Based Maintenance Screens

UNIT 1

149.13 MW

Discharge Flow

Total Head - 1A =

BFP 1A SUCT ST  
BFP 1A SUCT PR  
BFP 1A DISCH P  
BFP 1A DISCH F  
TOTAL HEAD  
THRUST HOUSIN  
NDE SLEEVE BR  
DE SLEEVE BRG

Get Runtime Tags

yes

12010: BFP 1A Runtime Hours when -BFP1A.RT

12011: BFP 1B Runtime Hours when -BFP1B.RT

12012: BFP 2A Runtime Hours when -BFP2A.RT

12013: BFP 2B Runtime Hours when -BFP2B.RT

12015: Condensate Pump A Runtime -COND\_A.RT

12019: Condensate Pump B Runtime -COND\_B.RT

| TagID | Tag Name | Tag Descriptor            |
|-------|----------|---------------------------|
| 12012 | BFP2A.RT | BFP 2A Runtime Hours when |

Value (Hours): 1996.35

Please add comment and initials.

Reset Runtime Counter

Instructions:

When the display loads it will pull back all \*.RT (Runtime Counter) tags from the stations PI Server.

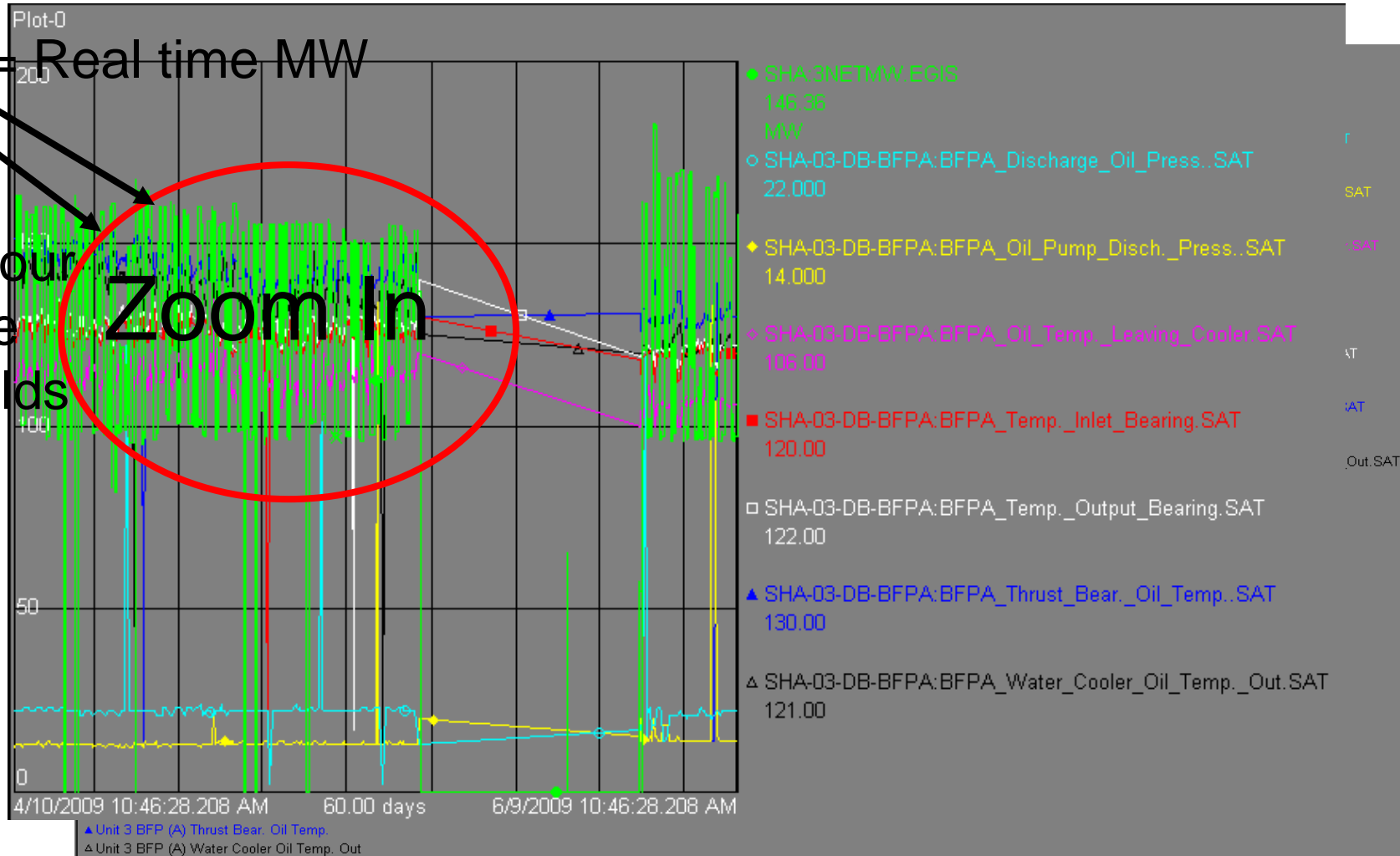
- Click on the runtime counter from the listbox that you would like to reset.  
\* - The Counter Information will be populated in the display below the listbox.
- Reset the Runtime Hours value in the text box next to the Value.  
\* - You can set this to any number of hours.
- Add comments and name or initials to the comments textbox.
- Click the "Reset Runtime Counter" button.

OSIsoft. REGIONAL SEMINARS

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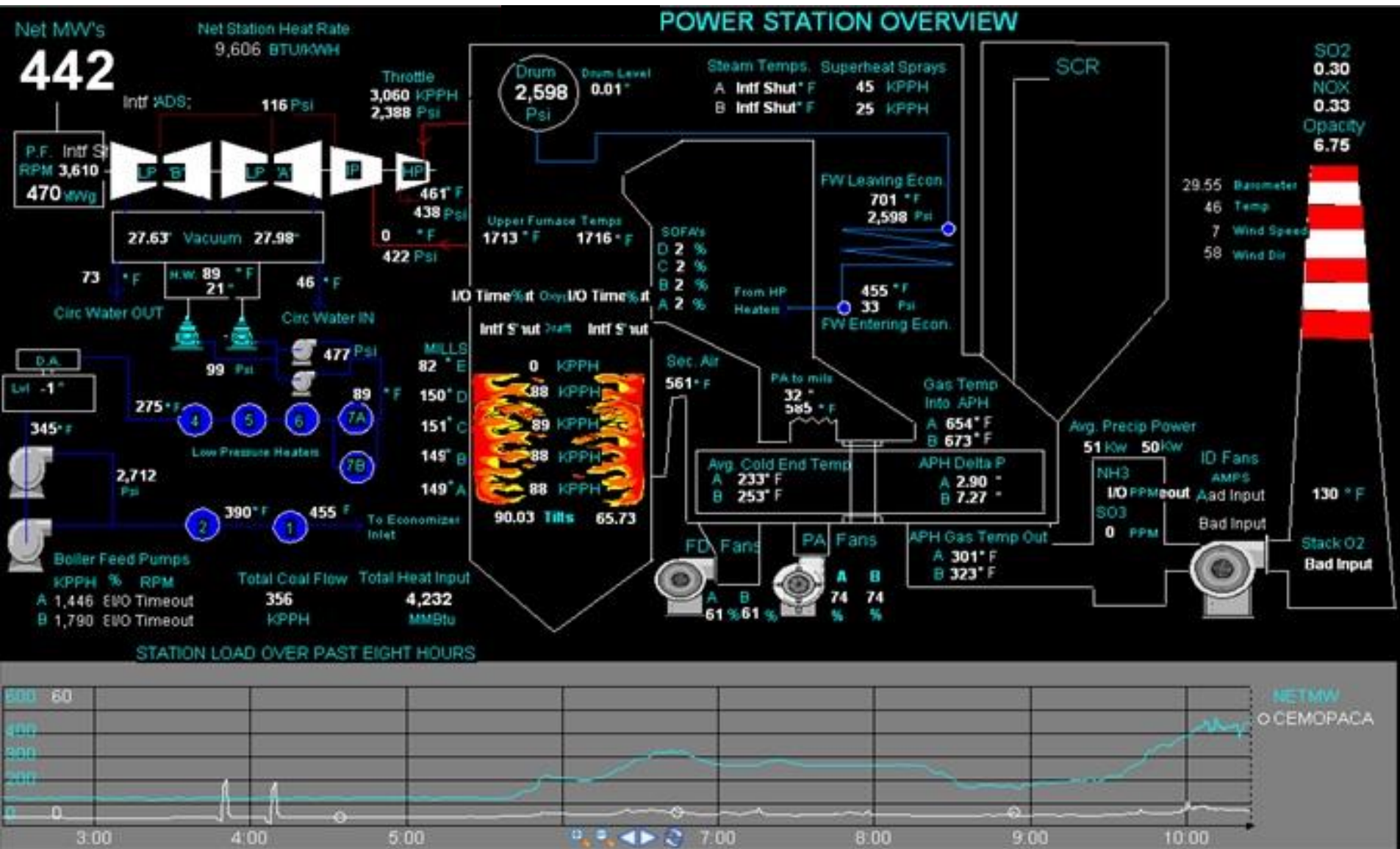
# Manual Round Data Correlation

Green = Real time MW  
Data  
Taken  
every hour  
from the  
handhelds





# Operations – Plant Overview



# Operations – Controllable Loss

## ETW 4 OPERATOR CONTROLLABLE LOSS

10/16/2009 17:04:03  
Net MW: 249

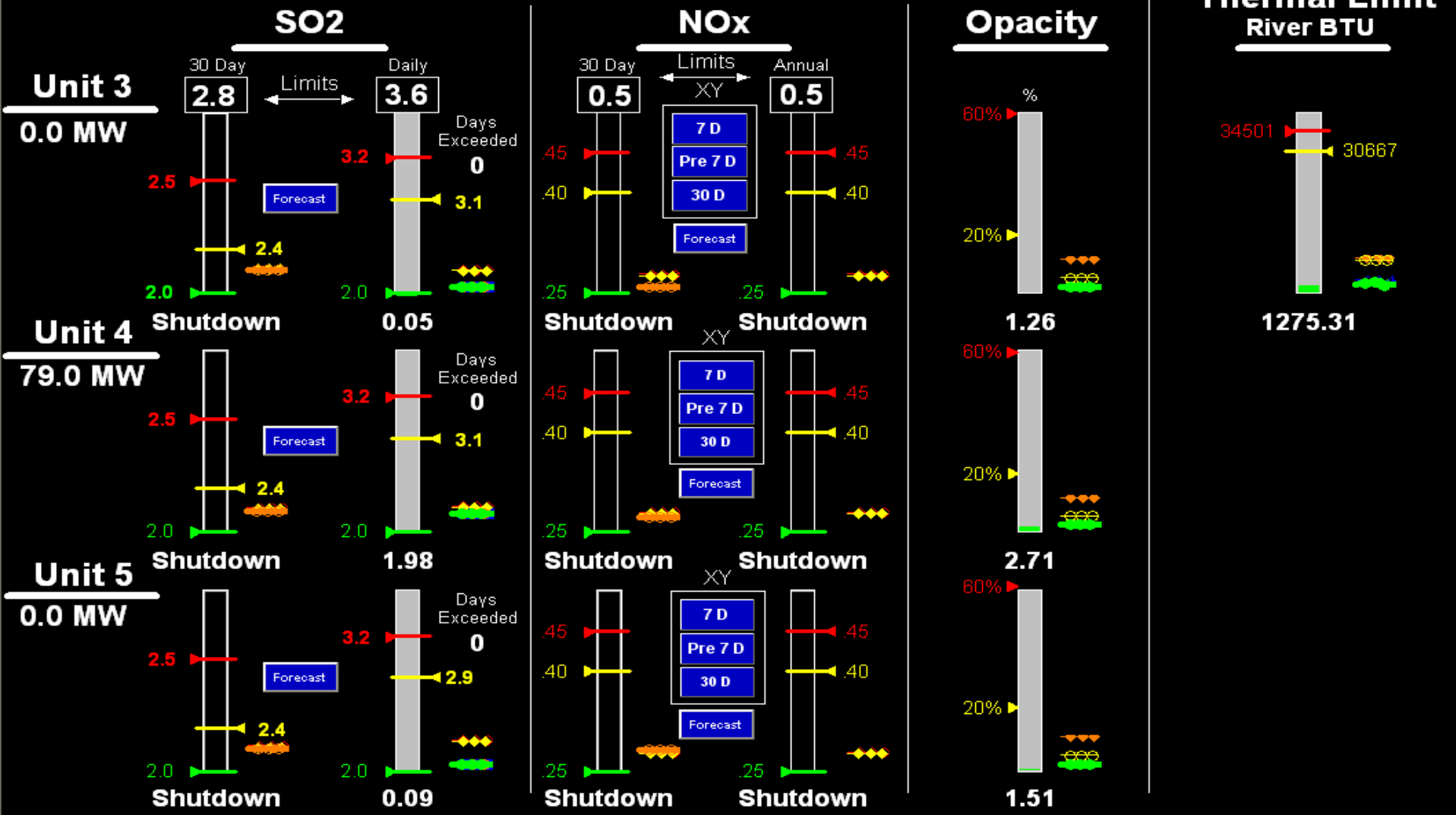
| Controllable Variable   | UNITS   | ACTUAL  | DESIGN  | +500 | DEVIATION (HR) | -500 | HR  | MW    |
|---|---------|---|---------|------|----------------|------|-----|-------|
| Main Steam Pressure    | PSIG    | 2401     | 2415    |      |                |      | -14 | -0.3  |
| Main Steam Temps       | °F      | 1040  | 1050    |      |                |      | 15  | 0.4   |
| SH Attenuation Flow   | klb/hr  | Bad Inp  | 0       |      |                |      |     |       |
| Hot RH Steam Temps     | °F      | 992   | 1000    |      |                |      | 13  | -0.9  |
| RH Attenuation Flow   | klb/hr  | 40.42    | 0       |      |                |      |     |       |
| Condensate Subcooling  | °F      | 2.5      | 4.0 max |      |                |      |     |       |
| Excess O2 *            | %       | 2.04  | 1.80    |      |                |      |     |       |
| Stack Temp             | °F      | 256.8   | 238.2   |      |                |      |     |       |
| Auxiliary Power        | MW      | 7.09  | 9.50    |      |                |      |     |       |
| Backpressure           | in Hga  | 3.37  | 2.00    |      |                |      | 447 | -10.3 |
| Vacuum  | in Hg   | 26.55   |         |      |                |      |     |       |
| Heat Rate            | btu/kwh | 10644   | 10306   |      |                |      | 338 |       |



# Environmental Monitoring

## Environmental Monitoring Summary

5/20/2009 8:19:13.01501 AM



## CONTROL DE PARQUE

TELECONTROL

UMB

## PARQUES EOLICOS

### Campisábalos

| Inc | P.olda | P.ible | Eto.% | Emes  | Eaño  | Cap.% |
|-----|--------|--------|-------|-------|-------|-------|
| 0   | 274    | 237    | 116   | 572.9 | 572.2 | 1     |

### Pozocañada

| Inc | P.olda | P.ible | Eto.% | Emes | Eaño | Cap.% |
|-----|--------|--------|-------|------|------|-------|
|     |        |        |       |      |      |       |

### Hijos

| Inc | P.olda | P.ible | Eto.% | Emes | Eaño | Cap.% |
|-----|--------|--------|-------|------|------|-------|
|     |        |        |       |      |      |       |

### Somolinos

| Inc | P.olda | P.ible | Eto.% | Emes | Eaño | Cap.% |
|-----|--------|--------|-------|------|------|-------|
|     |        |        |       |      |      |       |

### Morrablanca

| Inc | P.olda | P.ible | Eto.% | Emes | Eaño | Cap.% |
|-----|--------|--------|-------|------|------|-------|
|     |        |        |       |      |      |       |

### Catalojas

| Inc | P.olda | P.ible | Eto.% | Emes | Eaño | Cap.% |
|-----|--------|--------|-------|------|------|-------|
|     |        |        |       |      |      |       |

### TOTAL

| Inc | P.olda | P.ible | Eto.% | Emes  | Eaño  | Cap.% |
|-----|--------|--------|-------|-------|-------|-------|
| 0   | 274    | 237    | 116   | 572.9 | 572.2 | 1     |

90.38

55.09

5.09

GONDOLA 90.38

TOP

ROTOR

MULTIPLICADORA

90.38

90.38

FRENO

90.38

90.38

REFRIGERACION

2000.04

GENERADOR

90.38

S.HIDRAULICO

90.38

590.33

590.33

GIRO

90.38

GROUND

750.19

50.20

750.19

50.20

RED

TRANSFORMADOR

90.38

90.38

90.38

90.38

750.19

## VERSIONES AEROGENERADOR

Versión Armario Control Top

?

Versión Armario de Control Ground

?

AMBIENTE 24.76

0.09

## DATOS PRODUCCION

|                        |      |
|------------------------|------|
| Producción Año Actual  | 1.88 |
| Producción Mes Actual  | 1.88 |
| Producción Día Actual  | 1.88 |
| Producción Hora Actual | 1.88 |
| Producción Total       | 1.88 |

## DATOS DISPONIBILIDAD

|   |          |
|---|----------|
| Disponibilidad total en %                 | 90.2?    |
| Disponibilidad Total Red Horas            | 1,000.0? |
| Disponibilidad Total Turbina Horas        | 1,000.0? |
| Disponibilidad mes en %                   | 90.2?    |
| Disponibilidad Mes Red Horas              | 1,000.0? |
| Disponibilidad Mes Turbina Horas          | 1,000.0? |
| Disponibilidad mes anterior en %          | 90.2?    |
| Disponibilidad Mes Anterior Red Horas     | 1,000.0? |
| Disponibilidad Mes Anterior Turbina Horas | 1,000.0? |

## PROTECCIONES SUBESTACION

MINIMA TENSION

SOBRETEN. INSTANEA

SOBREINTENSIDAD

MAX.FRECUENCIA

MIN.FRECUENCIA

SOBRETENS. HOMOL.

DISP.CUBA TRAFQ

DIS.NEUTRO.Q.TRAFO

DISP.TERMOSTATO

ALARMA TEMPERATURA

DISP.TEMPERATURA

ALARMA BUCHHOLZ

DISPARO BUCHHOLZ

BAJO NM. ACEITE

SOBREPRES. TRAFQ

AUTOM. T TENSION

FALTA C.A

FALTA C.C



13/08/02

19:57:20.279

Alarm on - not ack.

ECM HIGH



# Non-routine Operations : Start-Up

## START UP Ramagundam U#3

### PRE START CHECKS

|                       |                |
|-----------------------|----------------|
| H2 Pr: 1.85Kg/cm2     | 1.97473        |
| H2 Purity:>98%        | 98.9995        |
| MOT Level LO          | NOT_LOW        |
| Lube oil temp: 45 deg | 46.8300        |
| Vacuum                | -693.366       |
| Gnd stm temp>280Deg   | 239.405        |
| M S line charged      | 151.630        |
| HP/LP charged         | OUT_OF_SERVICE |
| Dea stm charged       | 8.10537        |
| Drum Lvl              | -15.5041       |
| Dea Lvl               | 2423.75        |
| Hotwell Lvl           | 447.221        |
| Turning Gear :        | DISENGAGED     |

### Rolling Parameter

|                   |         |
|-------------------|---------|
| MS Pr : 75 Kg/cm2 | 151.630 |
| MS temp: 350 deg  | 538.275 |
| HRH Pr: 12 Kg/cm2 | 24.5788 |
| HRH temp: 320 deg | 521.469 |
| Boiler PH         | 7.70544 |
| Cond cation cond. | 0.12395 |

### Oil Injection test

### Electrical test

Total time at 3000 rpm

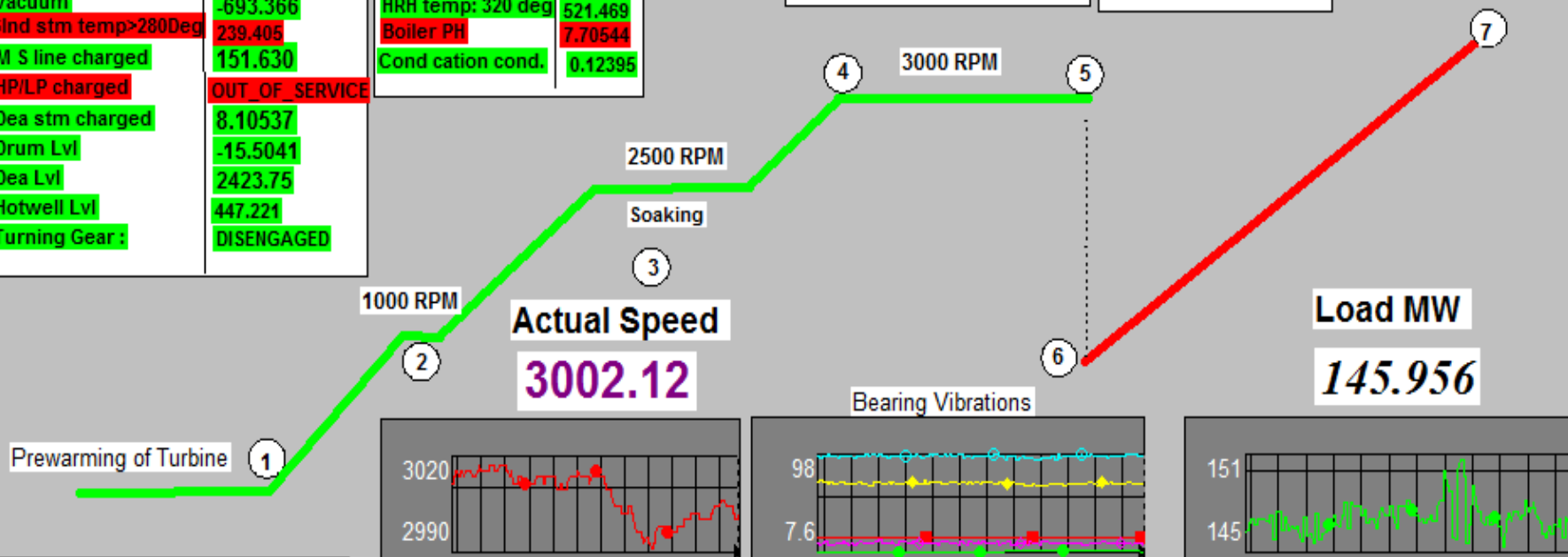
Time From step 4 to 5: 6 Hours

### Check 5

|                |         |
|----------------|---------|
| AVR Auto       | Auto    |
| H2Cold gastemp | 36.1253 |
| Seal oil temp  | 35.4081 |

### BLK 4,5 FINAL RAMP STABLISH

Raise full load: 200 MW @ 1.5 MW



### Check 1

|                                  |                 |
|----------------------------------|-----------------|
| Barring Speed: 3 to 5 RPM        | 3002.12         |
| EHC in service                   | NOT_MALFUNCTION |
| Criteria: ESV opening            |                 |
| Main Stm to CV Chest DT < 50 deg |                 |
| Criteria: CV opening             |                 |
| HP inner Shell Metal Temp > 165  |                 |
| Speed raising to 1000 rpm        |                 |

### Check 2

|                                     |         |
|-------------------------------------|---------|
| Turbine Speed: 1000 RPM             | 3002.12 |
| All Vibrations With in Limit        |         |
| Check for all Bearing temp normal   |         |
| Speed raising from 1000 to 2500 rpm |         |

### Check 3

|                                   |     |
|-----------------------------------|-----|
| Criteria : Speed raising 3000 rpm |     |
| - Accn rate 100 rpm               | 0   |
| -HRH pr 12 kg/cm2                 |     |
| Block Load : 10 MW                |     |
| AOP cut out 2800 rpm              | OFF |

### Check 7

Load Raising from Block load to 200 MW

Cross Over Pipe Inner Metal Temp. >= 175 Deg  
For 60 Minutes

HP Heaters Charged -1.14373

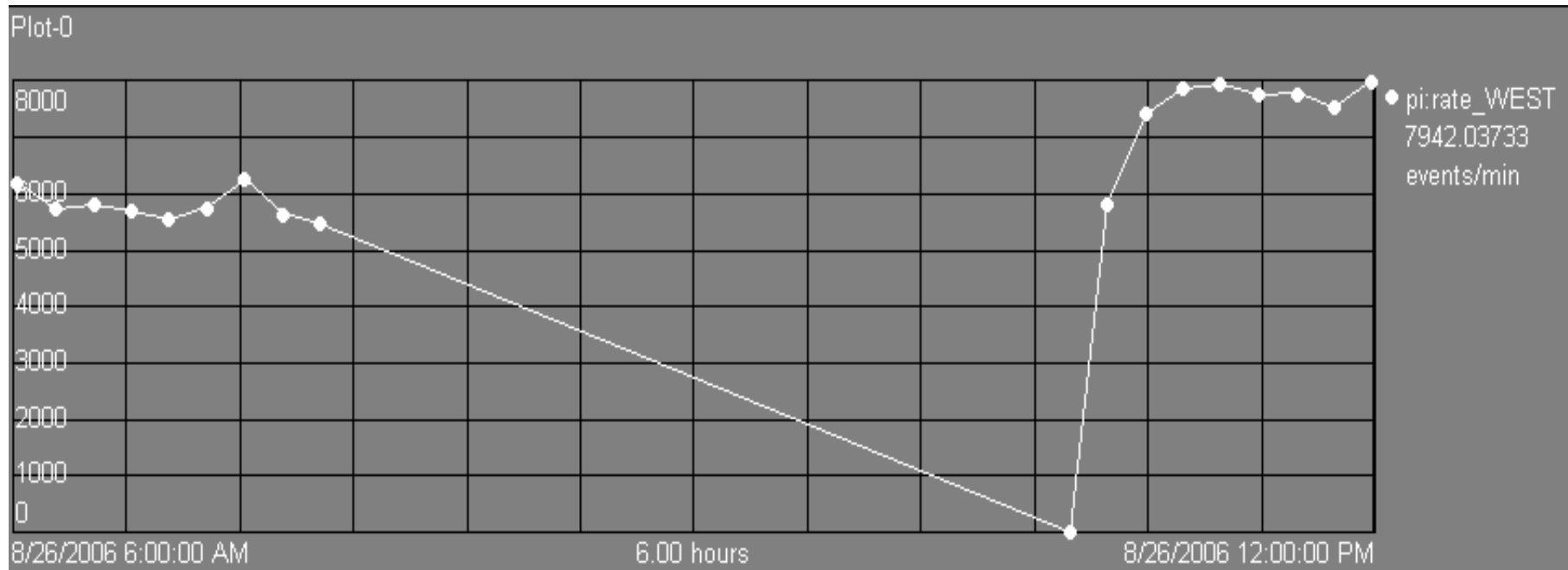
ROLLING

BLOCKWISE

# The Challenge

*So much data, So little time...*

- Larger systems
- Data Overload
- How can we mine the data for information?



# Advanced Pattern Recognition (APR) Modeling (Partner products using the PI System)

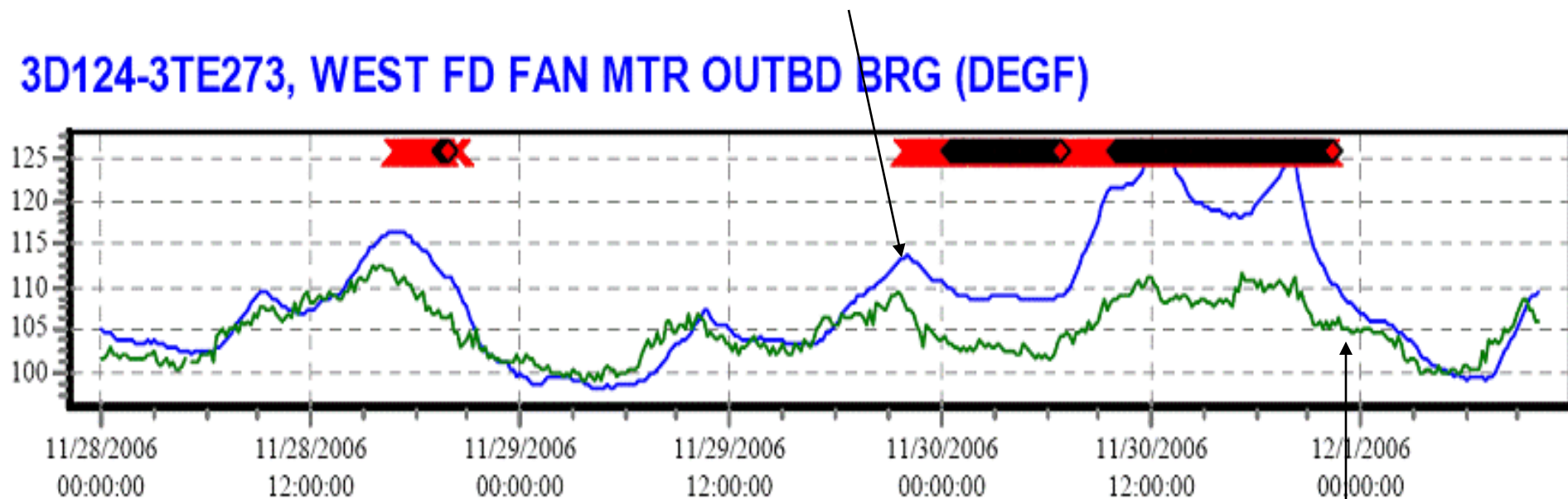
Predictive Analytics leverages the PI system

- *Computers working for you!*
- Reduces Manual Monitoring
- Detects anomalies on critical equipment and systems
- Early detection of slow developing failure
- Multiple sensor models, not just a single signal
  - Avoiding failures
  - Supporting Operations
  - Optimizing Maintenance

*Rules based monitoring of critical systems.  
Computer models watching the data all the time*

# Fan Motor Bearing

Temperature movement on FD Fan Motor outboard bearing (about 17 degrees above expected currently).



After detection, the filters were found dirty, replaced, and the real time oil level and temps are dropping back to the model expected value.



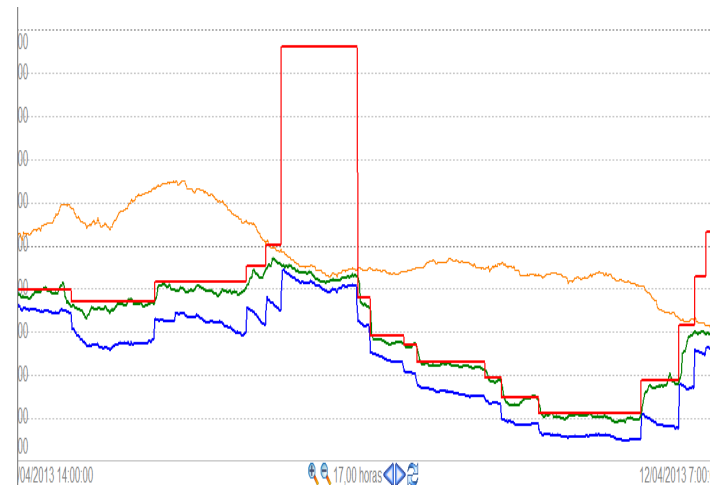
# PI System usage to improve Curtailment Strategies

*“... Along this month generation has been increased in more than 50 GWh, which would not have been generated if we had followed the former curtailment strategies.”*

*“This means an important benefit to our company. And also a few other facts such as less mechanical wear of our turbines, less urgent works on site, ... which are more difficult to quantify”*

**Gustavo Moreno**

CORE Manager



## Business Challenge

- Reduce inefficiencies
- To use aggregate real time data for real time decision making during curtailment issued by TSO

## Solution

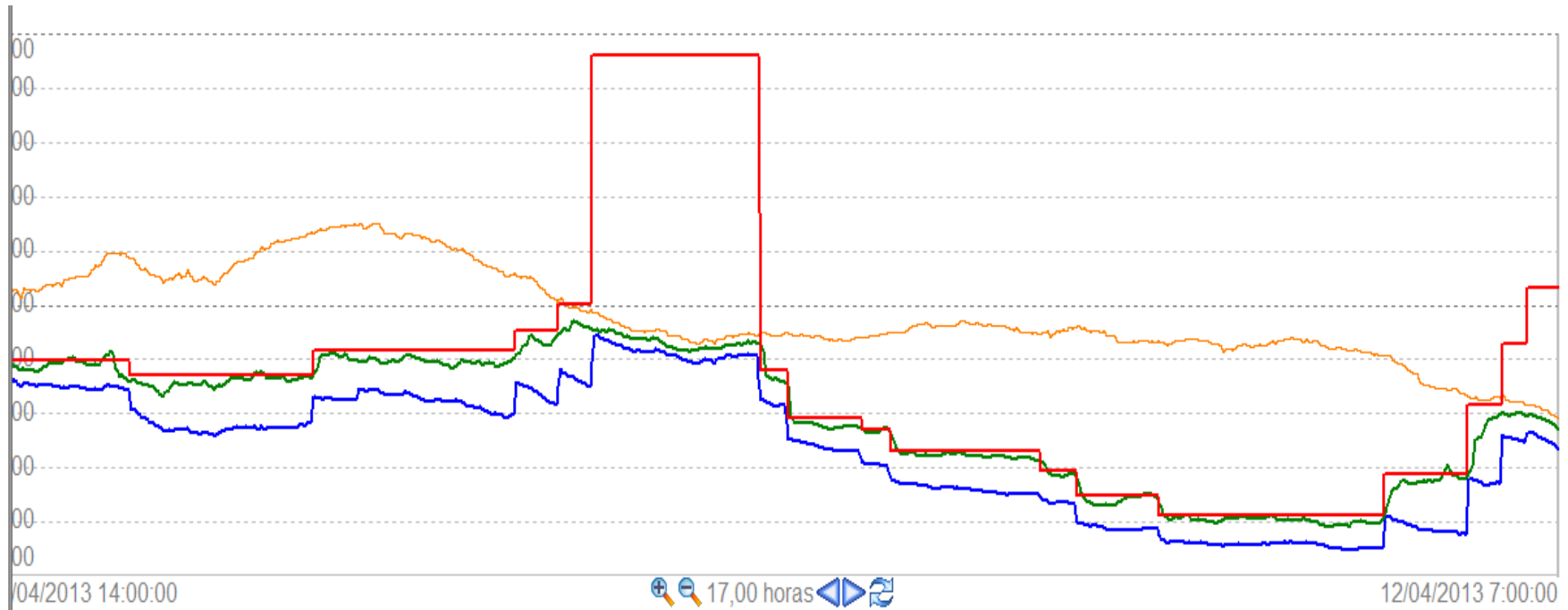
- PI AF training, design, planning and deployment
- CoE help with PI ACE deployment
- Calculated data inserted in PI Servers

## Results and Benefits

- Average increase in energy generation: 30% with peaks above 60%
- Other benefits not quantified yet



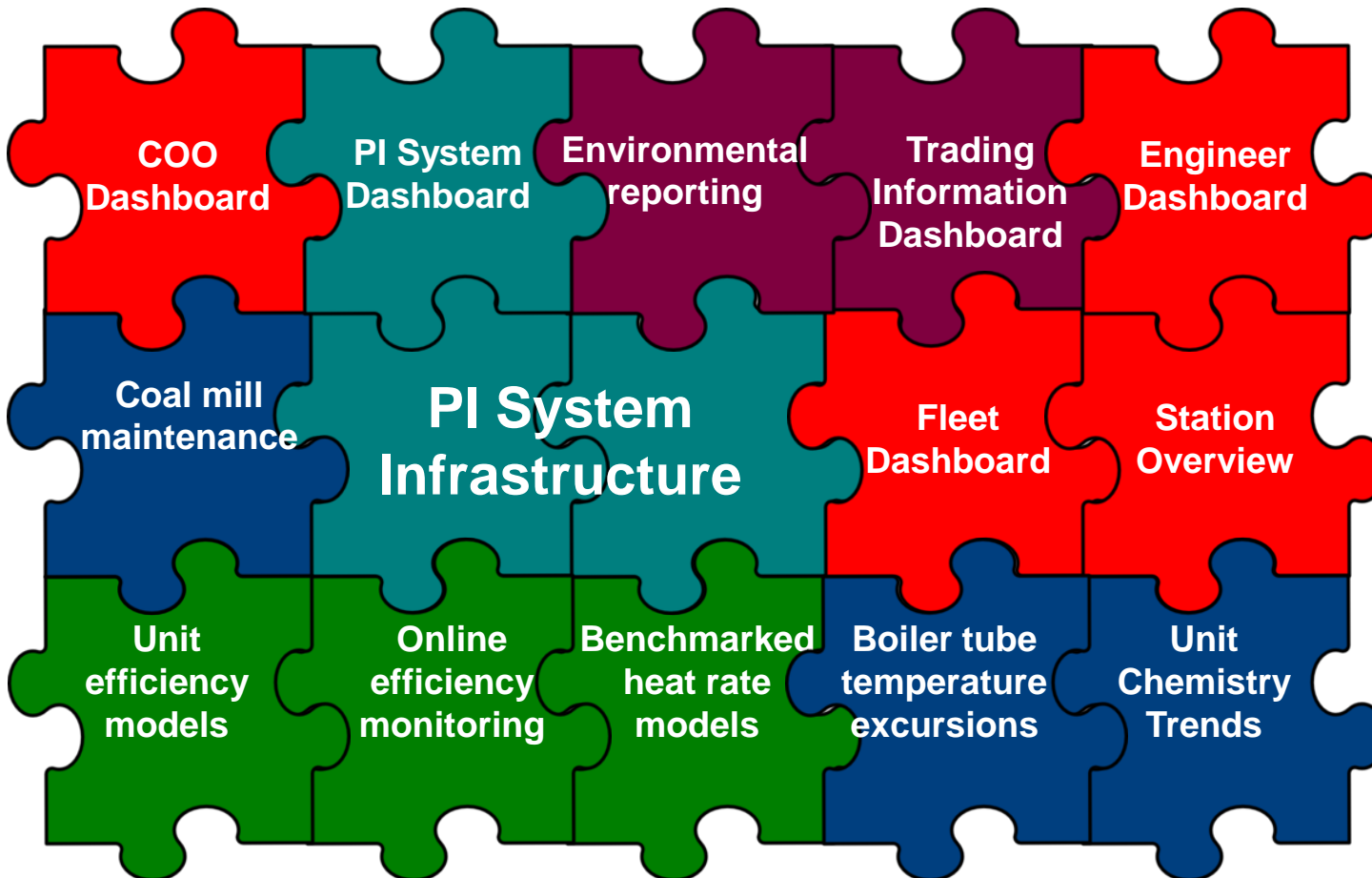
# CURRENTLY: Global Setpoint Curtailment



— Total setpoint    — Expected Power    — Estimated power with individual curtailment    — Total Actual Power

Average increase in energy generation: 30% with peaks above 60%

# Business Transformation - Benefits



Capability Development

PI System Infrastructure  
& data feeds

Integration with Intranet,  
create awareness

Explore expert systems:

- Performance Optimisation
- Asset use optimisation, predictive monitoring

Relate other data sources:

- Advanced analysis & process tuning



# Business Case – 12 months later

► Bu

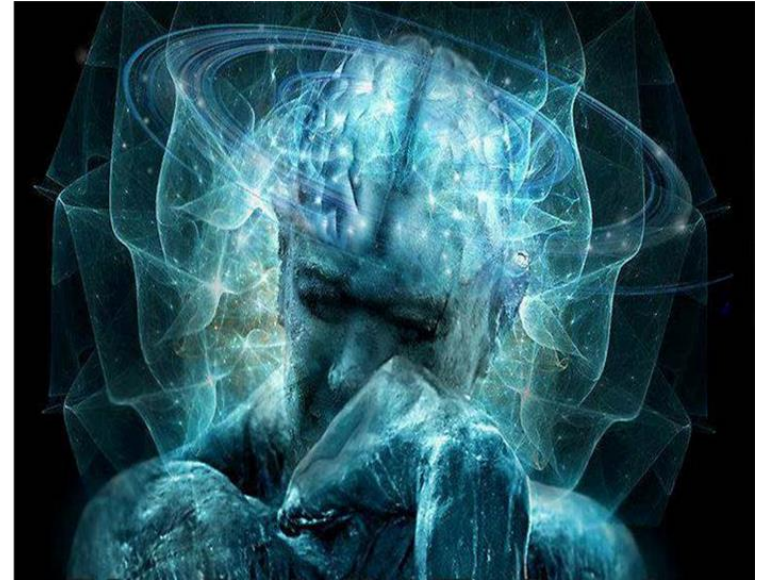
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# OSIsoft “Power Of Data”

- All data in real-time with context and history
- Decision Making is:
  - Faster
  - More Accurate and Complete
  - More Effective
- Preserve and expand knowledge
- Enable situational awareness and predictability
- Increase speed of execution
- Cultivate and leverage the collective “mind” power of the organization

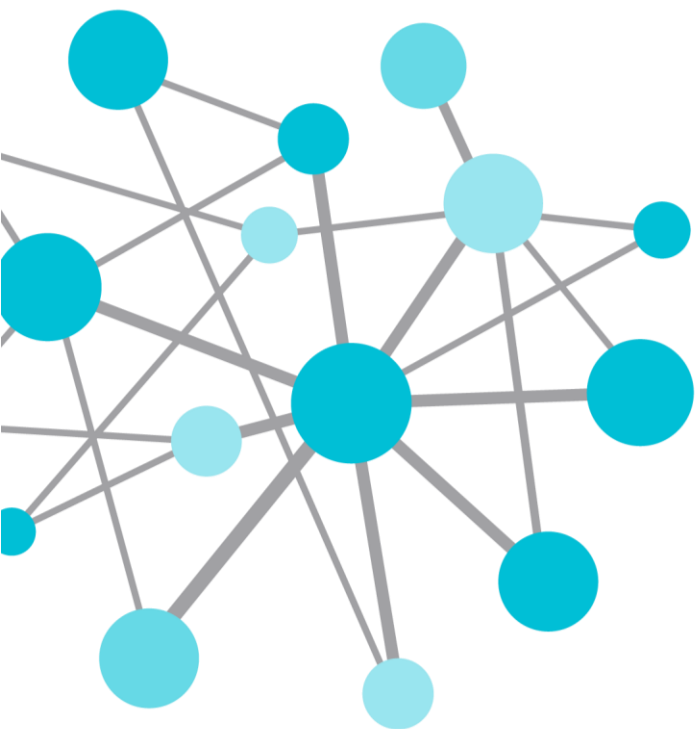


# Please contact us for more information

## Thank you for your attention

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