



OSIsoft®  
**REGIONAL**  
**SEMINARS** 2012  
The **Power** of **Data**



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# REGIONAL SEMINAR 2012

U · S · A

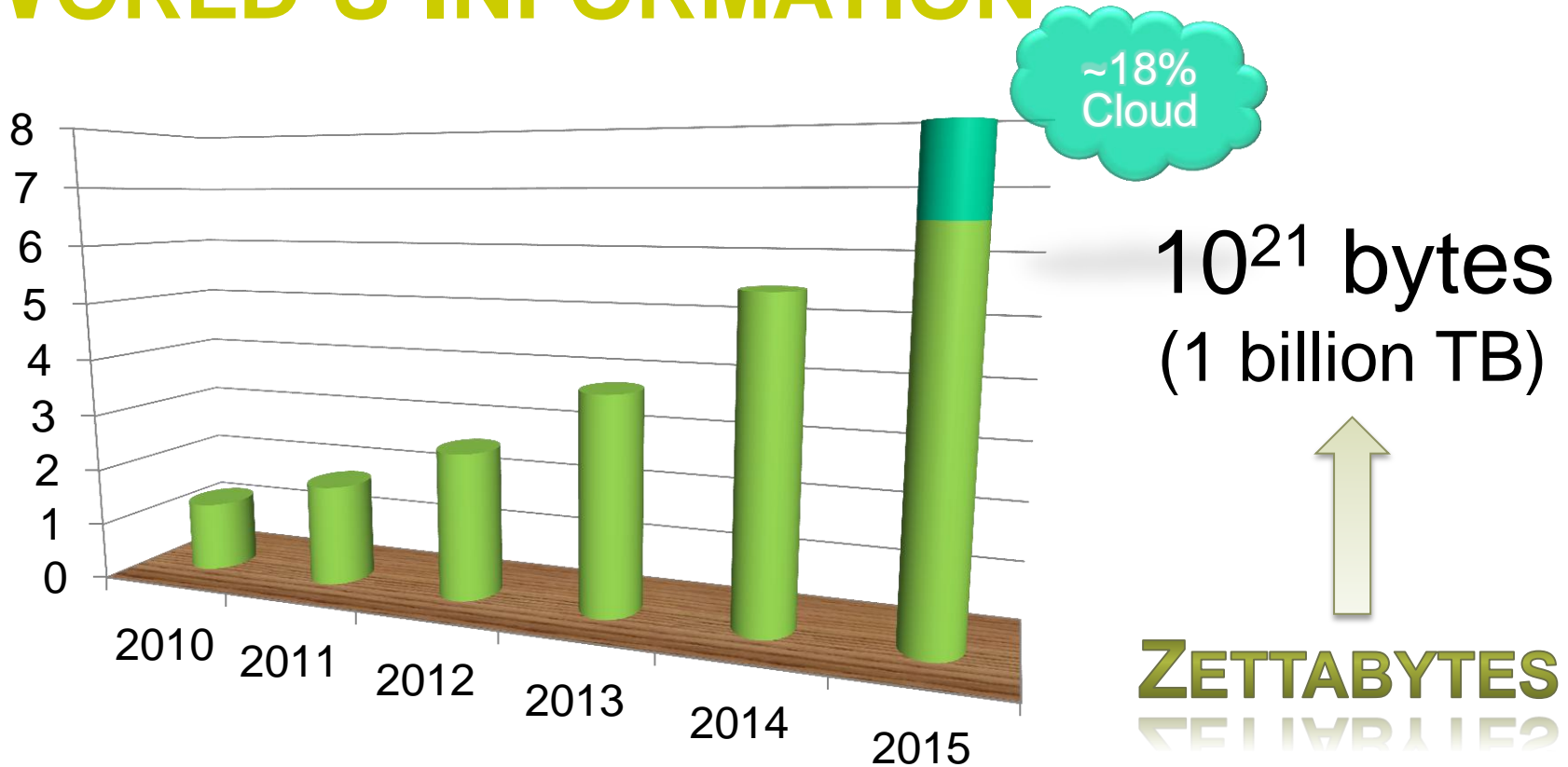
The **Power** of **Data**



# Infrastructure for Streaming Data and Events: The PI System

Presented by

# WORLD'S INFORMATION



Source: <http://www.emc.com/leadership/programs/digital-universe.htm>

# Characteristics of Big Data

Volume



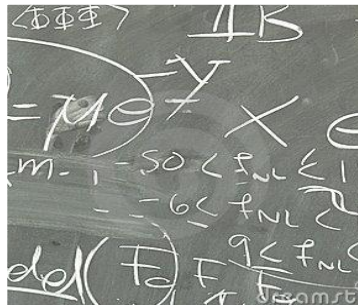
Velocity



Diversity



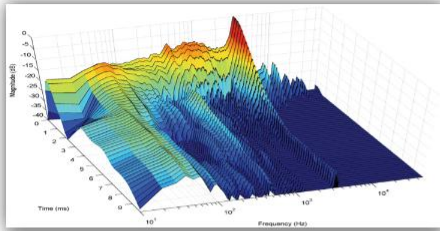
Analytics



Structure



# PI SERVER 2012



## Syncro Phasors

4.8K data streams, 120Hz  
3 years online  
Unique Events: 55 Trillion  
Estimated Data: 430TB

430TB



## Data Center

100K cells, 2M breakers  
10 years online  
Unique Events: 105 Trillion  
Estimated Data: 840TB

840TB



## Automated Metering

20M meters, 5-min reads  
7 years online  
Unique Events: 177 Trillion  
Estimated Data: 1,410TB

1,410  
TB



## Fleet Monitoring

1K assets, 1M points  
10 years online  
Unique Events: 6,307 Tr  
Estimated Data: 50,460TB

50,460  
TB





# PI System as Infrastructure

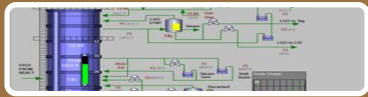
# Capabilities of the PI System



**Acquire – Collect streaming data and events**



**Historize – Store at resolution of acquisition and trend on demand**



**Present – Visualize pre-built and ad hoc displays or reports**



**Analyze – Process data including simple to complex calculations**



**Organize – Structure data and events based on assets**



**Monitor – Trigger and notify on events**



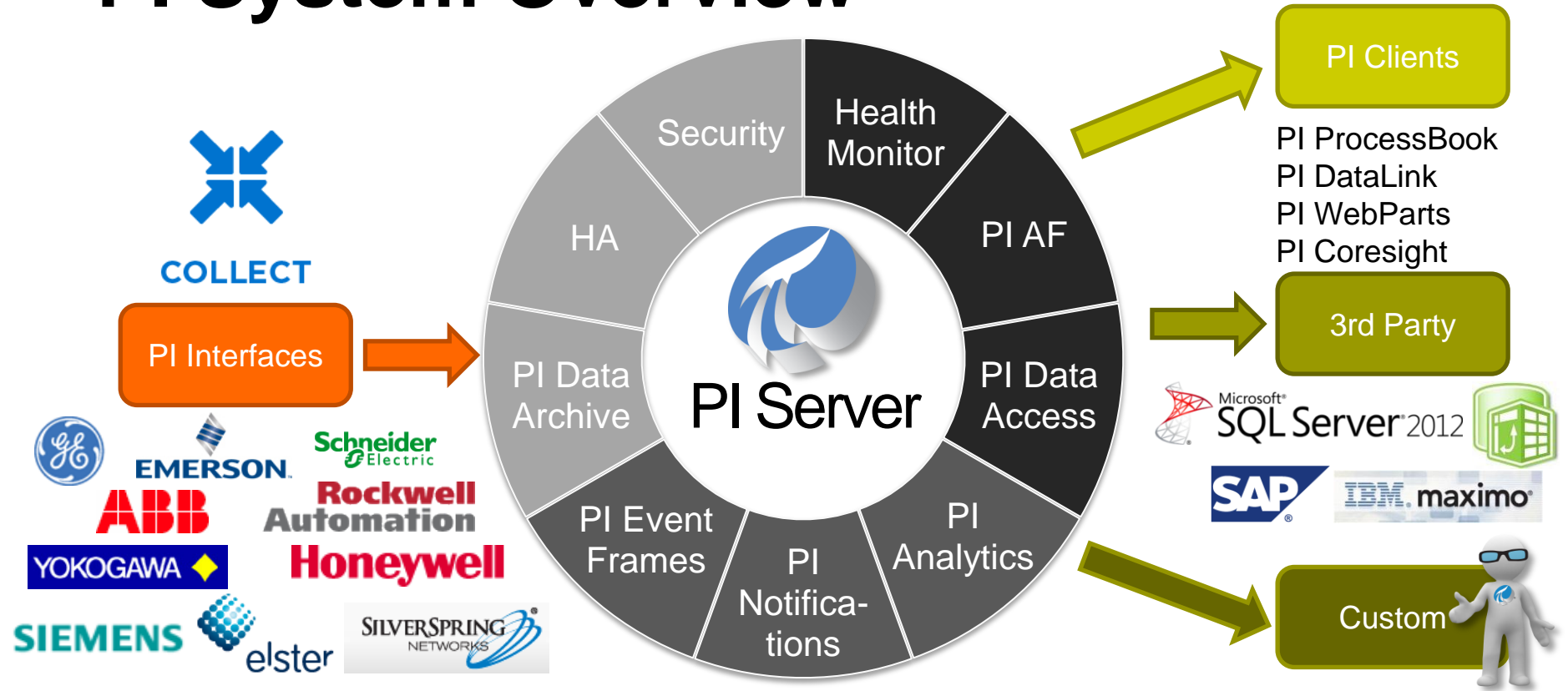
**Integrate – Exchange data with external systems**



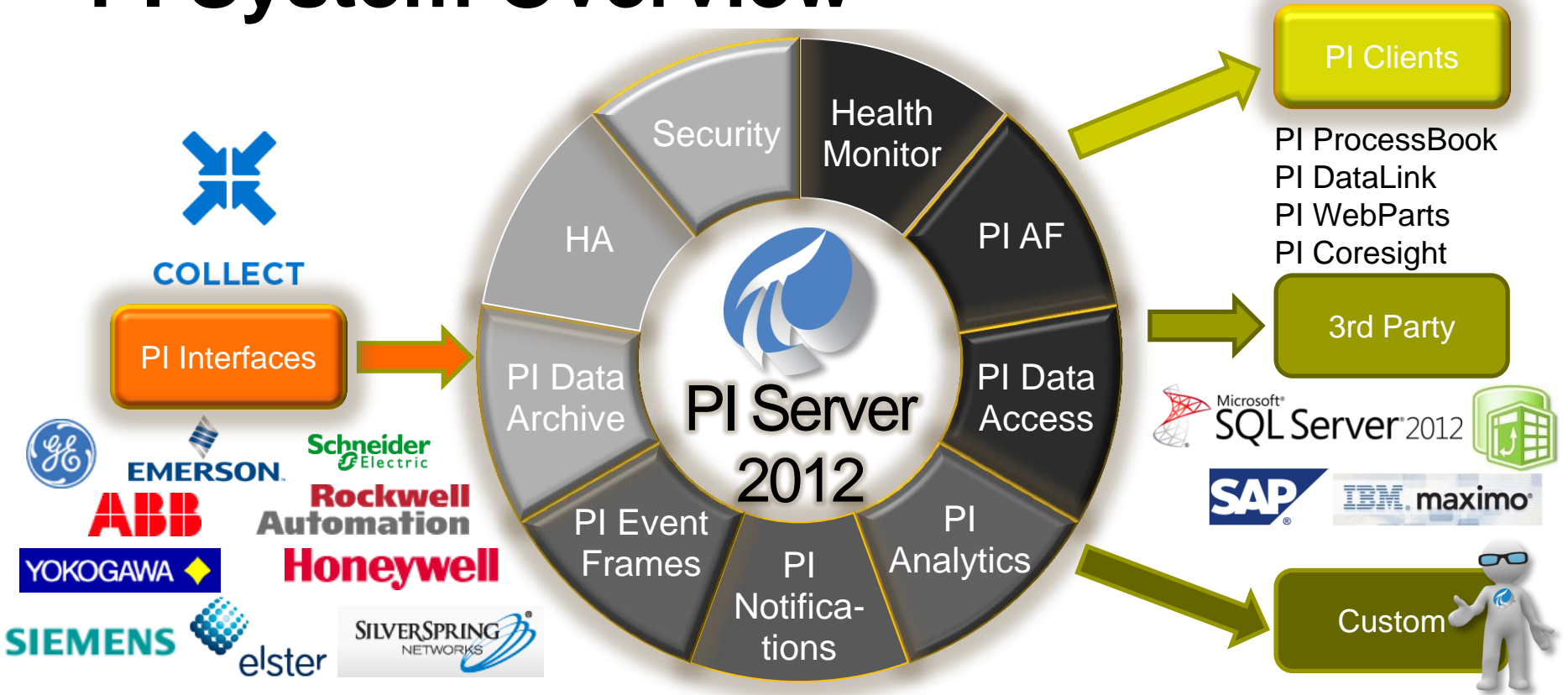
# INTRINSIC VALUES OF THE PI SYSTEM INFRASTRUCTURE



# PI System Overview



# PI System Overview





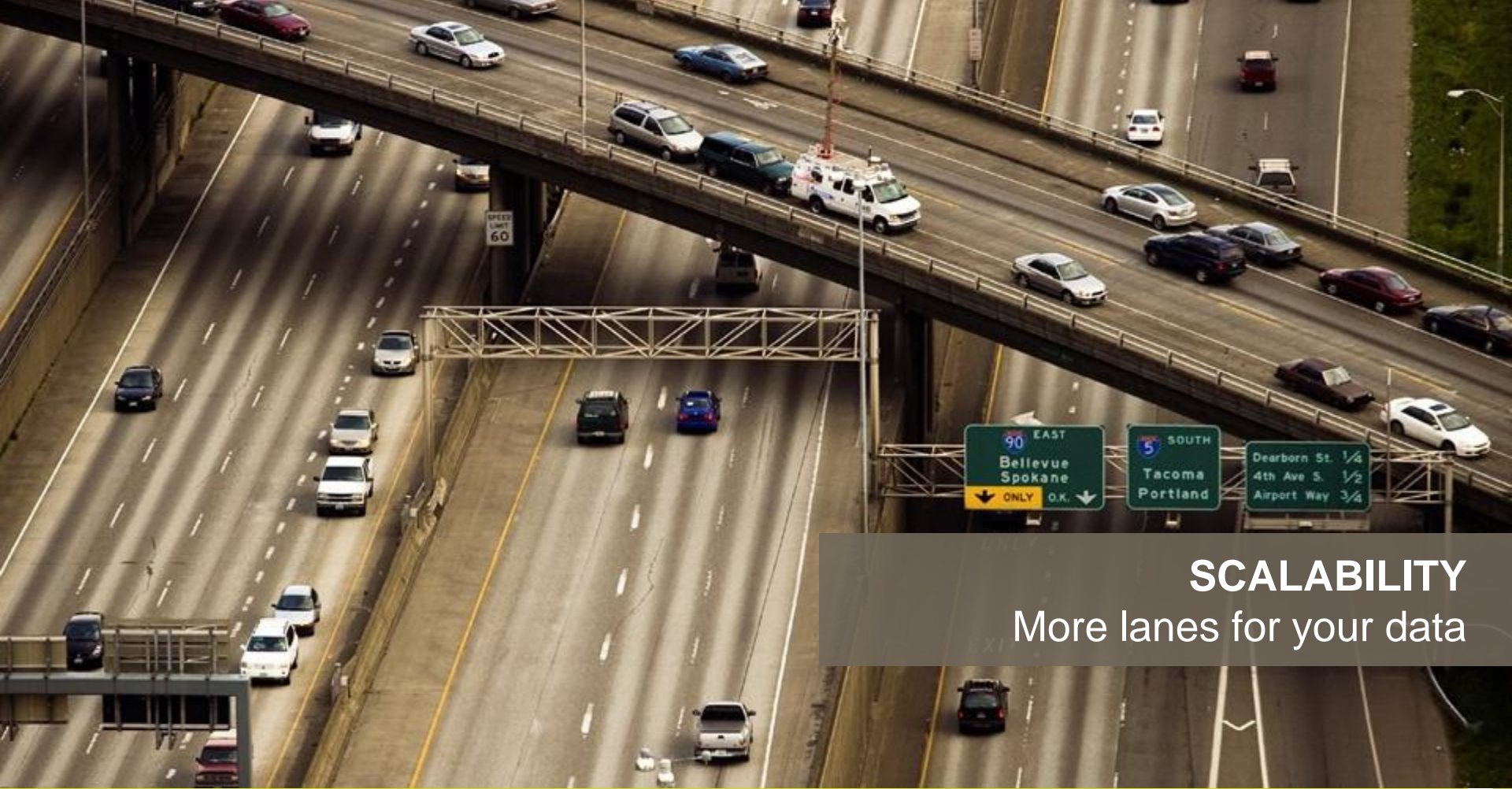
# PI Data Archive



**INFRASTRUCTURE**  
Highway for your data







**SCALABILITY**  
More lanes for your data





**PERFORMANCE**  
Move your data faster





**RELIABILITY**  
Most stable system for your data







**MANAGEABILITY**  
Bring all your data online





**SECURITY**  
Better protection for your data





# PI Asset Framework

# A Complete Picture of Your Asset

## Real-time Values

- Inlet pressure
- Inlet flow
- Ambient temperature

## Asset Details

- Name
- Make
- Model

## External Databases

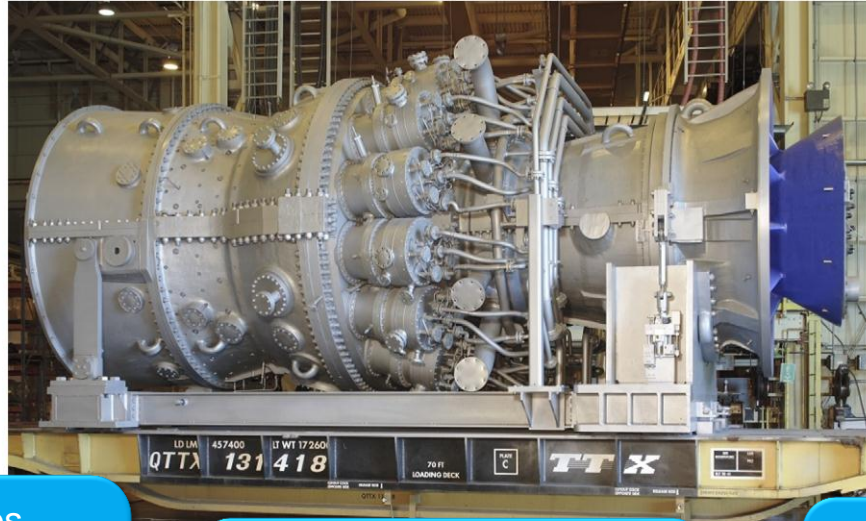
- Performance curves
- Last service date
- Design documents
- Inspection best practice

## Calculations

- Performance calculations
- KPI's

## Business Events

- Downtime
- Startup
- Excursions



## Real-time Values

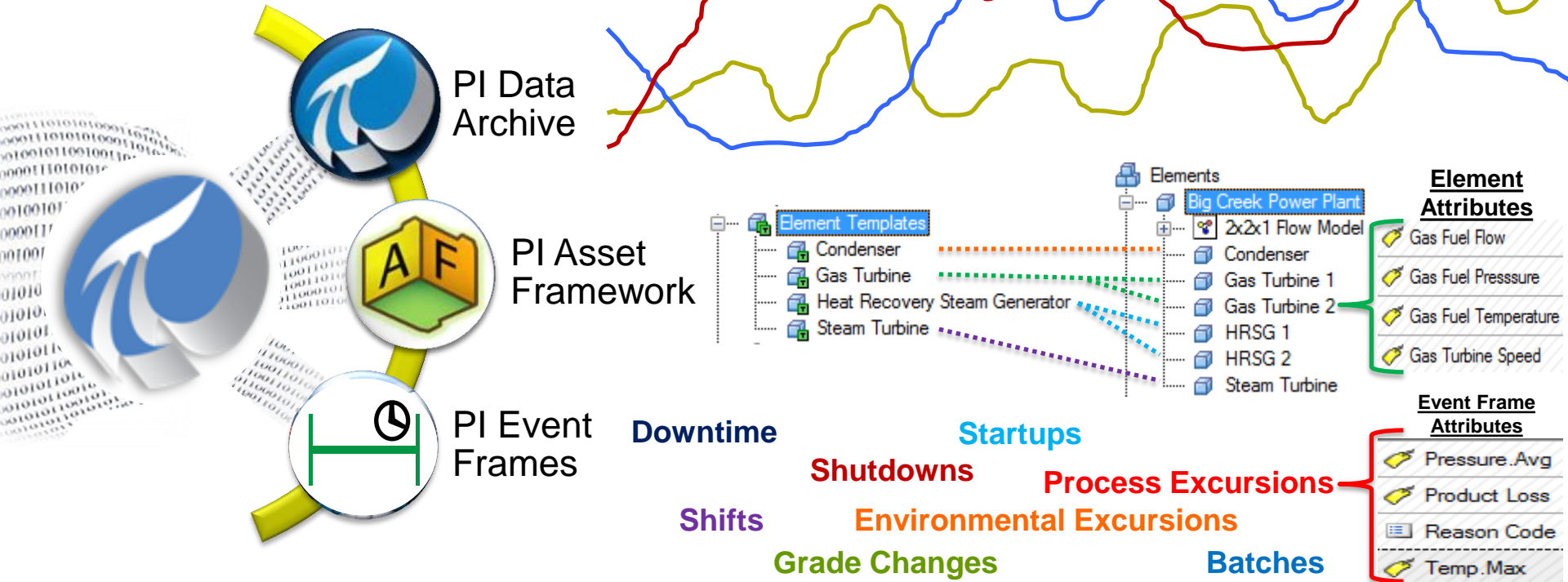
- Exhaust temperature
- Exhaust flow
- Measured MW output

## Notifications

- Performance excursions
- Temperature difference
- High temperature



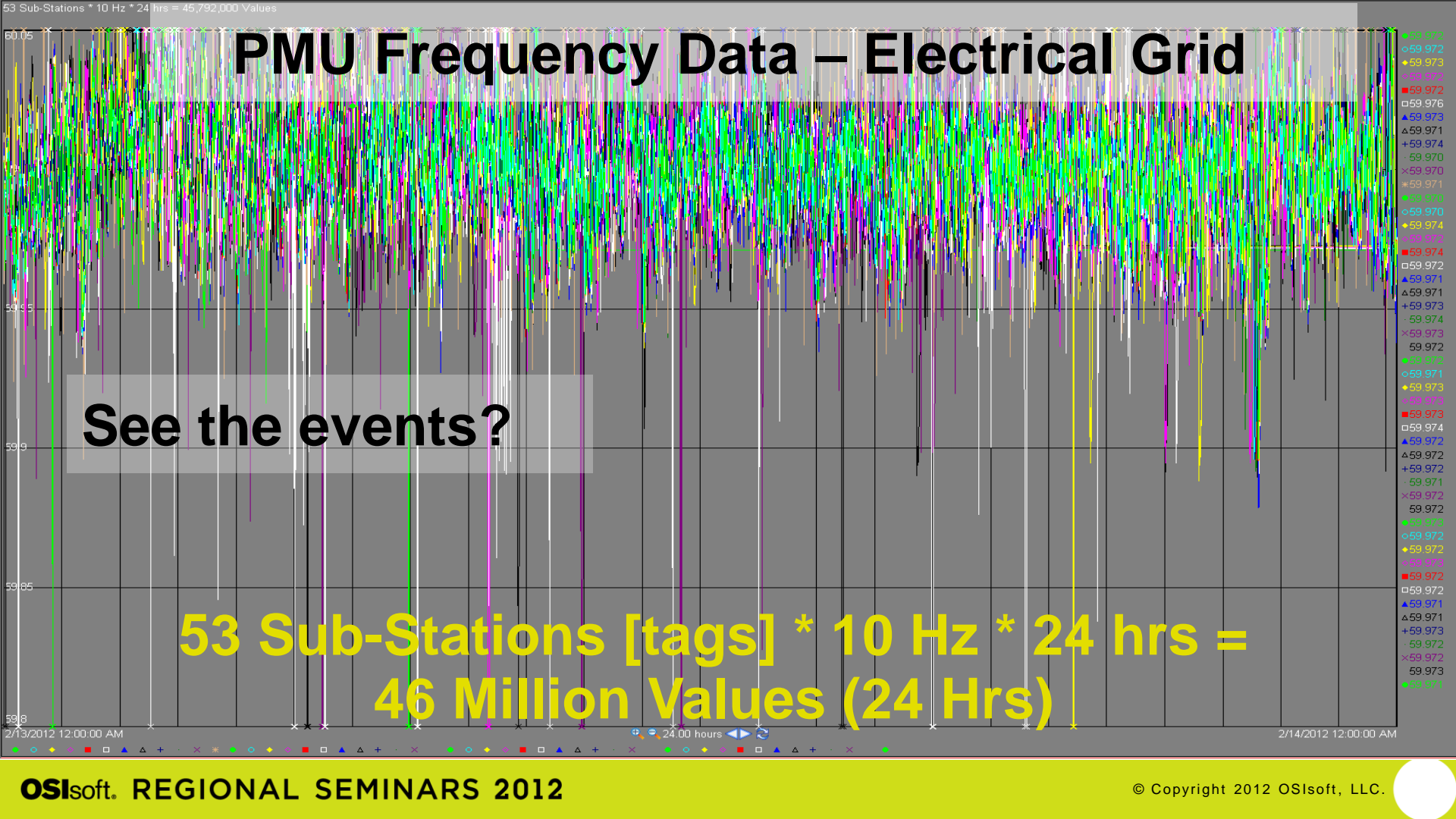
# How does the PI Server enable insight?





# PI Event Frames

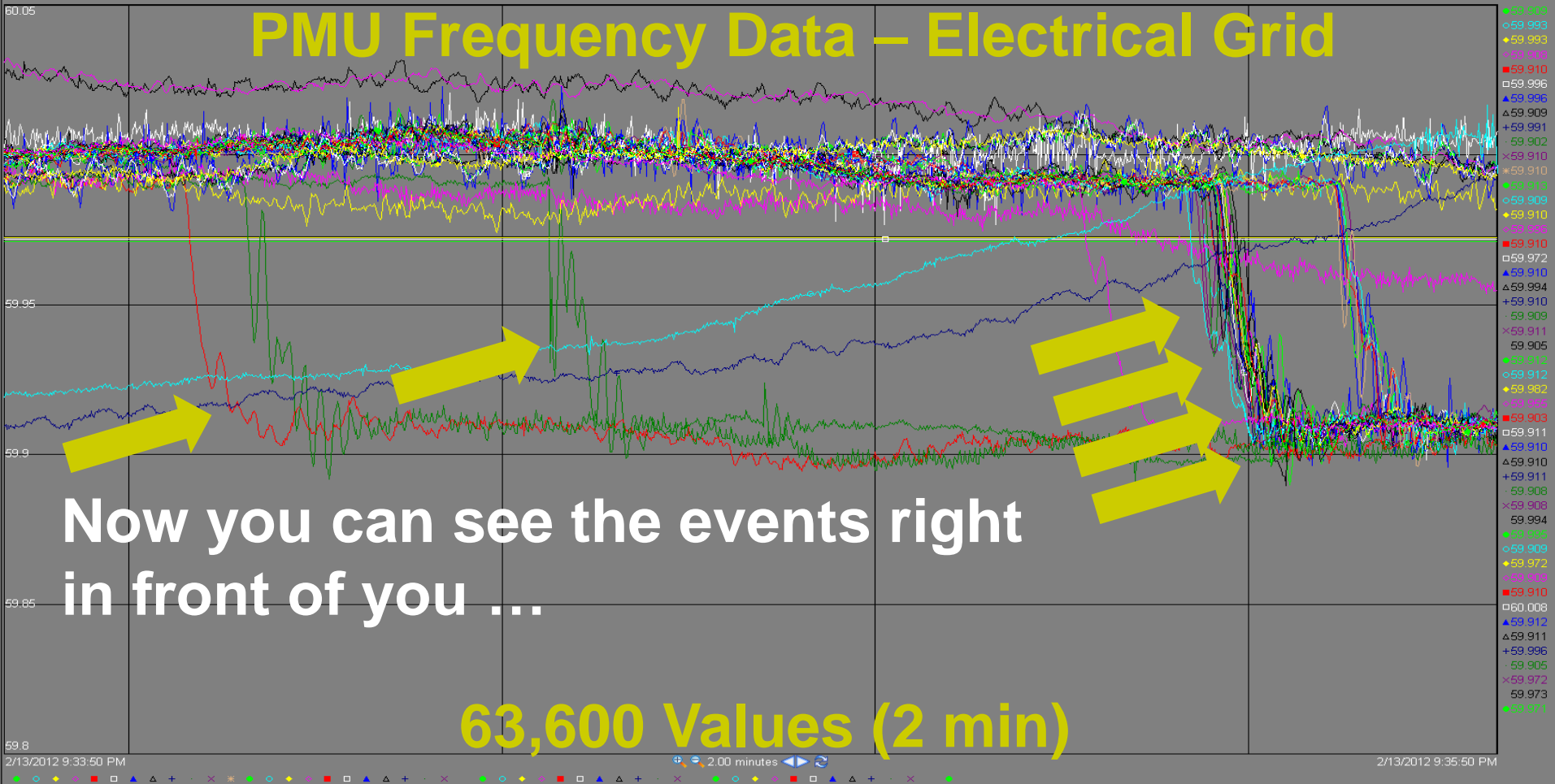
# PMU Frequency Data – Electrical Grid



See the events?

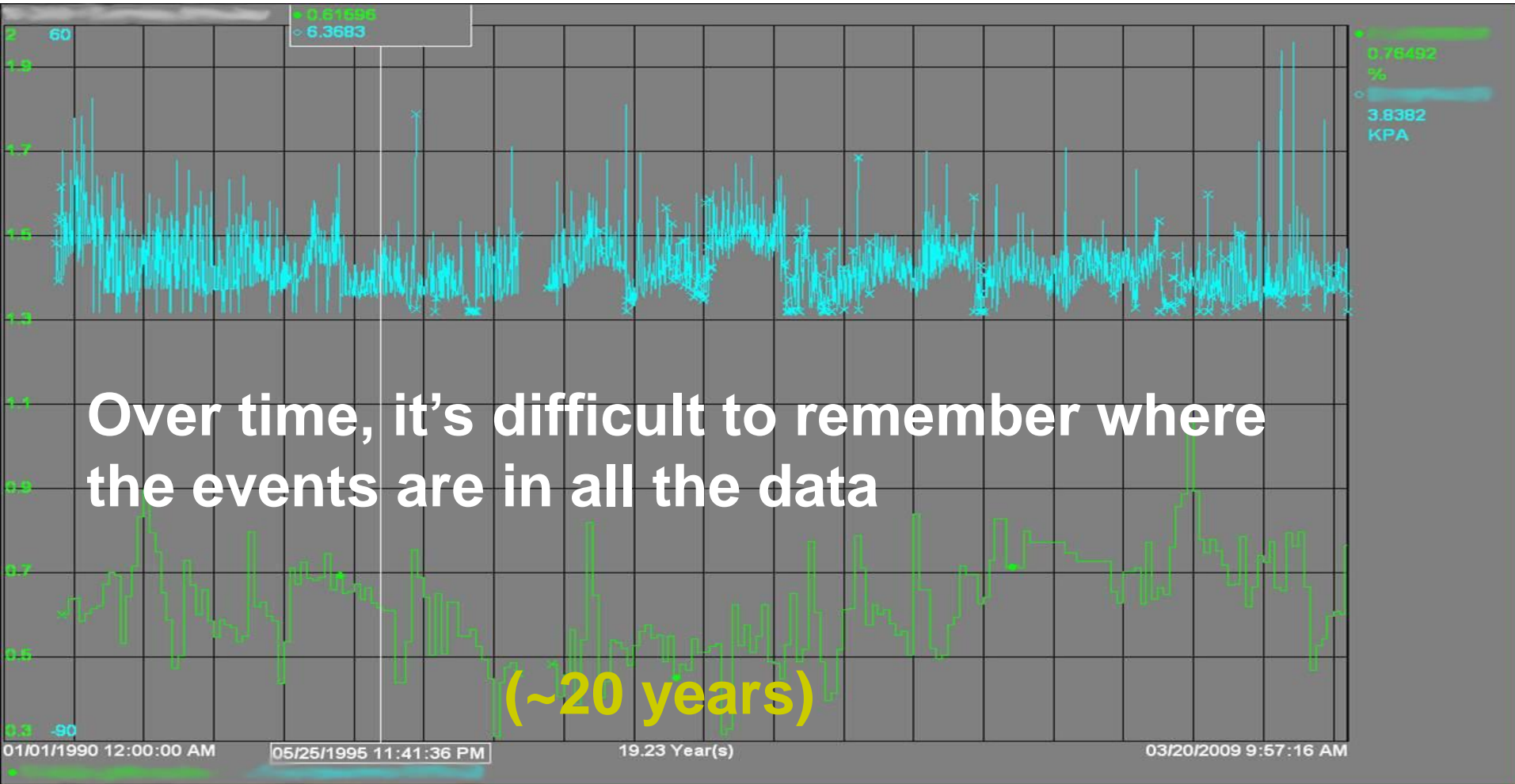
53 Sub-Stations [tags] \* 10 Hz \* 24 hrs =  
46 Million Values (24 Hrs)

# PMU Frequency Data – Electrical Grid



Now you can see the events right in front of you ...

63,600 Values (2 min)



Over time, it's difficult to remember where the events are in all the data






When was the last time a downtime event occurred?



What happened in the batch with the highest yield ever?

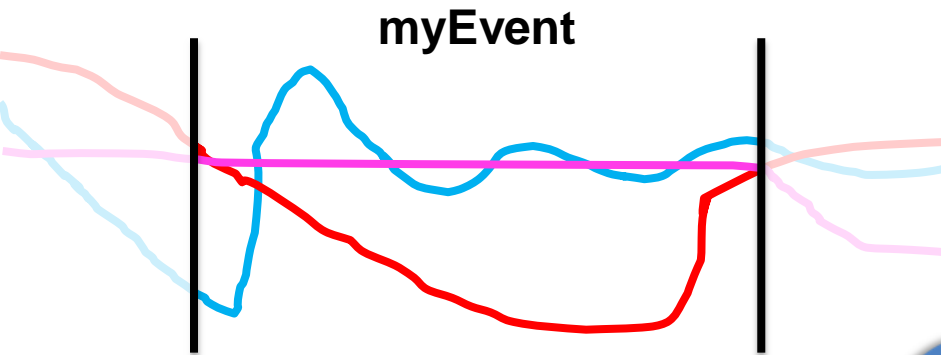




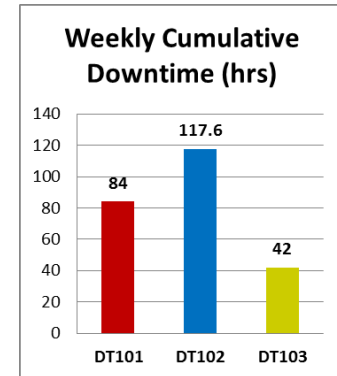
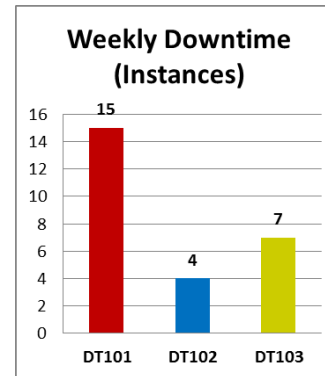
A man is sitting at a table in a restaurant or bar, looking down at two laptops. The table has several glasses and plates. In the background, there is a large, cylindrical, stainless steel wood-burning stove with a fire inside. The room is dimly lit with warm lights, and there are other tables and chairs visible. A large window on the left shows the interior of the restaurant.

What was the root cause for  
the \$200,000 process  
excursion event?

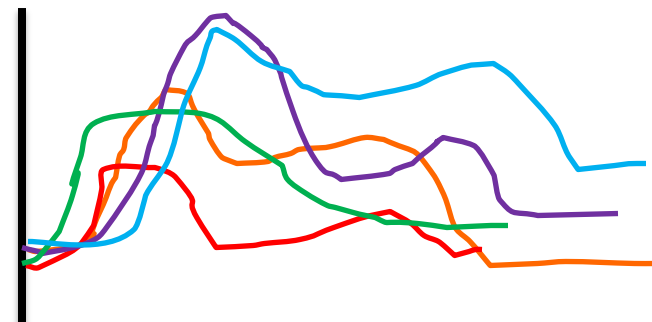
# Simplify Data Analysis



# Perform Asset Comparisons



## Event Overlay Trend

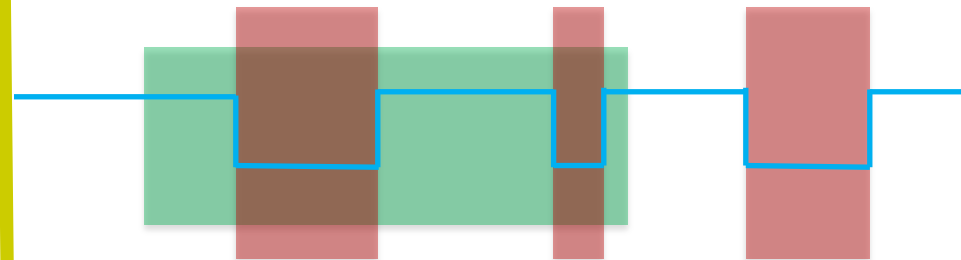


| Name | Temp.Max |
|------|----------|
| EF1  | 122.47   |
| EF2  | 109.34   |
| EF3  | 112.73   |
| EF4  | 98.61    |
| EF5  | 125.24   |



## Downtime Events

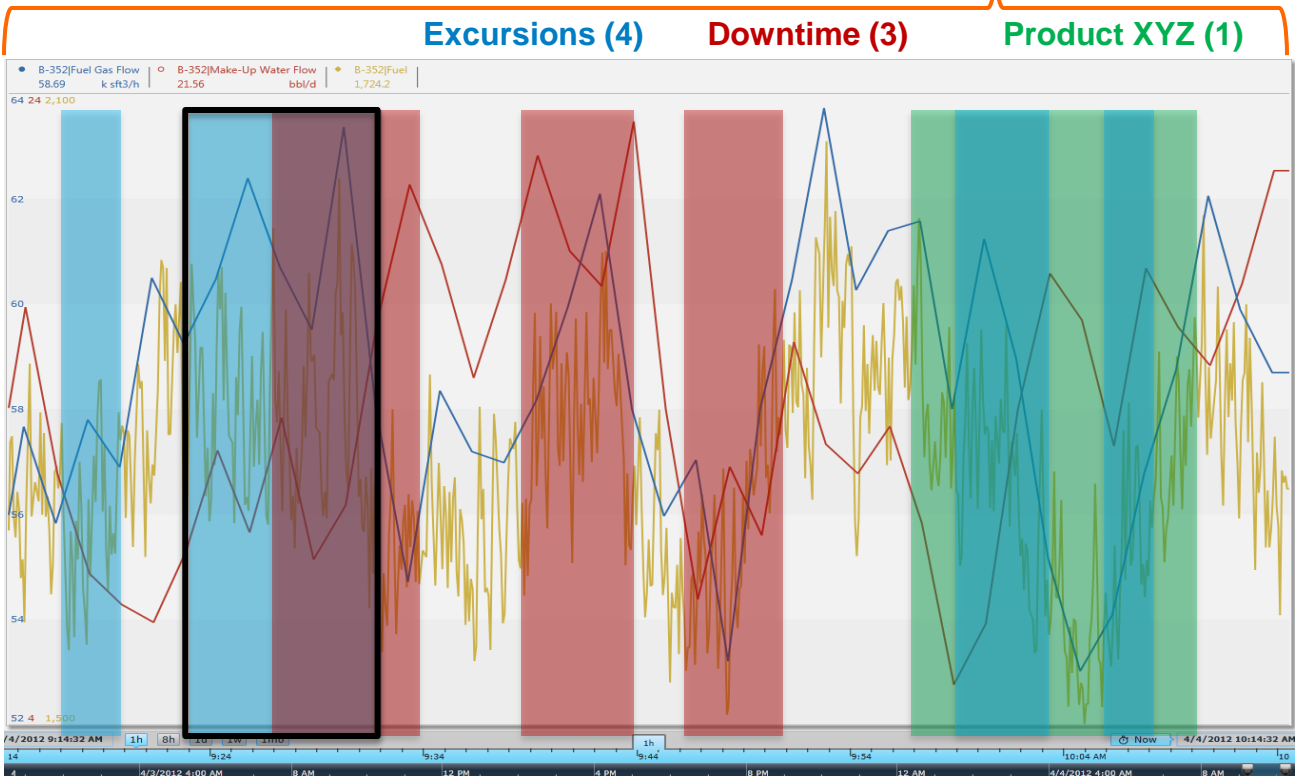
Product XYZ (1)  
Downtime (2)



# Perform Event Comparisons

# Discover Event Interrelationships

# PI Event Frames = events + related data





| Event Attribute   | Value                |
|-------------------|----------------------|
| Name              | Ex 20121215-0002     |
| Start             | 15-Dec-2012 10:35:02 |
| End               | 15-Dec-2012 10:47:26 |
| Duration          | 12 min, 24 sec       |
| Asset             | Boiler-459           |
| Excursion Type    | High Violation       |
| Fuel Gas Flow.Avg | 37.12 k sft3/h       |
| Fuel.Start        | 823.48 k sft3/ton    |
| myPIKPI.Max       | 47.19 bbl/d          |




# PI Analytics

# PI Analytics – Streaming calculations

## Have

|   |                    |
|---|--------------------|
| Category: Temperature   |                    |
|  | Casing Temperature |
| Category: Operation   |                    |
|  | Power Draw         |

## Need

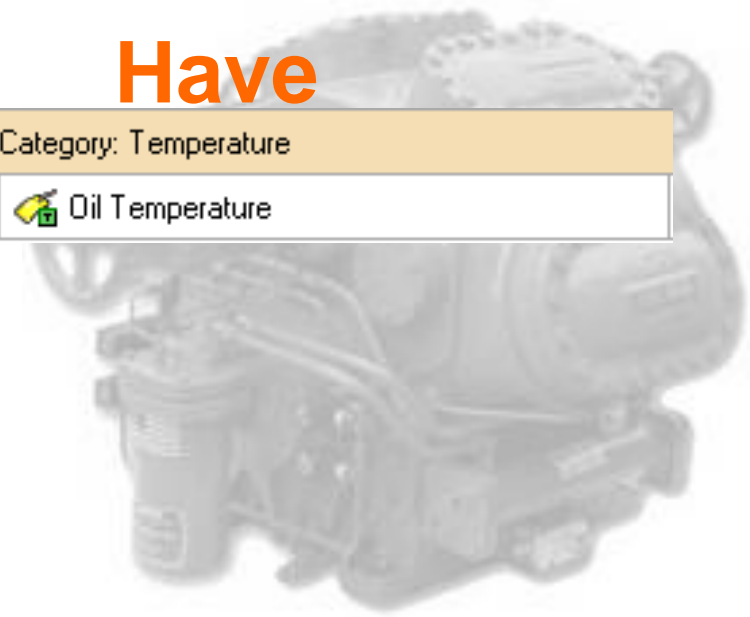
|   |                     |
|---|---------------------|
| Category: Calculation   |                     |
|  | Cooling Power Ratio |


“What is the hourly temperature average per total power draw that hour?”




# PI Analytics – Compare asset performance

## Have



|   |                 |
|---|-----------------|
| Category: Temperature   |                 |
|  | Oil Temperature |

## Need

|   |                                |
|---|--------------------------------|
| Category: Calculation   |                                |
|  | Oil Temperature Rate of Change |

“How fast is this thing heating up?”

# PI Analytics – Choose the best for you

## Configure

- PI AF Formula Data Reference
- PI AF Point Data Reference summary
- PI Client calculations

- PI Performance Equations
- PI Totalizers
- PI Statistical Quality Control (SQC)

## Programmatic

- PI Advanced Computing Engine (PI ACE)

On-demand

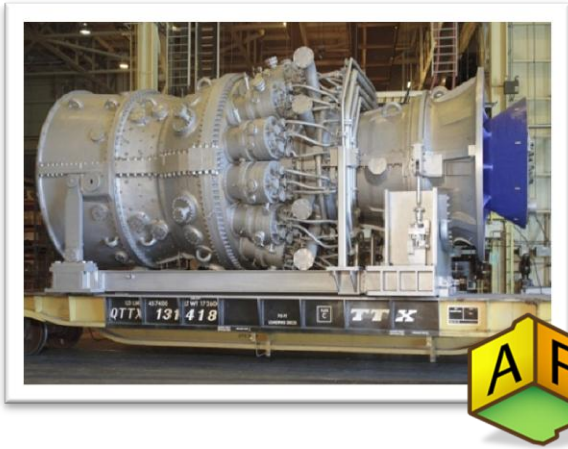
Schedule & Store



# PI Notifications & PI Data Access

# PI Notifications – keeps you informed of your assets

“One of the turbine’s exhaust thermocouples has been acting up... Let’s keep an eye on it and create a work order for maintenance if it fluctuates more than 5% in 5 seconds. Make sure Bob is notified of this also.”



DELIVER

A screenshot of an email notification and a mobile notification app interface. The email is from PINotAdmin to Mariana Sandin, with the subject 'Transformer TR0842 Load is in...'. It contains links for 'Instant PI WebParts Trend', 'Acknowledge With Comment', and 'Acknowledge'. Below the email is a table with details for the transformer load. To the right is a mobile notification app interface showing the same notification details, including the name 'Wild River Wind Farm', server 'DFPIAF', and triggering condition 'Load &gt; 22'. An orange arrow points from the 'DELIVER' text to these notification screens.

A globe icon with a smartphone in front of it, labeled 'Web Service', and a blue database icon with the 'SAP' logo. An orange arrow points from the notification screens to these icons.

# PI Data Access – Integrate your events



Time-Series Data

Assets

Events

**Big Creek Power Plant Summary Report**

| Event Type                         | Total Event Duration | In Minutes  | Event Count | Expected Duration |
|------------------------------------|----------------------|-------------|-------------|-------------------|
| GT Exhaust Gas Temperature Anomaly | 1,115:20:42          | 1,115:20:42 | 9           | 0                 |
| PowerPlantStartDrive               | 1:11:22:49           | 2122:47     | 40          | 2400              |
| PowerPlantStartUp                  | 1:45:20:39           | 1,075:06    | 41          | 2,220             |

| Asset Name            | Event Type                         | Total Event Duration | In Minutes | Event Count | Expected Duration |
|-----------------------|------------------------------------|----------------------|------------|-------------|-------------------|
| Big Creek Power Plant | PowerPlantStartDrive               | 1:11:22:49           | 2122       | 39          | 2340              |
| Big Creek Power Plant | PowerPlantStartUp                  | 1:45:20:39           | 1,075      | 40          | 1,800             |
| Gas Turbine 3         | GT Exhaust Gas Temperature Anomaly | 14:47:55             | 867        | 137513      | 23                |
| Gas Turbine 3         | GT Exhaust Gas Temperature Anomaly | 15:43:08             | 942        | 1,04958     | 9                 |

Web

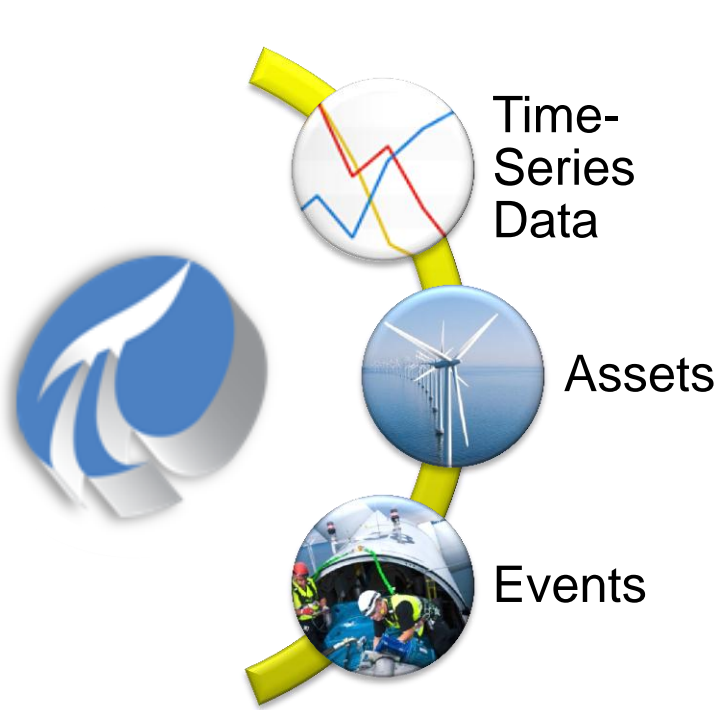






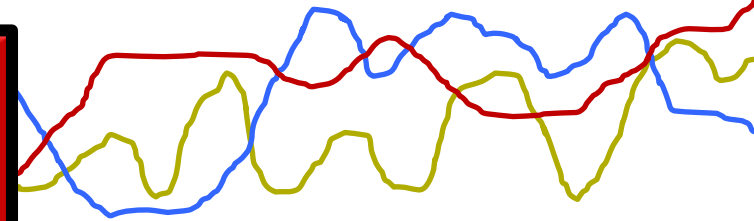
# PI Clients

# How does the PI Server enable insight?

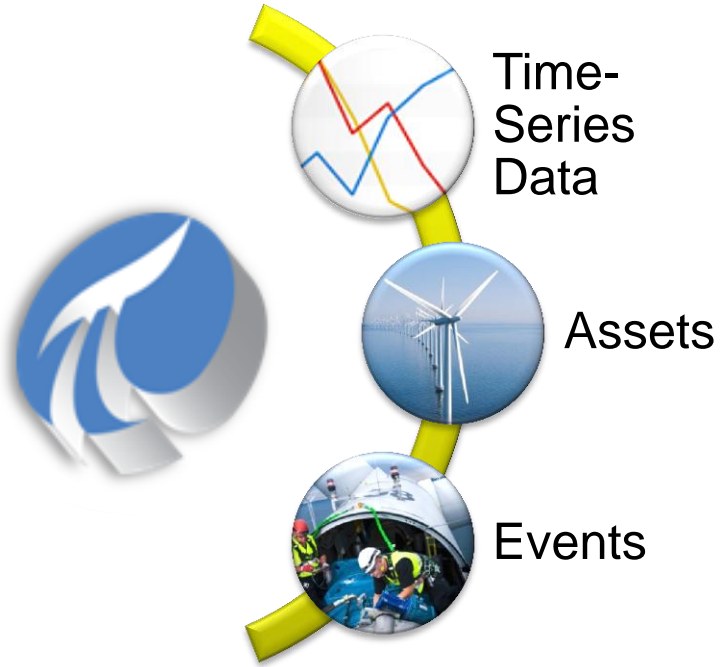


Store Full Data  
Fidelity

- Stores the raw data (not summaries)
- Enables ALL the possible analyses
- Don't miss critical information needed for analysis / reporting

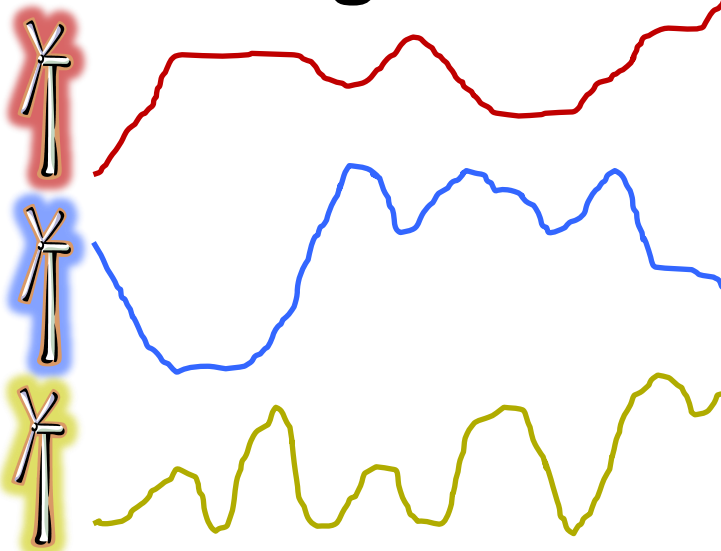


# How does the PI Server enable insight?



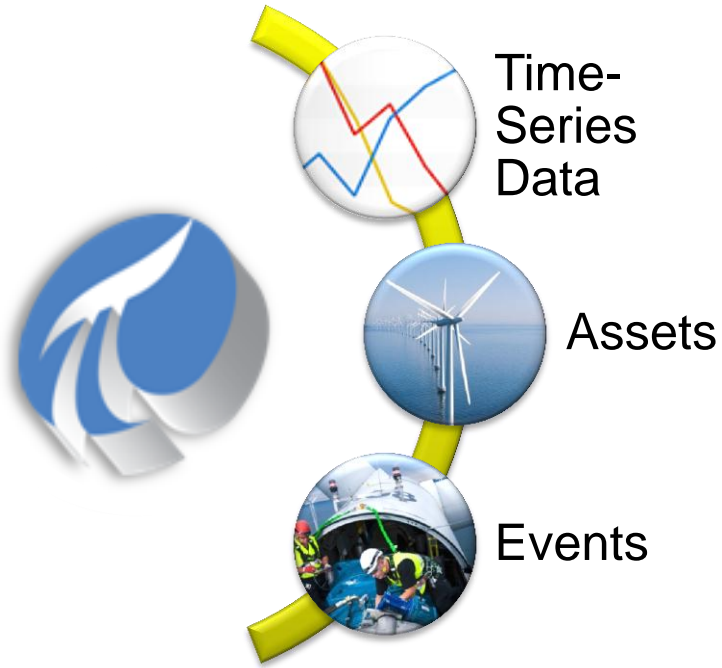
Store Full Data Fidelity

Perform Asset Comparisons



| Asset | Current | Day.Peak | Week.Total | Month.Avg |
|-------|---------|----------|------------|-----------|
| WT101 | 1.22 MW | 1.97 MW  | 13.32 MW   | 1.93 MW   |
| WT102 | 0.56 MW | 1.53 MW  | 15.56 MW   | 2.21 MW   |
| WT103 | 0.72 MW | 1.78 MW  | 9.34 MW    | 1.59 MW   |

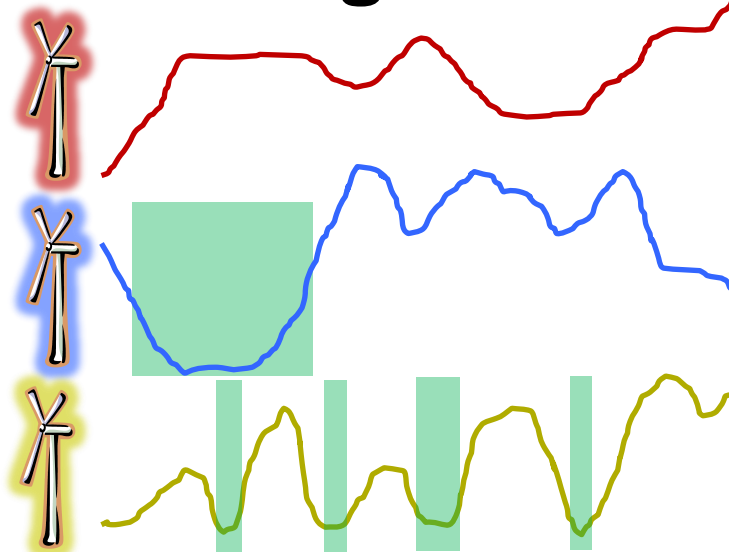
# How does the PI Server enable insight?



Store Full Data Fidelity

Perform Asset Comparisons

Perform Asset & Event Comparisons



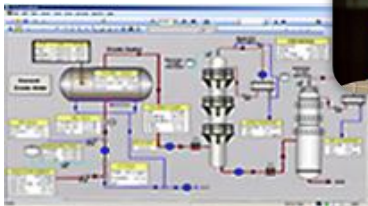
| Asset | # Downtime | Total Downtime |
|-------|------------|----------------|
| WT101 | 0          | 00:00:00       |
| WT102 | 1          | 08:21:23       |
| WT103 | 4          | 06:47:35       |

# Visualization Landscape

**PI Coresight:**  
*Ad Hoc Analysis & Collaboration*



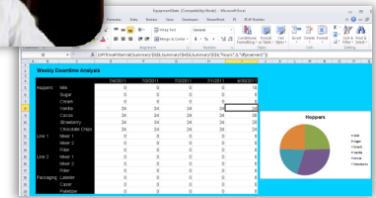
**PI WebParts:** Composite Apps, Shared broadly



**PI ProcessBook:**  
Display authoring and  
Process monitoring



**PI DataLink:**  
Reporting and table  
based analytics in  
Microsoft Excel





**Boiler-481**

\\DFPIA\OS\soft Enterprises CS

- [.]Wichita\Cracking Process
  - Boiler-352
  - Boiler-481
  - Pump-209
  - Pump-365
  - Pump-723
- [.]Houston\Cracking Process
  - Boiler-210
  - Boiler-235
  - Pump-214
  - Pump-456
  - Pump-560
- [.]Little Rock\Extruding Process
  - Boiler-045
  - Pump-077
  - Pump-447
  - Pump-724
- [.]Wichita\Distilling Process
  - Boiler-459
  - Pump-230
  - Pump-344
  - Pump-550
- [.]Little Rock\Distilling Process
  - Boiler-125

Search

**Related Assets (47)**

Cart

- DownTime
- Upset Boiler -481

Boiler-481|Burner  
**XG-40**

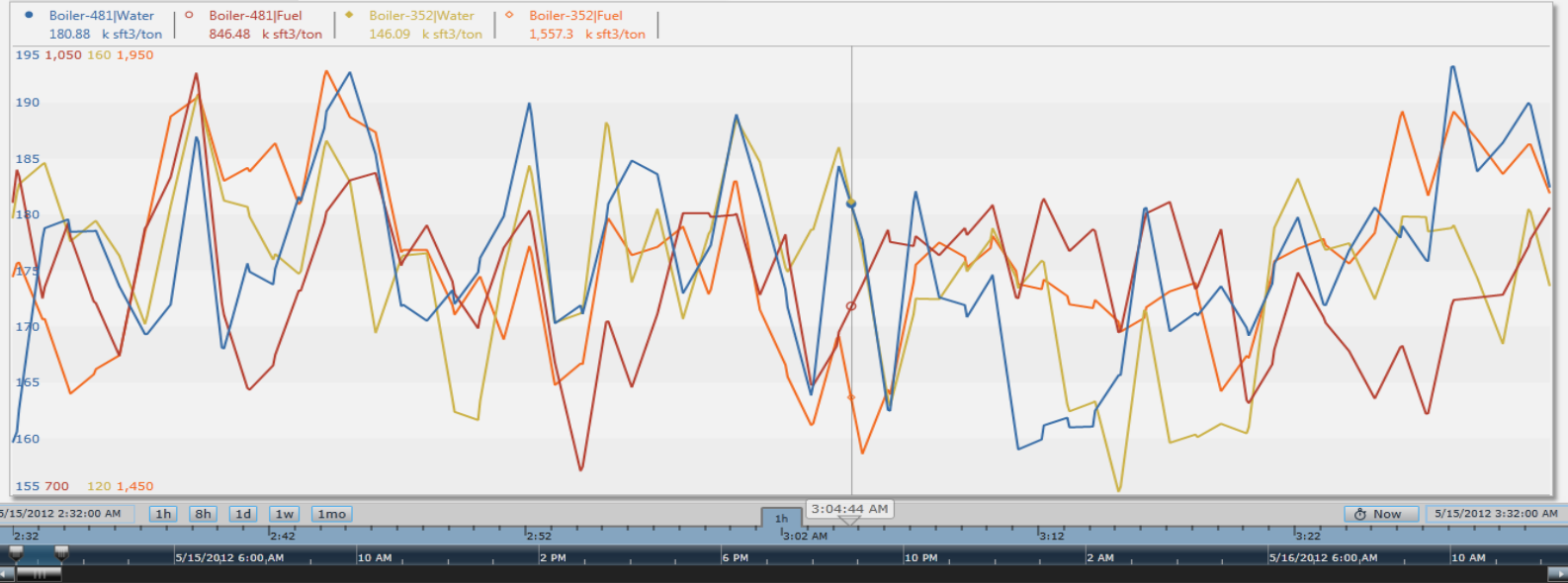
Boiler-4...nt State  
**Auto**

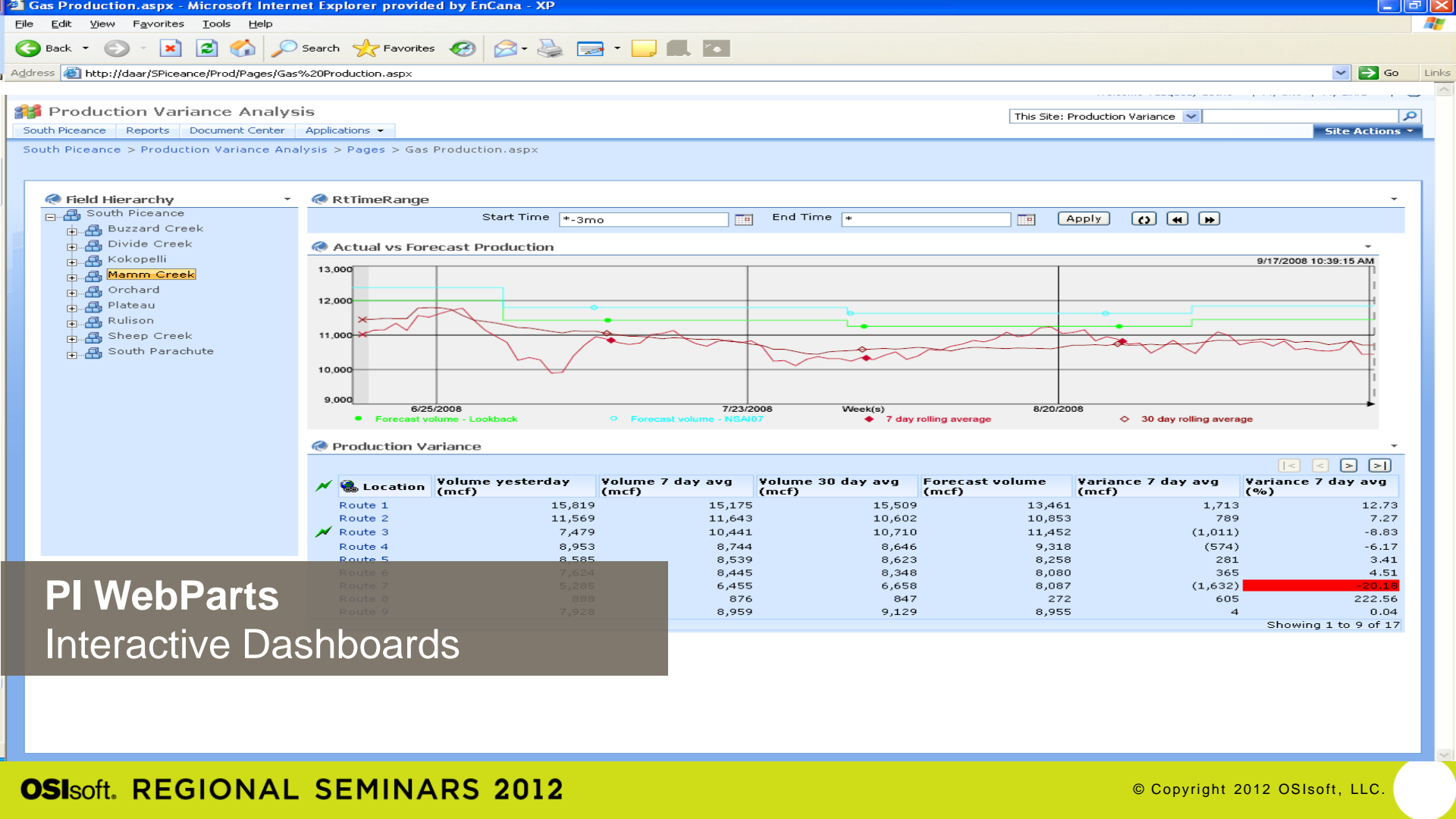
Boiler-4...ion Date  
4/6/1980 9:00:00 PM

| Name                    | Description                          | Value  | Units      | Trend | Minimum | Maximum |
|-------------------------|--------------------------------------|--------|------------|-------|---------|---------|
| Boiler-481 Water        | Relative Make-Up Water Use per ton   | 182.43 | k sft3/ton |       | n/a     | n/a     |
| Boiler-481 Make-Up W    | Make-Up Water Flow                   | 6.08   | bbi/d      |       | 5.41    | 6.36    |
| Boiler-481 Fuel Gas Flo | Fuel Gas Flow Rate                   | 30.82  | k sft3/h   |       | 25.32   | 33.22   |
| Boiler-481 Fuel         | Relative Fuel Gas Use per ton of Fee | 924.16 | k sft3/ton |       | n/a     | n/a     |
| Boiler-481 Equipment S  | Mode of operation                    | Auto   | STATE      |       | n/a     | n/a     |

| Name           | Description                        | Value  | Units   | Trend | Minimum | Maximum |
|----------------|------------------------------------|--------|---------|-------|---------|---------|
| Pump-209 Power | Relative Power Use per ton of Feed | 93.112 | kWh/ton |       | n/a     | n/a     |
| Current 20211  |                                    | 12.94  | A       |       | 12.90   | 13.09   |

# PI Coresight Ad-hoc Visualization & Analysis





# Production Variance Analysis

South Piceance | Reports | Document Center | Applications

South Piceance > Production Variance Analysis > Pages > Gas Production.aspx

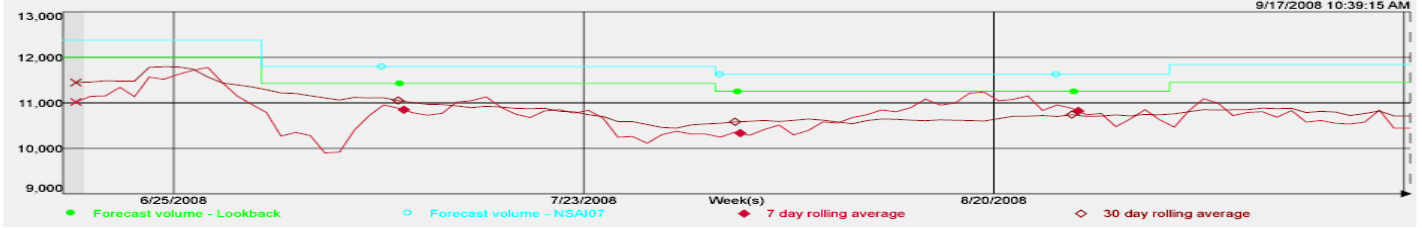
## Field Hierarchy

- South Piceance
  - Buzzard Creek
  - Divide Creek
  - Kokopelli
  - Mamm Creek**
  - Orchard
  - Plateau
  - Rulison
  - Sheep Creek
  - South Parachute

## RtTimeRange

Start Time: \*-3mo End Time: \* [Apply] [Refresh] [Previous] [Next]

## Actual vs Forecast Production



## Production Variance

| Location | Volume yesterday (mcf) | Volume 7 day avg (mcf) | Volume 30 day avg (mcf) | Forecast volume (mcf) | Variance 7 day avg (mcf) | Variance 7 day avg (%) |
|----------|------------------------|------------------------|-------------------------|-----------------------|--------------------------|------------------------|
| Route 1  | 15,819                 | 15,175                 | 15,509                  | 13,461                | 1,713                    | 12.73                  |
| Route 2  | 11,569                 | 11,643                 | 10,602                  | 10,853                | 789                      | 7.27                   |
| Route 3  | 7,479                  | 10,441                 | 10,710                  | 11,452                | (1,011)                  | -8.83                  |
| Route 4  | 8,953                  | 8,744                  | 8,646                   | 9,318                 | (574)                    | -6.17                  |
| Route 5  | 8,585                  | 8,539                  | 8,623                   | 8,258                 | 281                      | 3.41                   |
| Route 6  | 7,624                  | 8,445                  | 8,348                   | 8,080                 | 365                      | 4.51                   |
| Route 7  | 5,285                  | 6,455                  | 6,658                   | 8,087                 | (1,632)                  | -20.18                 |
| Route 8  | 888                    | 876                    | 847                     | 272                   | 605                      | 222.56                 |
| Route 9  | 7,928                  | 8,959                  | 9,129                   | 8,955                 | 4                        | 0.04                   |

Showing 1 to 9 of 17

PI WebParts  
Interactive Dashboards

**Search**

\*Farm

**Elements of Interest**

Group by:  Template

Filter

| Name                  |
|-----------------------|
| Big Buffalo Wind Farm |
| Black Mesa Wind Farm  |
| Black Wolf Wind Farm  |
| Deep Valley Wind Farm |
| Eldorado Wind Farm    |
| Grand Ridge Wind Farm |
| White Bear Wind Farm  |
| Wild River Wind Farm  |

# Turbine Overview

WDFPIAF\Windtopia\Wind Power Generation Fleet\Black Mesa Wind Farm\GE06

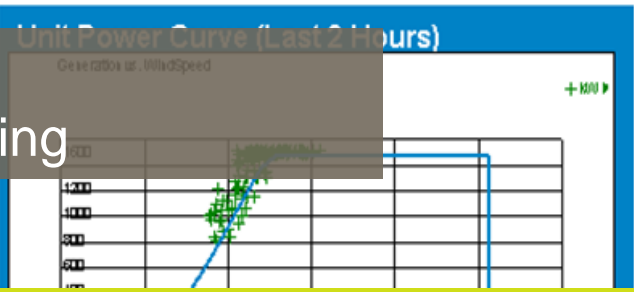
Capacity 0 20 40 60 80 100

**General Unit Information**

Unit Name: **WTG06**  
 Unit Model: **1.5 csCWE**  
 Unit Status: **Load Operation**

**Availability Information**

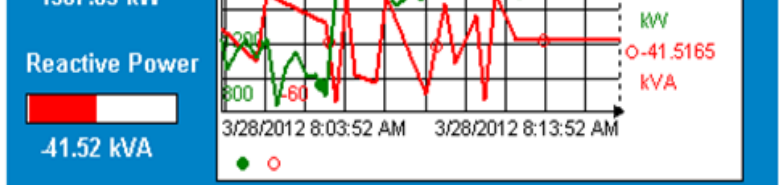
Energy (Daily): **27553.75 kWh**  
 Capacity Factor (Daily): **76.40 %**  
 Availability Factor (Daily): **98.23 %**



**Generation Information**

**Active Power**

1507.03 kW

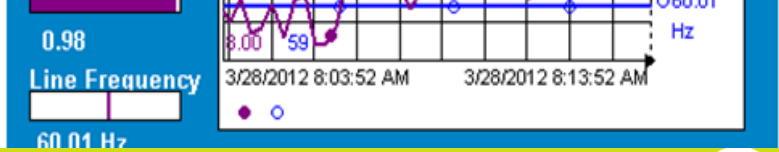


**Apparent Power**

1505.80 kVA

**Power Factor:**

0.98



**PI ProcessBook**  
Real-Time Monitoring

|    | A   | B                   | C            | D              | E               | F            |
|----|---|---------------------|--------------|----------------|-----------------|--------------|
| 1  | <b>2008 CO2 Emissions (lbs)</b>                 |                     |              |                |                 |              |
| 2  | <b>AQMD Unit ID:</b>                            | <b>Facility ID:</b> | <b>Type:</b> | <b>January</b> | <b>February</b> | <b>March</b> |
| 15 | D-15  | K-26                | Major        | 0              | 98,684          | 3,375,547    |
| 16 | D-16  | K-27                | Major        | 0              | 69,113          | 2,639,550    |
| 17 | D-83  | H-6                 | Process      | 96,274         | 56,349          | 13,120       |
| 18 | D-84  | H-20                | Process      | 37,588         | 13,418          | 2,701        |
| 19 | D-175   | H416                | Process      | 244,634        | 151,862         | 5,328        |
| 20 | D-176   | H417                | Process      | 19,283         | 2               | 0            |
| 21 | D-177   | H418                | Process      | 225,835        | 95,620          | 0            |
| 22 | E-173 (M24)                                     | AC                  | R219         | 64,400         | 46,711          | 13,942       |
| 23 | E-15  | Air Compressor      | R219         | 1,302          | 22              | 897          |
| 24 | E-16  | Generator           | R219         | 143            | 0               | 18           |
| 25 | E-18  | Air Compressor      | R219         | 1,109          | 292             | 11,618       |
| 26 | E-18B   | Air Compressor      | R219         | 16,188         | 320             | 13,096       |
| 27 | E-22  | Trash Pump          | R219         | 0              | 0               | 0            |
| 28 | E-23  | Trash Pump          | R219         | 0              | 0               | 0            |
| 29 | E-24  | Trash Pump          | R219         | 3,129          | 3,054           | 1,046        |
| 30 | E-25  | Steam Cleaner       | R219         | 649            | 0               | 0            |
| 31 | E-27  | Welder              | R219         | 5,869          | 123             | 4,269        |
| 32 | E-28  | Light Plant         | R219         | -1             | 4               | 113          |
| 33 | E-29  | Generator           | R219         | 0              | 0               | 0            |
| 34 | E-30  | Welder              | R219         | 11,904         | 125             | 3,404        |
| 35 | E-31  | Air Compressor      | R219         | 1              | 2               | 0            |
| 36 | E-32  | Generator           | R219         | 0              | 0               | 0            |
| 37 | E-33  | Pressure Washer     | R219         | 0              | 0               | 0            |
| 38 |   |                     |              |                |                 |              |
| 39 |   | <i>Major</i>        |              | 10,320         | 997,616         | 10,645,707   |
| 40 |   | <i>Large</i>        |              | 276,570        | 278,036         | 452,744      |
| 41 |   | <i>Process</i>      |              | 964,375        | 565,436         | 85,566       |
| 42 | R219  | <i>Gasoline</i>     |              | 5,685          | 3,369           | 13,578       |
| 43 |   | <i>Diesel</i>       |              | 34,610         | 572             | 20,881       |
| 44 |   | <i>Nat. Gas</i>     |              | 64,400         | 46,711          | 13,942       |
| 45 | Major, Large, Process, Natural Gas all in MMSCF |                     |              |                |                 |              |
| 46 | Gasoline, Diesel in gallons                     |                     |              |                |                 |              |

| Daily Report For :        |  | 23-Jul-07  |            |                |        |      |         |
|---------------------------|--|------------|------------|----------------|--------|------|---------|
| SHIFT FOREMAN             |  | John Smith | Mike Jones | Peter Richards |        |      |         |
| <b>FIBRE INPUT</b>        |  | Shift 1    | Shift 2    | Shift 3        | Total  | Spec | Unit    |
| Base NSSC - Grubbens      |  | 15         | 50         | 50             | 115    |      | BDT     |
| Total fibre input         |  |            |            |                | 115.00 |      | BDT     |
| <b>FIBRE TO FAN PUMPS</b> |  | Shift 1    | Shift 2    | Shift 3        | Total  | Spec | Unit    |
| Liner pulp                |  | 10         | 40         | 50             | 100    |      | BDT     |
| Base K4                   |  | 15         | 55         | 80             | 150    |      | BDT     |
| Base NSSC                 |  | 25         | 70         | 60             | 155    |      | BDT     |
| Base broke                |  | 1          | 5          | 15             | 21     |      | BDT     |
| Total fibre to fan pumps  |  | 51         | 170        | 205            | 426    |      | BDT     |
| <b>PAPER PRODUCTION</b>   |  | End of day |            |                |        |      |         |
| Grade (Shift start)       |  | ML140      | ML140      | ML225          | ML225  | Spec | Unit    |
| Standard speed            |  | 500        | 500        | 490            |        |      | m/min   |
| Actual Average speed      |  | 390        | 520        | 505            |        |      | m/min   |
| Gross Pope Production     |  | 40         | 180        | 220            | 440    |      | t/day   |
| Bone Dry Production       |  | 35         | 160        | 200            | 395    |      | BDT/day |
| Fibre Loss on Machine     |  | 16.0       | 10.0       | 5.0            | 31     |      | BDT/day |
| PM Production Over Scale  |  | 38         | 180        | 220            | 438    |      | t/day   |
| Saleable PM Production    |  | 10         | 160        | 220            | 390    | 400  | t/day   |
| Rewinder Production       |  | 0          | 0          | 10             | 10     |      | t/day   |
| Total Saleable            |  | 10         | 160        | 230            | 400    |      | t/day   |
| Broke                     |  | 20         | 5          | 0              | 25     |      | t/day   |
| Hold Reels                |  | 8          | 15         | 0              | 23     |      | t/day   |
| Second Cut                |  | 0          | 0          | 0              | 0      |      | t/day   |
| Jumbo's on Kitchen Roll   |  |            |            |                | 12     |      | tons    |
| <b>DOWNTIME</b>           |  | 240        | 15         | 0              |        |      |         |

PI DataLink  
Personalized Reports



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- Factory 1 Batch Cycle Time
- Factory 1 Batch Trend Comparison DLES
- Factory 1 Batch Trend Calcs

Add new link

Alarm Query Time Range

Start Time  
2/3/2010 12:00:00 AM

End Time  
2/4/2010 12:00:00 AM

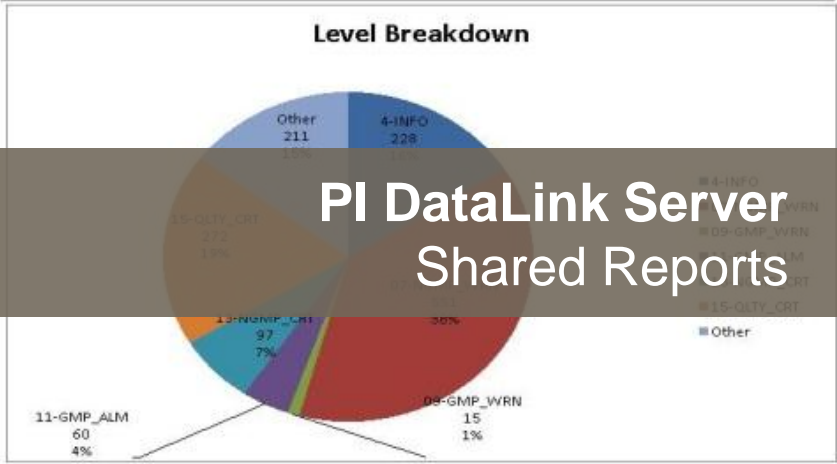
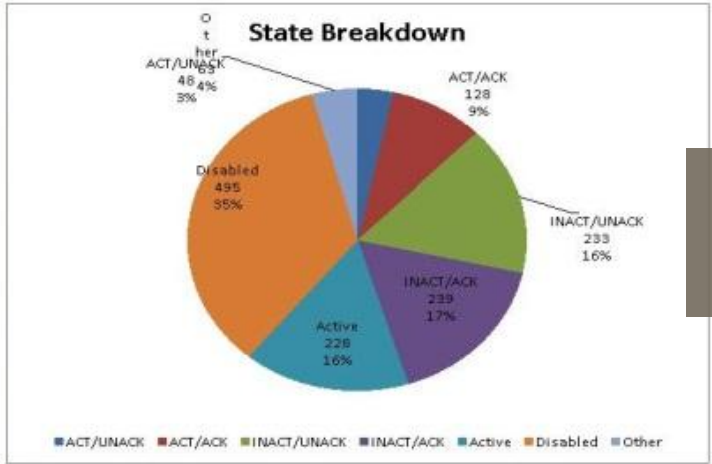
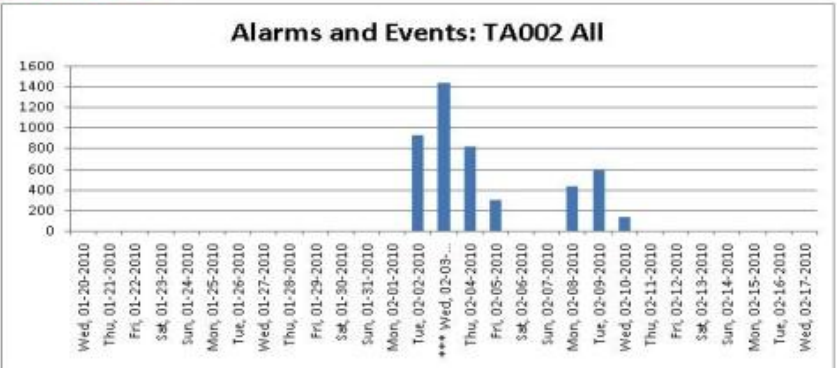
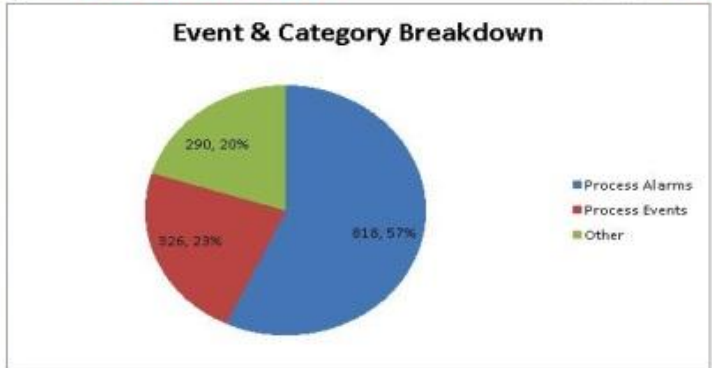
Apply

Select a Unit

- All Factory 1 Units
- All Units
- BF008
- BF009
- CIP005
- CIP006
- TA001
- TA002**

Unit: BioPharma\Factory 1\All Factory 1 Units\TA002 Start Time: 2010-02-03T00:00:00 # Values: 1434

Tag: BioPharma:TA002.AE.All End Time: 2010-02-04T00:00:00



PI DataLink Server Shared Reports

# When There's No Such Thing as Too Much Information



**➔ Net Gain – Output and Productivity 5 % to 6 % higher in DDD (Data Driven Decision Making)**

Reference: Brynjolfsson, et al., MIT, How does Data-Driven Decision making Affect Firm Performance, 2011.

<http://www.nytimes.com/2011/04/24/business/24unboxed.html>

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Product Manager

OSIsoft, LLC



# THANK YOU

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