PI System in Power Generation – Does the Type of Fuel Really Matter?

Chris Crosby, Business Development Executive
OSIsoft
Agenda

• OSI Power Generation Experience
• Power Generation Market in India
• Different Fuel Types
• Customer Business Results in Power Generation
• DTE Energy Benefits
• GenOn Benefits
• Entergy Benefits
• Other Customer Benefits
• Conclusion
Underlying Assumption

“Household electricity consumption is widely viewed and accepted as providing substantial standard of living (quality of life) gains. These gains come in many areas…refrigeration of food (health), lighting for reading (literacy), computers and internet access (education), productivity (income)…and suggest that observable household electricity consumption may provide useful insights into the nature of standard of living across countries and its changes over time.”

by

Roselyne Joyeux and Ronald D. Ripple in *The Evaluation of Standard of Living and the Role of Household Electricity Consumption*
OSI Power Generation Experience

- 55% of 475 GW average USA power generation is monitored by the PI System (coal, natural gas, renewables, hydro and nuclear)
- 75% of nuclear power generators in the USA use the PI System
- The US Nuclear Regulatory Commission (US NRC) uses the PI System
- 85% of total 23 GW USA wind generation is monitored by the PI System
- 90% of the ISOs/RTOs in the USA use the PI System
- 17 of the top 20 wind generating producers in the world use the PI System
- Over 50% of the Concentrated Solar Plants (CSPs) in the world use the PI system
- Many of the largest solar companies in the world use the PI System (SunPower, EDF-EN, E.ON, Iberdrola, EGP, Abengoa Solar, Sempra)
- Many solar, wind, turbine and other major equipment power generation OEMs in the world use the PI System
- Many power generation customers in India use the PI System
The PI System – The Defacto Standard in Power
Power Generation Market in India

- Population (1.2) (1/3) (50%, 25) (400)
- GDP (3rd)(8%)
- Electricity growth & consumption (7%, 2x,10)(5th)(728)(111th)(5000)
- Resource constrained
- Nuclear
- Politics & ideology
- Fossil fuels
- Renewables

Source of data: BP Statistical Review and IEA 2010 Key World Energy Statistics for 2008 data; presented at India Nuclear Summit by Arun Srivastava, V.P Raja, K.J. Sebastian
Power Generation Market in India - Consumption

Strong economic growth leads China and India to more than double their combined energy demand by 2035, accounting for one-half of the world's energy growth. Source EIA's International Energy Outlook 2011 – 9th September, 2011.
Power Generation Market in India – by Fuel Type

Installed Capacity
31 March, 2011

<table>
<thead>
<tr>
<th>Fuel Type</th>
<th>Capacity (MW)</th>
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<tr>
<td>Total</td>
<td>173,626</td>
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<td>Renewables</td>
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Different Fuel Types

What’s Different?
- Fuel/Fuel handling
- Availability of fuel
- Staffing levels
- Designed busbar cost
- Technologies
- Equipment types
- Efficiencies
- Optimum operating modes
- Regulators/Requirements
- Emissions and waste
- Bi-products
- Catastrophic failure risk

What’s the Same?
- Need for qualified, trained staff
- Need for highly available units
- Need for highly reliable equipment/systems
- Need for proactive environment
- Need for minimum outages
- Need for timely, informed decision making
- Need for low O&M costs
- Need for low busbar cost
- Need for low life-cycle cost
- Need for high efficiencies
- Need for high safety and environmental performance
- Need to meet regulatory requirements
## Customer Business Results in Power Generation

- $9 million in heat rate savings and ISO regulation penalty disputes/DMNC testing
- Annual savings in excess of $20 million fleet-wide
- $8.00 annual benefit per $1.00 invested cost
- Reduced forced outages by 1% and as a result increased margin by over $2 million annually
- 10% overall reduction in maintenance expenses
- Reduced start-up costs by approximately 1/3
- PI System + advanced analytics (CBM) pilot $1 million, one combined cycle unit in 6 months, deploy fleet-wide
DTE Energy History of PI System

- Pilot at Monroe PP in 1998
- Fossil Generation Fleet 1999 (18 units)
- GenOps – EMS Ranger 2001
- SOC SCADA– 2002
- Fermi Nuclear– 2003 (1 unit)
- DTE Subsidiaries – 2007
- Enterprise Agreement – 2007
- Continuous PI Expansion – 2007 on
- IT Monitoring – 2009
DCS installations on nearly every unit

Nearly 300,000 process data tags
  - PI Systems at each plant
  - PI Interfaces to DCS & many PLC’s

What is that **data screaming** at us?

How do you effectively **utilize** the data?

How do you turn data into **information**?
DTE Energy Raw Data Analysis

- Post trip analysis
- Process monitoring
- Optimization
- Early warning
- Alarming

$1,890,000
One Plant
1st year savings!
DTE Energy Engineering Applications
Fleet Performance Analysis (PMAX)

Thermal Performance Calculation Engine

$500,000 Annual Savings!
DTE Energy Engineering Applications
Digital Fuel Tracking System

$1,200,000 Annual Savings!
DTE Energy Engineering Applications
NOx Emissions Strategy

$2,200,000
Annual Savings!

NOx Reduction with Improved Heatrate

Before Implementation

After Implementation

Primary focus is NOx reduction only

Focus on operating near NOx budget curve

8 Hour History

Expected Curve

Current operation

Expected & Actual NOx Costs

NOx Cost ($MM/yr)

Percent Load (%)
The Plant Energy Management System is used to automatically control unit dispatch.

- Implements data validation on all fields
- Performs several calculations based on PI data to determine validity of inputs.
- Transported to EMS Ranger via PI

$120,000 Savings!
DTE Energy Engineering Applications
Fuel Cost Framework

**Fuel Supply**

1. **Current & Historic Data**
   - ESO PI
   - ps-eso-pi

2. **Analysis and Acquisition**
   - Blend Calculations

3. **Current Fuel Cost**
   - Auto calculate & update Ranger
   - ps-mon-pi
   - Blend Calculations
   - ps-tch-pi
   - Blend Calculations
   - ps-rrg-pi
   - Blend Calculations
   - ps-blr-pi
   - Blend Calculations
   - ps_hbh_pi
   - Blend Calculations
   - ps-grw-pi
   - Blend Calculations
   - ps-stc-pi
   - Blend Calculations

4. **Market Data**
   - Hourly & Daily Auto update

5. **Improvements**
   - 30 to 3 people
   - Timely data entry
   - Zero errors

6. **Annual Savings**
   - $530,000

7. **Location**
   - Ranger PI
   - Ann Arbor
AGC – Automatic Generation Control

5 largest Fossil units & Peaking Units are ramped through PI Set Point control

$200,000 Savings!
DTE Energy Web Visualization
Fleet Status – PI WEB enabled

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<th>Unit</th>
<th>Net MW</th>
<th>TMC</th>
<th>TCAP</th>
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<td>0.900 8893 10069</td>
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<td>1.000 9573 10593</td>
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</table>

Ludington DE EE 7293

Transactions
Firm Purchase
Non-Firm Purchase
Firm Sale
Non-Firm Sale
Service Area Load
Retail Schedule

Plant Generation 6281
Ludington Generation 6281
Peak Generation 378
Misc. Generation 85
Total Generation 6745
Total Load 7978
Steel Load 289
DTE Energy Web Visualization
Real-Time DCS Operator Displays

6000 real time dynamic actively linked WEB DCS graphics
DTE Energy Web Visualization
PI enabled - Event Re-play

Re-play events using historical PI data
DTE Energy System Dashboards
PI Enabled

2000 real time dynamic actively linked WEB System graphics
DTE Energy Expert Systems
PI Dependent

- Equipment & Process Monitoring – Advanced analytics
  - Fleet wide implementation 2006
  - A Primary Performance Center Application
  - $7,769,680 Annual Savings!

- Combustion Optimization – NeuCo
  - Startup on St Clair Unit 7
  - Installation in progress on Belle River 2
  - Planned for Monroe Units 1-4
  - $330,000/unit Annual Savings!
DTE Energy Technology Framework 2007

Annual Savings
Fleet Optimization
(Projected Savings)

- $20,000,000
- $11,000,000
- $1,000,000
- $5,500,000
- $4,500,000
- $3,000,000

Actionable Information – KPI’s

- Distributed OSIsoft PI Historians
- Large Population of Data
- Process Discrete to Data
- PMAX, Digital Fuel Tracking, Fuel Cost Framework
- WEB Visualizing
- Easy Access to Information
- Expert Systems
- Predictive Monitoring, Optimization
- System Dashboards
- Fleet Status Assessment
- Business Intelligence
- Reliability, 4-Block
- Outage & De-rate (UCF) & Market
- KPI’s
- Dashboards
- Fleet Optimization

Discrete data
Limited value
DCS installations on nearly every unit
Nearly 1,000,000 process data tags
PI Systems at each plant
PI Interfaces to DCS & many PLC’s

**Discrete data**
**Limited value**

**Actionable Information – KPI’s**

**Business Intelligence**
Reliability, 4-Block Outage & De-rate (UCF)
Maintenance & Market

**Expert Systems**
Predictive Monitoring, Optimization

**System Dashboards**
Fleet Status Assessment

**WEB Visualizing**
Plant Alarm, DCS Real-time WEB Graphics
Easy Access to Information

**Engineering Applications**
PMAX, Digital Fuel Tracking, Fuel Cost Framework

**Process Discrete to Data**
Distributed Control Systems (DCS)
Distributed OSIsoft PI Historians
Large Population of Data

**Drives Performance Excellence**
Process Costs, Asset Health, Operational Performance, Market Value, Fleet Optimization

**Relate all Data Sources**
Analysis Framework
(PI, ProcessGuard, Maximo, SAP, UCF, P3M, Predictive Monitoring, NeuCo, LIMS, Plant View ..)

**Advanced Analysis & Process Optimization**
Equipment and Process Monitoring
Closed Loop Process Optimization

**Fleet Drill down**
Subject Matter Experts

**Standard User Interface**
WEB Visualization

**Process Discrete Data**
PMAX, DFTS, eNote, Fuel Cost Framework, Alarm Management

**Post Event Analysis**
DCS, PLC & PI

90% Complete
DTE Energy Unit Capacity Framework (UCF) 2009

- Manages all Unit Capacity and De-rates - Interfaces to MISO, P3M & EMS
- Automatically Generated Status Report (Availability on BlackBerry)
- Dynamically linked with Outage and de-rate process

$6,900,000 Savings To Date!
Entergy Performance Monitoring & Diagnostics Center (PM & DC)

Support plant objectives to achieve fleet commercial excellence through improved unit performance, equipment condition, and operational risk management
Entergy’s PM & DC PI Infrastructure

• PI Servers located at 16 plants
• Operations Information Systems (OIS) implemented on 30 units:
  – Real-time performance monitoring & diagnostics thru pre-built PI-Process Book displays and General Physics EtaPro™
• Advanced Pattern Recognition (APR) implemented for 33 units:
  – Anomaly detection and alerting via advanced pattern recognition software using near real-time data from the plant PI servers
Entergy PI Use in the PM & DC

- OIS/PI is primary means of accessing plant data for routine monitoring
- Build custom ProcessBooks and DataLinks for trip analysis, unit/equipment problem diagnostics, and special monitoring
- Using PI Alarm View and PI ACE for PM&DC’s Alarm Management System
- All based on the foundation of the PI data collected and stored at each plant
Entergy PM & DC Monitoring Tasks

- Unit trip monitoring and diagnostics
  - Plants can use extra eyes during upsets
- Unit Start-up monitoring
  - Complex process with many opportunities for error
- Routine monitoring
  - Looking for early signs of emerging equipment problems or failed instrumentation
- Purchased Advanced Pattern Recognition (APR) software to greatly enhance anomaly detection capability and data mining
- Performs special analysis requested by plants - lost MWs, performance issues, and equipment problems
Entergy PM & DC Benefits

- Early identification of changes in equipment physical, thermal, operational & environmental performance
- Improved ability to mitigate degrading equipment condition and unit performance
- Improved ability to maximize unit value considering current market opportunities
- Leverage expertise and technology
- Enhanced teamwork
Entergy PM & DC Results

- **PM&DC Benefit to cost:**
  - **First year:** 2 to 1
    - Including initial set up cost
    - O&M dollars only
  - **Ongoing after first year** 3 to 1
    - O&M dollars only
  - **Ongoing after first year** 8 to 1
    - O&M + fuel & replacement power

- **Catches:**
  - **First year** 252
  - **Ongoing** 400-500 / yr
GenOn - Driving Factors for OSIsoft Solution

Problem: Many disparate plant systems and the need to turn data into actionable information
- DCS, PLC, CEMS, Analyzers…
- Various timestamps
- Data accessibility & integrity

Solution: OSIsoft, Enterprise Wide Infrastructure
- Common real-time database
- Common visualization and analytic toolset
- Common technology for development and advanced analytics
- Leverage SMEs (Central & Plant)

IPP, not a utility requires effective maintenance practices
GenOn OSIsoft Continuous Value Proposition

- Fleet Wide Deployment 2002
- Condition Based Maintenance on Critical Assets 2004
- Advanced Pattern Recognition Fleet-wide Rollout 2005
- Water Chemistry Automation 2007
- Automated Operator / Maintenance rounds 2008 - 2010
- Environmental Monitoring 2008
- Proactive Maintenance Data Gateway 2009 - 2011

Every phase a business value and positive ROI
GenOn Boilers Highest Lost Margin System

Boilers – “The race car tire of Power Generation”

- Highest Lost Margin Opportunity
- Most outages / de-rates
- Improve Water Chemistry
  - Make visible via PI
  - Transformation of data
- Track Temperature Excursions

Highest LMO makes easy ROI with technology solution…
GenOn Water Chemistry Automation

- Improve and interface to analyzers
- Cycle Water Chemistry screens
- Response Procedure Reports (EPRI standards)
- Calculate minutes in / out of spec
- Notifications on limits

*Transform and use data in a new way…*
GenOn APR Modeling

**Business case developed from history:**

- Review equipment failures
- Outages and related lost margin
- Combined cycle plant pilot had 5 catches (~value $948K)
- Decision to apply fleet wide
- Model critical systems and equipment

*Very intelligent rules based monitoring of critical systems…*
GenOn Summary

• Implement Enterprise Wide Infrastructure (EWI)
• Use for core business processes
  • Operations, Maintenance, Engineering
  • Equipment and Vendor performance
  • Common Tools, Visuals, Notifications & Training
  • Common Solutions and Advanced Analytics
  • Leverage staff and expand their skills sets

Every phase has positive ROI!
EDF Wind – Avoiding Significant Failure

PI System alerts and notification allow failure conditions to be identified early.

PI System replacement before causing significant failures
- Scheduled maintenance vs. unscheduled maintenance

Example:
- Observe the bearing temperatures to determine bearings approaching failure
- Replace the bearing before the generator fails
- Plan for equipment/tool need to service in advance

Replacement of bearing became a scheduled outage, no impact to generator.
SunPower Solar

SunPower O&M Overview

- > 500 MW monitored
- > 550 systems monitored
- > 95 power plants >1MW
- > 10 years of O&M experience
- Guaranteed performance

- 24/7/365 real-time plant monitoring
- Customer visibility of system performance via web portal
- Regional service centers
Conclusion

• There exists a huge electricity supply and demand gap in India
• Many new plants need to be built…and there are many obstacles
• In the mean time, we need to maximize the availability and output of existing plants at the lowest achievable cost
• Many characteristics and requirements of fuel-to-electricity conversion processes vary as a function of the fuel-type
• Many core characteristics and requirements do not
• The PI System can support nearly 100% of those that do not vary and can be a core infrastructure technology to help close the supply and demand gap in India
India and America – Common Values, Shared Success

op ed this week, USINPAC Blog Network

“The remarkable deepening of US-India ties over the past decade is only a start, as the relationship has still not reached its full potential. If Indians and Indian-Americans continue to contribute their ideas, their energy and their commitment, I am sure that even more exciting days lie ahead.”

Senator Richard Lugar, the Republican leader of the U.S. Senate Foreign Relations Committee
“Strength does not come from physical capacity. It comes from an indomitable will.”

“You must be the change you want to see in the world.”

“Whatever you do will be insignificant, but it is very important that you do it.”
Thank you