Finding Benefits by Modeling and Optimizing Steam and Power Systems

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Air Liquide Large Industries U.S. LP

Air Liquide and Energy

- One of the world’s largest industrial gas suppliers
- Large pipeline network along the Texas and Louisiana Gulf Coast
  - ~2,000 miles of pipe
  - O2 and N2 parallel
  - Hydrogen
- Bayport – Largest industrial gas complex in the world for Air Liquide
  - Steam system
  - Cogen and boilers
  - Extraction/Condensing turbines
Air Liquide and Energy: OCC

- Energy management for pipeline system facilities
- Use of software tools where appropriate
  - Pipeline hydraulic modeling, Supply chain management, Liquid Optimization, etc.
- Specific to Bayport, shared responsibility for the steam system management
  - Visual MESA used for real-time, on-line energy management
  - Accessed and used by both Bayport and OCC staff

OCC Tools & Models

Enterprise Data Delivery Engine

- Customer Data
- Asset Data
- Fleet Data
- SCADA Data
- Market & Weather Data
- Contract Data
- Risk Mgt. Data

Contract Valuation Model
Forecasting & Planning
Risk Mgt. Model
Financial Position Mgt. Model
Supply Chain Optimizer
Potential Action Valuation Model

Interface
- Operations Group
- Merchant Group
- Energy Group
- Senior Mgt.
Energy Management: Visual MESA

- Background: Implemented at Bayport in 1997
- Adequate metering included in project
  - Steam flows, pressures, temperatures
  - Major users: turbines, letdowns
- 4 Cogen units, 3 stand-alone boilers
- Large extraction/condensing steam turbine-driven compressors
- A number of large topping turbine-driven compressors
- Spared pump operation: turbine/motor swaps
Visual MESA Scope

- Provide Off-Line “What If” Tool for
  - Bayport Engineering & Operations Staff
  - OCC / Corporate Engineering / Energy Management Groups

- Provide On-Line Tool
  - Linked to
    - Data Historian/SCADA (Customer Loads)
    - Bayou Cogen Data (Separate System at the time)
    - Power/Natural Gas Market information (i.e. Platts)
  - As an Advisory System
  - For Lowest Cost Utility Operation

- Local and Global Optimization
  - Local - equipment can move 10% of its range from current operation
  - Full – equipment can move across 100% of range
  - Global - equipment can start/stop and can move across 100% of range

Bayport System – Visual MESA
Implementation

- Begun and completed in 1997
- ROI: simple payback of initial investment in less than one year
- Results and recommendations available for viewing in the Visual MESA software front-end as well as SCADA/DCS user interface
  - Results of model runs published back to historian

Scope Detail: Plant Information Flow

- Provide Data Exchange
  - SCADA
  - Bayou Cogen

Process Data Server Link Between: Bayou Cogen DCS and the Bayport SCADA System

- SCADA
- Condensate
- InPlant DCS
- Customer O2
- Customer N2
- Customer Steam
- Grid Power
- #4 ASU DCS
- Equipment Status
- Internal Steam
- Bayou Cogen

The world leader in industrial and medical gases
MESA/SCADA Interface

- SCADA is the "data repository"
- Visual MESA accesses real-time and historical data via the OPC bridge
- Visual MESA passes recommendations back to Historian through the OPC bridge
- Operators can view results
  - In SCADA interface
  - In Visual MESA
  - In Excel Reports

SCADA/Historian

How Visual MESA is used today

- Day-to-day site operations
  - Setpoints for equipment
  - Lowest cost operation
  - Maintaining "N-1" steam reliability
- Outage forecasting and advanced planning
  - Hurricane planning
  - Plant and equipment maintenance
  - "4CP" events – reduction in power demand costs in ERCOT
- Long-term site planning
  - To determine cost or benefit of
    - New units
    - Steam system upgrades
### Excel-based Optimization Recommendation Reports

<table>
<thead>
<tr>
<th>Steam Generation Summary (kWh)</th>
<th>Local Optimization</th>
<th>Full Optimization</th>
<th>Global Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculation</td>
<td>Local</td>
<td>Full</td>
<td>Global</td>
</tr>
<tr>
<td>BOF O2 Production</td>
<td>3900</td>
<td>3845</td>
<td>3845</td>
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<tr>
<td>BOF Slag Production</td>
<td>400</td>
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<tr>
<td>BOF Slag Production</td>
<td>410</td>
<td>3800</td>
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</tbody>
</table>

<table>
<thead>
<tr>
<th>Leakdown and Vent Summary (kWh)</th>
<th>Local Optimization</th>
<th>Full Optimization</th>
<th>Global Optimization</th>
</tr>
</thead>
<tbody>
<tr>
<td>Calculation</td>
<td>Local</td>
<td>Full</td>
<td>Global</td>
</tr>
<tr>
<td>100kW to 110kW</td>
<td>0.2</td>
<td>0.2</td>
<td>0.2</td>
</tr>
<tr>
<td>115kW to 130kW</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
</tr>
<tr>
<td>Vent</td>
<td>0.2</td>
<td>0.1</td>
<td>0.0</td>
</tr>
</tbody>
</table>

### SCADA Recommendations

**ALPHU**

- LAST RUN REPORTED = NO
- DATA VALIDATION ERROR = NO
- EXECUTION/STABILITY STATE ERRORS = NO

**FIELD WATER PUMPS**

- BOILERS
- AIR COMPRESSORS
- PRODUCT COMP.
- MISF STEAM
- EXCESS CAPABILITY
- 1750 Balance

**STEAM ALLOCATION**

- LAST HEBU RUN
- COMPLETE RUN %

**SW/HL**

- PER DAY USING THE 10% SETPOINT
- PER DAY USING THE 15% SETPOINT
- PER DAY USING THE 20% SETPOINT
SCADA Recommendations

Users of Visual MESA

- Bayou Cogen shift operators
- Bayou Cogen shift supervisors
- OCC Duty Control Engineer
- OCC Product Supply Manager
Role of each user

- Shift operators: Primary implementation of Visual MESA optimizer recommendations
  - Cogen and boiler loading optimization
  - Steam turbine extraction (minimization of condensing in most cases)
  - Steam turbine or motor-driven pump selection
- Shift supervisors and OCC Duty Control engineers: Drive day-to-day optimization
  - How closely are operations following targets from Visual MESA?
  - Are there large deviations in the “Local”, “Full”, or “Global” optimization results?
  - Discuss implementation with shift operators in real-time, while savings can still be achieved through action

Operational Strategy and Capital Project Development

- Visual MESA identifies underperforming equipment
- Captures inefficient operational modes for training purposes
  - “Historizing” Visual MESA recommendations
- Daily Conference Call
  - For optimization and forecasting
  - Involves shift supervisor, OCC product supply manager, energy personnel, and upper management
  - “Higher level” optimization discussion
  - “Sustainability” of Visual MESA the goal
Future Development: “Closing the Loop”

- Proven path forward
  - Visual MESA is already used in closed loop mode at 10 facilities of one of the world’s largest refiners
- Ensuring integrity of results
  - Data validation
  - Steady-state detection
  - “Local” optimization
- Eliminates “time lag”
  - Steam flow setpoints sent directly to equipment
- Leads to additional savings realized via real-time implementation

Questions?

VISUAL MESA
Energy Management System

Marketed and Implemented together with:

www.soteica.com for more about Visual MESA
Financial & Risk Management Information Structure

1. Host SCADA
2. Local SCADA
3. Advanced Process Control
4. Local System Optimization (GCPL, MRPL, BPT, MESA)

- Sensor, Detection, Value
- Distributed Control System (DCS), Programmable Logic Controller (PLC), Remote Terminal Unit (RTU), Flow Computer
- Local ASU / Facility Optimization
- Data Collection & History
- Set Point Control
- Target

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