Optimization strategies: how to optimize production in a deregulated environment

October 6, 2010
Heidelberg, Germany
Agenda

- New challenges for optimization
- Ventyx portfolio optimization methods
NEW Ventyx Solution Map
1,900 employees in 30+ countries

Physical Asset & Work Mgmt.
- Asset Mgmt.
- Supply Chain
- Work Mgmt.
- Operations Mgmt.
- Safety & Compliance

Mobile Workforce Mgmt.
- Forecasting & Planning
- Scheduling & Dispatch
- Mobile Work Execution

Customer Mgmt.
- Customer Information
- Billing Management
- Call Center Management

Network Management
<table>
<thead>
<tr>
<th>Energy and Generation Management</th>
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<tbody>
<tr>
<td>- Security Control &amp; Assessment</td>
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<tr>
<td>- Transmission Coordination</td>
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<tr>
<td>- System Monitoring/ SCADA</td>
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<td>- Generation Control/ AGC</td>
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<td>- Reliability Control</td>
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<td>- Control Area Function</td>
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<tr>
<th>Distribution Management</th>
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<tr>
<td>- Distribution Coordination</td>
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<tr>
<td>- System Monitoring/ SCADA</td>
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<tr>
<td>- Analysis</td>
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<tr>
<td>- Switching Control (auto /orders)</td>
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<tr>
<td>- Outage Management/Restoration</td>
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<td>- Volt/Var Optimization</td>
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<thead>
<tr>
<th>Market Management</th>
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<td>- Market Interfaces/ Communications</td>
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<td>- Bidding-Timeline/ Awards</td>
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<tr>
<td>- Settlements</td>
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<tr>
<td>- Market Clearing Engine</td>
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<tr>
<td>- Security Control &amp; Assessment</td>
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<tr>
<td>- Congestion Management</td>
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Energy Commercial Operations
- Load & Rev Forecasting
- Demand Response
- Trading & Risk Mgmt
- Smart Grid Operations
- Unit Optimization & Bidding
- Physical Scheduling
- Market Comms & Settlement

Energy Planning & Analytics
- Forecasting & Analysis
- Market Price Formation
- Portfolio Analysis and Planning
- Market Data Intelligence
- Advisory Energy Consulting
Ventyx Solutions – One View of the Truth Now Includes Real-Time

1. Regional Capacity Expansion
2. Corporate Investment IRP Rate Case
3. Operations Budget
4. Physical Position
5. Market Communications
6. Market Results
7. DA Bids/Offers
8. RT Dispatch
9. T – n Years
10. T – n Months
11. T – 30 Days
12. Trade Day
13. T + 60 Days
14. Load Forecasting
15. Retail Contracts and DR
16. Market Price Analysis and Simulation
17. Congestion Management

Market Analytics
- History and Simulation Data
- Regional Expansion and Compliance Planning
- Zonal and Nodal Market Analysis
- Market Analysis and Simulation

Portfolio Analytics
- Market Price Forecasts
- Portfolio Expansion and Compliance Planning
- Portfolio/Analysis and Budgeting
- Portfolio Analysis

Trading & Risk
- Trading and Risk Management
- Asset Risk Analysis/Position Reporting
- Scheduling
- Operational Strategy

Operations
- Unit Commitment And Dispatch
- Generation Bid Formation
- Portfolio Optimization
- Market Communications & Settlements

Portfolio and Market Operations
- Load Forecasting
- Network Management
- P&L Gross Margin
- Actual Costs
Why a company needs an optimization solution

Client Needs:

- A comprehensive solution that supports the **optimal** management of power resources

Functional Requirement:

- The solution must support unit commitment, fuel nominations, bidding, and leveraging of contracts and import/export capabilities

Ventyx Solution:

- *Generation Operations*
Optimization Problem

**Objective**
- Maximize Profit or Minimize Cost

**Inputs**
- Demand (Hourly Load)
- Reserve requirement
- Unit characteristics

**Outputs**
- Unit Commitment: Which units are On/Off
- Economic Dispatch: Unit loading and schedule
General Model

- Actual Unit Operation
- Updated Load Forecast
- Updated Fuel Prices
- Updated Unit Availability
- Updated Trades

**Ventyx Platform**

- Commitment and dispatch schedule, fuel forecast, etc
- Generation Operations
- Trading
- Fuels Group
- Operations Report
Key Features: Business Solutions

- **Constrained Modeling for Multiple Time Horizons**
  - Month ahead, week ahead, day ahead, post analysis, etc

- **Trading Support**
  - Transaction pricing and evaluation
  - Interactive transaction evaluation
  - Supply Curve for bidding / trading support
  - Emissions trading

- **Physical Risk Management**
  - Simulation scenarios to support “What If” analysis
What does the system do?

- Unit commitment and economic dispatch
- Optimizes the revenue and cost of resources
- Forecasts fuel consumption, pricing of short-term transactions, and facilitates the analysis of alternative scenarios
- Improved unit commitment and dispatch forecasts which can significantly increase profitability
Simple Supply and Demand Curves for One Hour

P [€ /MWh]

Price

Supply

Demand

Optimal Schedule

Quantity

Q [MWh]
Supply and Demand Without Demand Response

Price [€/MWh]

80%

20%

Quantity [MWh]

Supply

Potential
Wholesale Demand and Supply Curve With DR

Price [€ /MWh]

Demand Curve With Demand Response

Demand Curve Without Demand Response

Supply

Quantity [MWh]
# Unit Commitment Techniques Summary

<table>
<thead>
<tr>
<th></th>
<th>Speed</th>
<th>Accuracy</th>
<th>Modeling Capabilities</th>
<th>Computer Requirement</th>
<th>Mathematical Foundation</th>
</tr>
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<tbody>
<tr>
<td>Priority List</td>
<td>HIGH</td>
<td>LOW</td>
<td>LOW</td>
<td>MEDIUM</td>
<td>LOW</td>
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<tr>
<td>Dynamic Programming</td>
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<td>Lagrangian Relaxation</td>
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<td>HIGH</td>
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<td>Sequential Unit Commitment</td>
<td>LOW</td>
<td>MEDIUM</td>
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Key Issues Addressed

- **Enhanced Coordination Between**
  - Plant operations
  - Optimization
  - Market

- **Capturing Price Spikes**
  - Replacement and back up
  - Ability to shut down, start up and ramping due to market conditions

- **Start up Costs Modeling**
  - Costs change based on number of incurred start ups/shut downs
  - The cheaper the cost, the more will happen

- **Multiple Fuel Blending**

- **Emissions**
  - Trading and allowances

- **Bulk Transmission Modeling**
Hydro Modeling

Modeling Techniques
- Feed forward method
- Feedback method
- Global optimization
Integration of renewable energy sources presents new challenges

Wind and Solar requires more balance power

Source: SvK
Virtual Power Plants Aggregate Distributed Energy Resources

VPP WEST: Critical Peak Pricing

VPP NORTH: Pricing Program

VPP SOUTH: Direct Load Control

VPP EAST: DG & Storage
### Virtual Power Plants Characteristics

<table>
<thead>
<tr>
<th>Virtual Power Plant Characteristics</th>
<th>Traditional Plant Characteristics</th>
</tr>
</thead>
<tbody>
<tr>
<td>DR Capacity Forecast</td>
<td>Operating Limits</td>
</tr>
<tr>
<td>Number of Execution</td>
<td>Start Constraints</td>
</tr>
<tr>
<td>Event Durations</td>
<td>Total Energy Constraints</td>
</tr>
<tr>
<td>Time Between Event</td>
<td>Chronological Constraints</td>
</tr>
<tr>
<td>Customer Payments</td>
<td>Fuel and O&amp;M Costs</td>
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<tr>
<td>Opt-Out</td>
<td>Maintenance</td>
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Benefits of Implementing DR in the Demand and Supply Curve

**Economic**
- Connect end customers to wholesale markets
- More efficient energy costs
- Better use of existing infrastructure
- Deferment of new infrastructure (fuels, transmission, distribution, transformation, generation)

**Environmental**
- Reduction on emissions
- More efficient use of fuel
- Reduced impact on new construction

**Other**
- Customer satisfaction
- New product and services
- Other…
Example: Demand Response Program at FPL

- FPL works actively with customer to help them reduce electricity consumption and lower their bills.
- Together, FPL’s demand response programs total 3,300 MW.
- Over 20% of peak load.
- FPL has been able to avoid building ten 400 MW power plants.
Eliminating the top 100hrs of energy usage through efficiency programs and demand response is worth over €72M annually.
SmartGrid Operations Summary

How to connect Commercial Operations to the customer

- Program flexibility and ease of use
- IT requirements and challenges

How to make demand response programs actionable in Commercial Operations

- Design and implementation of VPPs
- Complete portfolio optimization
- Maximizes benefits for storage, wind and solar generation

The value of *Virtual Power Plants* in Commercial Operations

- Not just emergency/reliability, but economics (A/S, ramping, etc)
Thank you!