Utilization of the PI System Data in Transmission System Planning

Hantz A. Présumé
Principal Engineer
System Planning
VELCO Background

- Nation's first statewide, "transmission-only" company formed in 1956 by local utilities
- Owned by Vermont’s 17 local utilities and VLITE (public benefits corporation)
- 738 miles of transmission, 115 kV, 230 kV, 345 kV, and 450 kV
- 55 substations, switching stations and terminal facilities
- 225 MW HVDC Converter connecting VELCO to Hydro-Québec
- 1 STATCOM, 4 Phase Shift Transformers & 4 Synchronous Condensers
- 1400 miles of looped fiber optic networks
VELCO substations connect to the sub-transmission systems of:

- BED (20,000 customers)
- GMP (254,000 customers)
- Lyndonville (5,200 customers)
- Swanton (3,500 customers)
- Stowe (3,942 customers)
- VT Electric Co-op (34,000 customers)

Vermont distribution utility owners of VELCO
Transmission planning

• Why prepare a transmission plan
  – Federal requirement to assess the system annually
  – State requirement to file a 20-yr plan every 3 years
  – Society expects a high level of reliability
  – It takes several years to implement a solution

• Assess system performance under a wide-ranging set of operating scenarios varying:
  – Load level
  – Generation output and status
  – Transmission system topology and status

• General steps
  – Agree on system assumptions
  – Model and test scenarios
  – Interpret results and identify system deficiencies
  – Resolve system deficiencies
Simplified examples of transmission planning

- **Load serving (Import) problem**
  - Transmission solutions
    - Add a third line
    - Upgrade both lines
  - Non-transmission solutions
    - Energy efficiency, voluntary pre-arranged load disconnection (demand response)
    - Add generation

- **Generation congestion (Export) problem**
  - Transmission solutions
    - Add a third line
    - Upgrade both lines
  - Non-transmission solutions
    - Do nothing – increased competition
    - Storage
    - Control scheme to reduce generation
Serving load reliably

The transmission grid is designed to serve maximum demand/load.

PI System data analysis helps us understand the characteristics of electric demand.
Load characteristic is as essential as the amount of load

- The PI System allows us to monitor and understand evolving load behavior
  - Relatively constant versus spiky load curve on the peak day
    - Gives a sense of duration of a potential emergency exposure
    - Affects the type of solution: demand response, peaking generation, energy efficiency, or transmission upgrade
  - Timing of the peak load is in the winter or summer, in the morning, afternoon, or in the evening
    - Affects the type of solution: solar power, efficient lighting
    - Evolution: timing of daily peak demand is occurring later due to solar PV
- Geographic distribution of the load – allocate total load into zones
  - Understanding which part of the system is growing faster, or behaves differently, e.g. one region peaks in the summer vs. the winter
Utilizing the PI System to calculate zonal loads

- VELCO has limited access to distribution loads
- Zonal loads are calculated by adding generation located in the zone to the tie line flows into the zone
- Load = Gen1 + Gen2 + Tie1 + Tie2 + Tie3 - Tie4
Example of load zone calculation

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Geographic distribution varies over time, by season and load level

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- 7/18/2013: 11.94% 7.65% 6.97% 9.63% 2.31% 3.67% 16.46% 6.27% 5.90% 8.78% 3.13% 1.22% 6.21% 3.71% 3.44% 2.69% 1.00
- 9/11/2013: 11.59% 7.41% 6.66% 9.50% 2.14% 3.66% 16.35% 6.53% 6.21% 8.54% 3.29% 1.31% 6.39% 4.12% 3.53% 2.79% 1.00
- 10/29/2013: 11.97% 7.73% 7.43% 10.65% 3.01% 3.44% 14.25% 5.47% 5.40% 9.02% 3.22% 1.51% 6.13% 3.78% 3.79% 3.20% 1.00
- 1/2/2014: 13.35% 9.66% 7.78% 9.05% 2.36% 3.33% 13.98% 5.00% 4.27% 9.51% 3.79% 1.78% 5.37% 3.83% 3.99% 2.94% 1.00
- 3/3/2014: 12.64% 10.17% 7.23% 9.21% 2.73% 3.31% 14.12% 4.97% 4.81% 9.20% 3.40% 1.60% 5.67% 3.96% 3.95% 3.02% 1.00
- 5/15/2014: 11.15% 9.28% 6.52% 8.30% 3.59% 3.45% 14.20% 5.74% 6.94% 9.56% 3.15% 1.36% 6.40% 4.10% 3.53% 2.72% 1.00
The transmission grid is undergoing a profound transformation
Renewable energy
Smart grid

PI System data analysis helps us adjust our study assumptions as the system evolves
VELCO Load Curve Study
Case #1

Increase of solar generation “behind the meter” is offsetting VELCO demand curve

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Solar generation is reducing the summer peak
Model accuracy is critical

The model includes tens of thousands of generators, loads, lines and other equipment.

Many opportunities for errors.

PI System data analysis to compare the computer results to system measurements.
PI System snapshot can be displayed in an Excel diagram
The right solution is not always obvious

Selecting the preferred option involves weighing tradeoffs

PI System data analysis can help us select the most appropriate solution
Simplified example of an export constraint

- **Assumptions**
  - Load is constant
  - Generation is constant
  - The constraint is due to line capacity only

- **Export problem**
  - Generation is always restricted
  - Transmission solutions
    - Add a third line
    - Upgrade both lines
PI System data show that the export margin is not constant.

- **Reality**
  - Load is not constant
  - Generation is not constant
  - The constraint itself can vary based on several factors
Spreadsheet what-if analysis: Added 60MW Solar

- Scaled existing solar generation by 60 MW
- Negative margin is the estimated amount of additional curtailment of generation
  - Nearly daily occurrence
  - Exposure estimated to be about 10% of the time
- The solution may be other than transmission, ~ $80M for a 20-mi line
- A less costly option may exist
  - Restriction, ~ $XM / year
  - Storage
  - Hybrid solution
Next Steps

• Upgrade to PI Server 2015
  – Look into Future Data storage for peak load forecast data
  – Look into Asset Analytics to automate the load calculations and move away from using a spreadsheet
  – Look into PI Notifications to receive real-time alerts in case of failure events (or near-failure events)
PI System improves transmission planning

**COMPANY and GOAL**

VELCO is Vermont’s transmission-only utility. Its functions include:
- Plan, design, operate, maintain, and construct the transmission system in a cost-effective manner

**CHALLENGE**

Design a reliable system in the midst of an evolving regulatory, public policy and market environment.
- Forecast load while accounting for future effects of efficiency spending, renewable energy goals
- Check model for unknown changes
- Account for intermittent generation

**SOLUTION**

Review PI System data more frequently to detect trends in system behavior, and adjust study approaches.
- Compare real time system events against computer simulations
- Review the same type of data regularly over time
- Look for new ways of analyzing data

**RESULTS**

Realistic system model.
Methods evolving with system.
Cost-effective solutions.
- The PI System is a window into the real system
- Transmission upgrades can be very costly
- Better models and methods result in more cost-effective solutions
Contact Information

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VELCO
Questions

Please wait for the microphone before asking your questions

State your name & company

Please don’t forget to...

Complete the Survey for this session

Evaluation Form (Seminar Location - Date)

Name: ___________________________ Company: ___________________________

Email: __________________________

Quality and content of the presentations

- Welcome
- The Journey To Real Time Operational Intelligence
- The Power of Connection
- Tank Level Management System
- Using the PI System to Aid in Troubleshooting Operational Aspects of Oil and Gas Well Drilling and Completion
- Unleash your Infrastructure
- Information on the Spot
- Wrap-up/Seminar Conclusion

Quality and organization of the seminar

- Choice of date
- Time allowed for lunch/breaks
- Choice of presentations
- Pros and cons allowed for the organization
Thank You

Danke

Merci

Gracias

Spasibo

Obrigado

감사합니다

谢谢

ありがとう