2012 Grid Strategy: Distribution Management System

Advanced Applications for Distributed Energy Resources

Jared Green
Project Manager

January 14, 2013

IEEE PES DMS Task Force Meeting
2012 Strategic Topic Goals

• Understand the basics of DMS advanced applications
• Ability to rank benefits of advanced DMS applications based on utility preferences
• Reveal the value of each application
• Show benefits of combined DMS applications are greater than the sum of the individual programs
Distribution System of the Future

**Bulk Electric System**

- CBS
- IHD
- REIT
- CES
- RES
- EMS

**Substation**

- Flow Battery
- Feeder Improvements: CVR/VVO, ASR

**EV Impact**

- Smart Thermostats
- Simply Solar
- Smart Appliances

**Partner Projects**

- Sunverge
- Smart EVSE Charging

**Rates**

- Critical Peak
- Normal

**Red denotes project or device interactions with other projects or devices.**

© 2013 Electric Power Research Institute, Inc. All rights reserved.
Emerging Technology Office
Education Seminar Series

Distributed Energy Resource Management System (DERMS)
Duke Energy DERMS

• For more information on the Alstom DERMS Demonstration at Duke Energy please contact Jared Green (jgreen@epri.com) at EPRI to be directed to the appropriate contact at Duke Energy.
Cost-Benefit Analysis Guiding Documents

• “Methodological Approach,” published Jan, 2010
  - Jointly funded by DOE and EPRI
  - Provides framework for estimating benefits & costs
  - Provides definitions, concepts and data sources
  - Publicly available: Product ID 1020342

• “Guidebook for Cost/Benefit Analysis of Smart Grid Demonstration Projects: Measuring Impacts and Monetizing Benefits,”
  - Provides a manual for practical application with step by step instruction
  - Provides guidance for documenting the project in detail and approach to perform a CBA,
  - Includes templates for working through the process.
  - Vol. 1 Publicly available (Replaced): Product ID 1021423
  - Rev. 1 publicly available (Jan. 2013): Product ID 1025734
CBA Terminology: Impacts, Metrics, and Benefits

- Functions are capabilities and features of the SG system.
- Impacts are measurable physical changes within the bounds of the demonstration system.
- Impacts are differences between a measured quantity and its baseline measurement.
- Benefits are monetary products of impacts. Some may be costs.
- In short: We measure impacts, calculate metrics, monetize costs and benefits.
DMS Advanced Applications – CBA Evolution

- Wide variety of applications and objectives/benefits.
  - We’ll categorize these to narrow our focus.

- DMS Impact Measurement
  - Many of the apps don’t lend to experimentation to demonstrate impacts.
DMS Advanced Applications– CBA Evolution

Categorized Objectives of Smart Grid Applications

- **Reliability**
  frequency and duration of customer interruptions

- **Utility Operational Efficiency**
  people and how they do their jobs:
  non-fuel O&M, non-production A&G assets, safety

- **System Operational Efficiency**
  the power system and how efficiently it runs:
  losses, combustion, dispatch optimization, emissions

- **Utility Asset Efficiency**
  production assets required in GT&D

- **Power Quality**
  harmonics, sags/swells, voltage violations

- **Customer Efficiency**
  energy consumption required to provide desired benefits

- **Others?**
  theft reduction, customer service, satisfaction, others?

Primary Objectives of most Advanced DMS Applications are in these categories.
<table>
<thead>
<tr>
<th>Applications</th>
<th>Primary Objective Category</th>
<th>Secondary Objective Category</th>
</tr>
</thead>
<tbody>
<tr>
<td>Condition-Based Maintenance</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Workforce Location</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Asset Management</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Outage Management</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Unbalanced Load Flow</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>State Estimation</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Contingency Analysis</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Operator Training Tool</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Switching Management</td>
<td>Util Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>FLISR</td>
<td>Reliability</td>
<td>Util Op Eff</td>
</tr>
<tr>
<td>DER Management</td>
<td>Reliability</td>
<td>Sys Op Eff</td>
</tr>
<tr>
<td>Volt-Var Management</td>
<td>Sys Op Eff</td>
<td>Util Asset Eff</td>
</tr>
<tr>
<td>Optimal Network Reconfiguration</td>
<td>Sys Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Short-term Load forecasting</td>
<td>Sys Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Adaptive System Protection</td>
<td>Sys Op Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Dynamic Equipment Rating</td>
<td>Util Asset Eff</td>
<td>Reliability</td>
</tr>
<tr>
<td>Demand Response Mgt</td>
<td>Util Asset Eff</td>
<td>Reliability</td>
</tr>
</tbody>
</table>
Utility Cost Sheet with Customer Focus

<table>
<thead>
<tr>
<th>Economic Costs and Benefits</th>
<th>System Operational Efficiency</th>
<th>Utility Operational Efficiency</th>
<th>System Asset Efficiency</th>
<th>Reliability</th>
<th>Environment</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fuel</td>
<td>Purchased Power</td>
<td>A/S</td>
<td>Emissions - SO2, NOx, CO2</td>
<td>Operator Costs</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Revenue on Enabled Sales</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Non-Fuel O&amp;M</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Customer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>A&amp;G</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Non-Prod Assets</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Trucks, A&amp;G, Tools</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Capital Deferral/Advancement/Savings</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Value of Service (Comfort, Light, etc)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Cost of equipment (Devices)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Equity</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Theft Reduction</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ΔTons SO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ΔTons CO2</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ΔPounds Hg</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ΔParticulates</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Security Impacts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Oil Saved</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Major Blackouts Avoided</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Power Quality Impacts</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Change in Momentary Outages</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Change in Sags, Swells, Voltage violations</td>
</tr>
<tr>
<td></td>
<td>Efficiency Impacts</td>
<td></td>
<td></td>
<td></td>
<td>ΔkWh System Losses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ΔkW System Losses</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>ΔkW Consumed</td>
</tr>
<tr>
<td></td>
<td>Equity Impact</td>
<td></td>
<td></td>
<td></td>
<td>Metering Accuracy</td>
</tr>
</tbody>
</table>

- ΔFuel expense (for generating companies)
- ΔPurchased Power (esp for non-gen retailer)
- ΔA/S (mainly in ISO/RTO markets)
- Δ$ for allowances (for generating companies)
- ISO/RTO operator costs
- Δ$ for enabled sales, under some conditions
- Δ revenue requirements
- Δ$ revenue requirements
- Customer costs, from damage functions
- Customer costs, from damage functions
- Economic loss estimate, apart from utility cost
- Value at least as great as otherwise paid for it
- Cost of program-related devices
- Revenue gained or energy saved @ marcost
- May be monetized or noted in quantity
- May be monetized or noted in quantity
- May be monetized or noted in quantity
- May be monetized or noted in quantity
- Barrels saved. (monetization included in fuel)
- Qualitative note, too uncertain for quant.
- Qualitative note. Minimal economic diff.

This could serve as a top-level CBA summary sheet, with additional details behind.

Other line items can be added as needed.
Key Findings from the Questionnaire

• DMS is the system of choice
• DMS focus on traditional apps
• DR and DER functionality being added to DMS
• Management systems cross functional lines
• Systems to be linked in future
• Limited desire for automatic dispatch of DR and DER
• Limited forecasting of resources
• Benefits attributed to advanced apps centered around system improvements
Together...Shaping the Future of Electricity