New Frontiers of Smart Grid Panel

Transitioning to a New Future State

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ARRA Grid Modernization

- US Spent $7.9B in ARRA Smart Grid Projects
  - Includes $4.5B Federal stimulus and industry matching funds
  - Five year grants starting in 2010

- Results are available
  - www.smartgrid.gov
  - Several reports are posted
  - Recipients are here!

- Developing a platform for significant grid modernization investment

Source: US Department of Energy Office of Electricity and Energy Reliability: Results and Findings from the ARRA Smart Grid Projects, May 2013
S&C Smart Grid Technologies

- Reactive Compensation
- Substation Batteries 10’s of MW
- Distributed Intelligence and Control
- Storage at Grid Edge 10’s of kW
- Micro-grids

Graphics adapted from an EPRI Presentation ©2011 www.sandc.com
# Industry in Transition

<table>
<thead>
<tr>
<th>Past:</th>
<th>Future:</th>
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<tbody>
<tr>
<td>• Regulated business models</td>
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<td>• Large generation stations</td>
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<td>• Centralized dispatch</td>
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<td>• Minimal constraints</td>
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<td>• Outages “tolerated“</td>
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<td>• Grid “over designed”</td>
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<td>• Radial distribution</td>
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<td>• Homogeneous technology</td>
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<td>• Slow distribution operations</td>
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<td>• Uni-directional power flow</td>
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<td>• Emerging “customer choice”</td>
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<td>• Distributed &amp; green resources</td>
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<tr>
<td>• Distributed intelligence</td>
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<td>• Pressures for “green power”</td>
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<td>• Less tolerance of outages</td>
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<td>• Infrastructure exhausted</td>
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<td>• Looped or meshed distribution</td>
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<td>• Mixing old with new</td>
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<td>• Near real-time micro-grids</td>
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<td>• Multi-directional power flow</td>
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My bet:

- Grid automation + energy storage
- Integration across applications
- Optimized oversight with local intelligence
Facilitates “System” Optimization

- Reliability and resiliency expectations are increasing, and yet...
- Utility system performance can be improved, but there are affordable limits
- View of “System” is changing to include the customer
- Satisfies multiple objectives
  - Service differentiation
  - Reliability / Resiliency
  - Demand response
  - Renewable integration

Reliability vs. Customer Expectation

- Micro-Grid: Satisfies multiple objectives most of the time
- System Future: Good, Average, Perfect
- System Now: Best, Good, Average, Perfect
- Customer Expectation: Majority are satisfied most of the time
Organization

- Centralized policy
- Local intelligence
- Occasionally matrixed
Challenges for the Future

• Connecting infrastructure investment to economic vitality
• Overcoming regulatory hurdles for distributed activity to capture and reward all value streams
• Interoperability of all the pieces including the legacy system
• Managing bi-directional power flow
• Developing workforce competencies
• Creating tools for planning and dynamic operations
• Utilizing large amounts of data – available now and growing
• Overcoming cyber-security obscurities