Business Rationale for Implementing “Smart Grid” T&D Architecture to Support DER Integration

Marianne Dickerson, Principal Bridge Strategy Group

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Today’s Discussion…..

- Changing Business Requirements for the Power Delivery System of the Future
- What is “Smart Grid” and How Will it Change the T&D Architecture
- Why DER Integration & Control is a Key Component of the “Smart Grid”
  - Meet customer needs regarding customized energy management solutions and enable dynamic load control
  - Achieve carbon reduction goals as part of RPS
  - Enhance grid capabilities to mitigate and respond to grid contingencies
  - Improve capital efficiency and asset management
The business environment for utilities is rapidly changing......

**Changing Customer Needs**
- "Digital age" – more demanding customers
- Specific customer segments desire solutions to better manage energy consumption

**Aging Grid**
- Increasing risk of reliability degradation
- Limited information to monitor asset condition

**Increasing Regulations**
- State and Federal emphasis on decreasing GHG emissions (e.g. RPS targets)

**Resource Constraints**
- Aging workforce with increasing workloads for load growth and asset replacement projects

**Technology Evolution**
- Evolution from analog to digital T&D technologies
- IP-based communications

**Changing Loads & Energy Supply**
- More volatile energy supply due to intermittent renewables
- Peak loads increasing while base load factors decline

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...the “future” power delivery system must be different from today’s system

**Today’s Power Delivery System**
- Homogeneous service offering
- Customers uninformed participants in the energy supply chain
- Energy supply from central generation, primarily fossil, nuclear, natural gas, and hydro
- Predictive-based asset replacement
- Grid communications primarily one-way, SCADA based
- Limited ability for grid to diagnose and respond to grid contingencies, operator intervention required

**Future Power Delivery System**
- Customized service offerings tailored to different customer segments
- Customers become active participants in the energy supply chain
- Energy supply from central and distributed generation sources, significant increase in capacity from renewables
- Condition-based asset replacement
- Two-way, “real-time” communications throughout the grid
- "Real-time” monitoring, diagnostic, reconfiguration capabilities enable the grid to respond to grid contingencies automatically
The future power delivery system will require a “Smarter” T&D architecture with enhanced capabilities along four key dimensions …..

A “Smart Grid” T&D Architecture Should……

Enable Customer Energy Management Solutions and Dynamic Load Control
Deliver solutions that enable customers to become “active” participants in the energy supply chain to better manage energy consumption. Optimize grid response to changing load conditions through dynamic load control during system-wide peaks and isolated circuit contingencies.

Reduce GHG Through Integration of Bulk and Distributed Renewable Energy Supply
Integrate and manage new sources of bulk and distributed renewable energy supply in a manner that maintains/improves power quality, reliability, and economic dispatch.

Improve Reliability & Power Quality Through Real-Time Diagnostics and Remediation
Mitigate catastrophic bulk power system failures through advanced wide-area measurement and control capabilities. Monitor and assess distribution system conditions and control distribution system configuration “real-time” to respond to system contingencies to minimize service disruption.

Improve Asset Throughput and Overall Capital Efficiency
Increase power throughput on transmission & distribution assets. Improve capital efficiency by ensuring assets are replaced or capacity is added “at the right time”, “right amount”, and “right location”.

…requiring a number of new technologies as part of the “Smart Grid” T&D architecture.

Technology Components of the “Smart Grid” Architecture - Examples

- AMI
- Smart Meters
- HAN
- MDMS
- DER
- PV
- PHEV
- Microturbines

- Bulk renewable interconnection
- Solar Thermal
- Wind
- Biomass
- Dynamic voltage control
- SVCs
- DER interconnection & control systems
- multi-agent “intelligent” distribution control systems

- Wide area management systems
- Synchronized phasor measurement units
- “Closed loop”predictive control systems
- Distribution automation
- DER microgrids
- Dynamic voltage control

- Equipment monitoring
- Dissolved gas analysis
- Distribution transformer monitoring
- Offline/online cable monitoring
- DER
- Energy storage
- HTS conductors & transformers
- Composite core conductors

- Advanced telecommunications (Wi-Max, BPL, RF Mesh, etc.)
- Middleware and data management architecture to support system interoperability
Customized Energy Management solutions should provide customers with choices regarding demand and supply side options

- Alerts regarding price-signals and/or curtailment events sent via customer channel preferences (e.g. text, email, etc.)
- Web-based reporting and analysis tools available for customer analysis
- Customers define parameters under which demand and supply side resources are managed
- Wide-range of channel partnerships deployed by utilities for EE, DR, and DER programs for customers to select from
- Prescriptive and non-prescriptive EE programs
- Price-based and incentive-based DR programs
- Options for integration and management of DER devices (customer-owned/utility dispatched, etc.)

The T&D architecture must also include advanced load control technologies that manage both demand and supply side resources

### Level of Sophistication - Load Management Capabilities

<table>
<thead>
<tr>
<th>Solutions</th>
<th>Description</th>
<th>Level of Sophistication</th>
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<tbody>
<tr>
<td>A/C Cycling</td>
<td>A/C compressor switches can be activated by the utility to reduce load during curtailment events</td>
<td>Load curtailment targeted to customers on “circuits under stress”</td>
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<tr>
<td>Comprehensive End-Use Device Control</td>
<td>End use devices can be customer programmed or controlled by utilities to respond to price-based signals based on customer defined preferences (e.g. Shut off specific end use devices)</td>
<td>Real-time assessment of dispatchable DR on a locational-marginal pricing node basis</td>
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<tr>
<td>Reliability &amp; Economic Dispatch Based Load Control (Demand-Side Resources)</td>
<td>Load curtailment targeted to customers on “circuits under stress”</td>
<td>Considers and activates customer-sited DER as a “dispatchable resource” in addition to load curtailment</td>
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<td>Customer DER Dispatch</td>
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<td>Real-time grid configuration and VAR support</td>
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- Automatically dispatch DER to provide VAR support
- Enable real-time reconfiguration (e.g. self-islanding microgrids) based on system contingencies
DER should be considered as a viable option to enable utilities to achieve RPS goals

Current Situation – RPS Targets

- Many utilities face a difficult challenge of meeting RPS targets, particularly in the next five to seven years
  - transmission constraints are proving to be a major barrier in states such as CA and TX

- Utilities are beginning to realize that DER should be considered a viable option towards achieving RPS goals
  - e.g. SCE’s PV initiative

DER will play a key role in enhancing the grid’s “real time” grid control & remediation capabilities

The Smart Grid architecture should incorporate DER to improve voltage regulation capabilities and enable microgrids as a remediation option for grid contingencies
DER should be factored into system planning processes as an option to defer capital projects and improve capital efficiency

- DER is a viable option for grid support to improve reliability, power quality, and defer capacity upgrades
  - May be applicable as a peak shaving option on specific circuits approaching capacity thresholds
  - Can be used to address localized power quality issues
  - Provide temporary power during maintenance and repair events

- DER assets are integrated into the grid in one of three modes:
  - Directly (internally) to a specific circuit
  - At the substation
  - In an “island” mode to perform maintenance

- Some utilities such as DTE have formally incorporated DER assessment into their system planning processes to evaluate “what if” scenarios involving DER versus traditional T&D capacity upgrades (e.g. new substation, transformer replacement, etc.)