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

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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

…the "future" power delivery system must be different from today's system

Today's Power Delivery System	Future Power Delivery System
Homogeneous service offering	Customized service offerings tailored to different customer segments
Customers uninformed participants in the energy supply chain	Customers become active participants in the energy supply chain
Energy supply from central generation, primarily fossil, nuclear, natural gas, and hydro	Energy supply from central and distributed generation sources, significant increase in capacity from renewables
Predictive-based asset replacement	Condition-based asset replacement
Grid communications primarily one-way, SCADA based	Two-way, "real-time" communications throughout the grid
Limited ability for grid to diagnose and respond to grid contingencies, operator intervention required	"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

Enable customer energy management solutions and dynamic load control
- AMI
  - Smart Meters
  - HAN
  - MDMS
- DER
  - PV
  - PHEV
  - Microturbines
- Advanced load control systems

Reduce GHG through integration of bulk and distributed renewable energy supply
- Bulk renewable interconnection
  - Solar Thermal
  - Wind
  - Biomass
- Dynamic voltage control
  - SVCs
- DER interconnection & control systems
  - multi-agent "intelligent" distribution control systems

Improve reliability and power quality through real-time diagnostics, and remediation
- Wide area management systems
  - Synchronized phasor measurement units
  - "Closed loop" predictive control systems
- Distribution automation
- DER/microgrids
- Dynamic voltage control

Improve asset throughput and overall capital efficiency
- 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 <u>and</u> supply side options

Customized Reports & Information Distribution

- 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

Options for End-Use Control (DR and DER)

- Customers define parameters under which demand and supply side resources are managed

Selection of Delivery Channels

- Wide-range of channel partnerships deployed by utilities for EE, DR, and DER programs for customers to select from

Menu of Demand and Supply Side Options

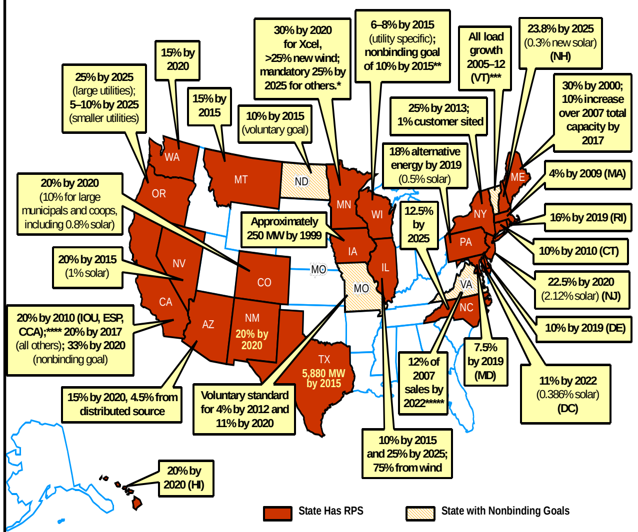
- Prescriptive and non-prescriptive EE programs
- Price-based and incentive-based DR programs
- <u>Options for integration and management of DER devices</u> (customer-owned/utility dispatched, etc.)

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 →

Solutions	A/C Cycling	Comprehensive End-Use Device Control	Reliability & Economic Dispatch Based Load Control (Demand-Side Resources)	Customer DER Dispatch	Real-time grid configuration and VAR support
Description	• A/C compressor switches can be activated by the utility to reduce load during curtailment events	• 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)	• Load curtailment targeted to customers on "circuits under stress" • Real-time assessment of dispatchable DR on a locational-marginal pricing node basis	• Considers and activates customer-sited DER as a "dispatchable resource" in addition to load curtailment • Dispatch based on reliability and economic dispatch priorities	• Automatically dispatch DER to provide VAR support • Enable real-time reconfiguration (e.g. self-islanding microgrids) to based on system contingencies

DER should be considered as a viable option to enable utilities to achieve RPS goals

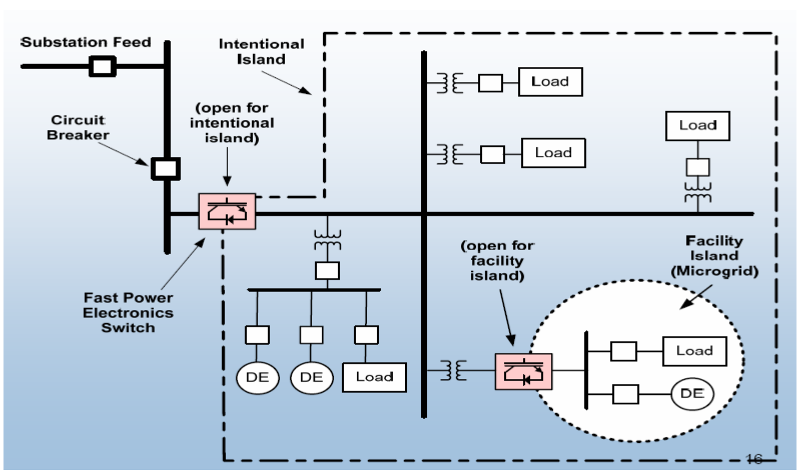


Current Situation – RPS Targets

- 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

Source: Cambridge Energy Research Associates, Database of State Incentives for Renewable Energy (DSIRE).

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

Source: NREL: DER Applications & Testin

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.)

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