

# SMART TRANSMISSION MAKING A SMART GRID SMARTER

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# Smart Transmission Is The Intersection Of Four Elements

- The physical infrastructure of the system
- Advanced information technologies
  - ▣ Measurement, analytics, automation, controls
- High-speed bi-directional communication
  - ▣ Control commands
  - ▣ Hierarchical communication of data
- Advanced components
  - ▣ Superconductors
  - ▣ Energy storage
  - ▣ Power electronics (FACTS devices)
  - ▣ HVDC (point to point and advanced multi-terminal)

# Impacts On Renewable Generation

- Continued investment in basic transmission infrastructure is still needed and is essential for renewable generation access
- Deployment of advanced technology is critical to properly integrate new forms of generation into the grid reliably and at lower cost
- This needs to be done reasonably fast
  - ▣ We need to stop the practice of every transmission owner doing their own alpha and beta testing (other industries don't do this)

## Section 1301 Of The Energy Independence & Security Act of 2007

- Increased use of digital information and controls technology to improve the reliability, efficiency and security of the grid
- The dynamic optimization of grid operations, with full cyber-security
- Development of interoperability standards, including the infrastructure serving the grid (“plug and play”)

# Technology

## Communication, Sensing and Measurement

- Many owners investing in high-bandwidth communication networks
  - ▣ Collect network information
  - ▣ Communication, command and control between power plants, breakers, relays, sensors and the control center
- Advanced sensing
  - ▣ Synchrophasor technology is an example
  - ▣ 30 samples *per second!* Not once every four seconds

# Technology

## Data Management

- New sensing equipment and high-broadband communication are producing mountains of raw data
  - ▣ Can overwhelm the system operators
  - ▣ Therefore the industry is deploying hierarchical data management
    - Data initially stored at the substation
    - Critical information sent immediately
    - Processed with advanced control room tools to present the operator with the most critical information – the nuclear approach
- Data ultimately archived for post-operation review and to assist asset management decisions

# Technology Analytics

- All of this technology is no good if we can't manage it in real time
- The modern transmission operator is using the following tools in the control room
  - ▣ State estimation
  - ▣ Topology processors
  - ▣ SCED and SCUC
  - ▣ Contingency analysis

# Technology

## Analytics (cont.)

- Transmission operators are likely to be using the following tools in the near future
  - Advanced operator decision support tools
    - Think “Boeing 777” (It diagnoses its own problems and suggests the fix to the pilots)
    - Tiered information including “drill down”
    - Automatic data “hiding” during severe events
  - Congestion management visualization
  - Wind forecasting tools (Texas and Midwest events)
  - Synchrophasor displays
  - Automatic remote “resetting” of protective relaying to match the topology of the network post-contingency
  - And more to come

# Technology

## Advanced Components

- Superconductors
  - Ideal for urban environments
  - Fault limiters
- Voltage Source Converter HVDC
  - Highly controllable
  - Independent real and reactive power control
  - Power reversals without polarity reversal
  - Can operate at zero power flow (conventional HVDC can't)
  - Ratings of modules now up to 800-1000 MW
  - Can help stabilize the AC network
- Multi-terminal VSC HVDC
  - Multiple injection points and multiple withdrawals
  - Ideal for wind farm collection over distance (or offshore)
  - European Supergrid will likely use this
  - US adoption likely

# Storage – Unlocking The Full Potential Of Renewable Generation

- The “Missing Link” – multiple technologies will be deployed
- Ultimately a critical technology
- Bulk storage – temporal energy shifting
  - ▣ Pumped hydro, CAES and large batteries
- Load following, black start and reserve sharing
  - ▣ Batteries and super capacitors
- Frequency regulation
  - ▣ Flywheels
  - ▣ Batteries

# Summary

- Smart transmission expected to provided many benefits
  - Better reliability
  - Increased system throughput
  - More efficient generator fuel use
  - Greater use and penetration of renewable resources
  - More effective use of storage
  - Fosters an improved wholesale market
- How will we know we're "there"????

## Summary (cont)

- First of all, this is a journey and not a final destination
- However, we will know we have crossed the threshold into a full transmission smart grid environment when...
  - ▣ Our tools and analytics can pinpoint problems and proactively suggest solutions/corrective actions for most events
  - ▣ The human operator “retreats” from hands-on operation of the grid during most hours of the day
- Finally, the “new world” will demand operators and engineers who are facile with the technology
- Simulators will take on even greater importance

# Thank You!



## Questions?