

# *Integration and Operation Challenges in Modernizing the Grid*

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*Dominion Virginia Power*

*Electric Transmission Operations & Reliability*











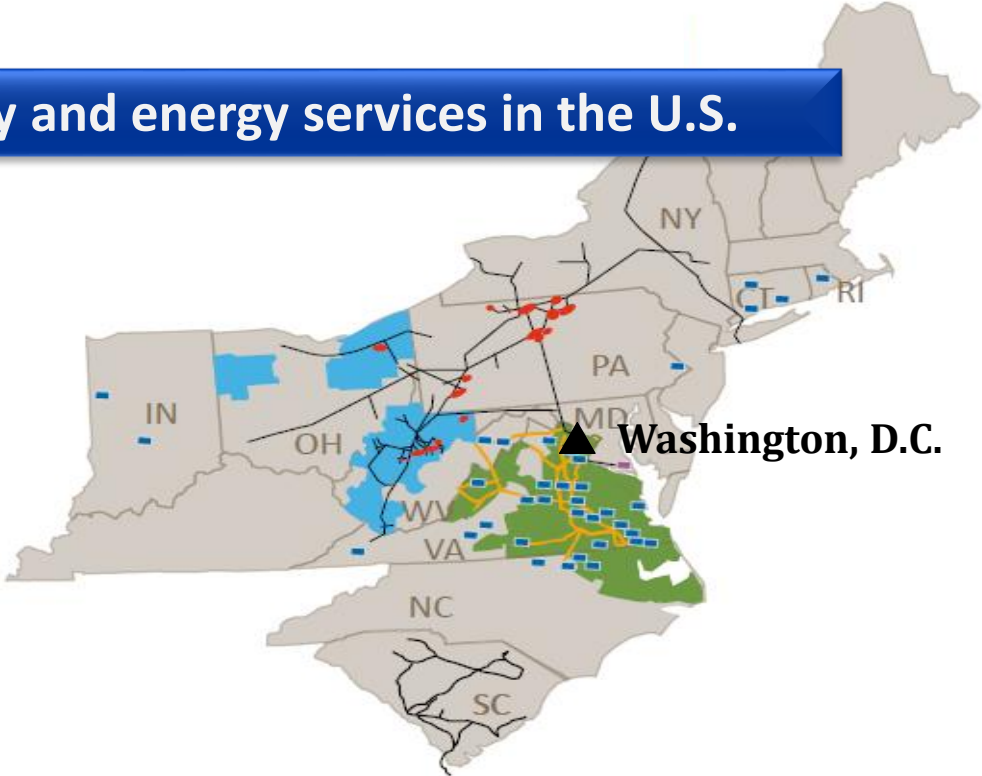
2016 Electric Power Industry Conference  
Pittsburgh, PA

# Dominion Profile



**A leading provider of energy and energy services in the U.S.**

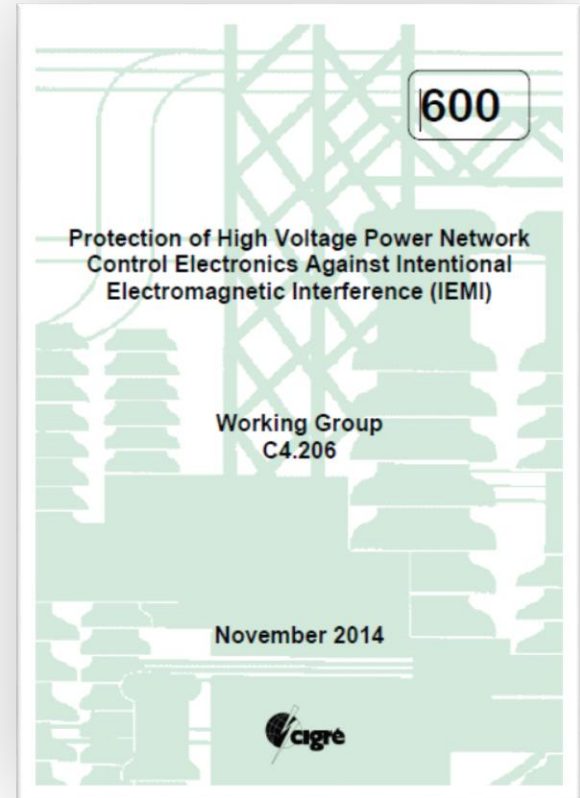
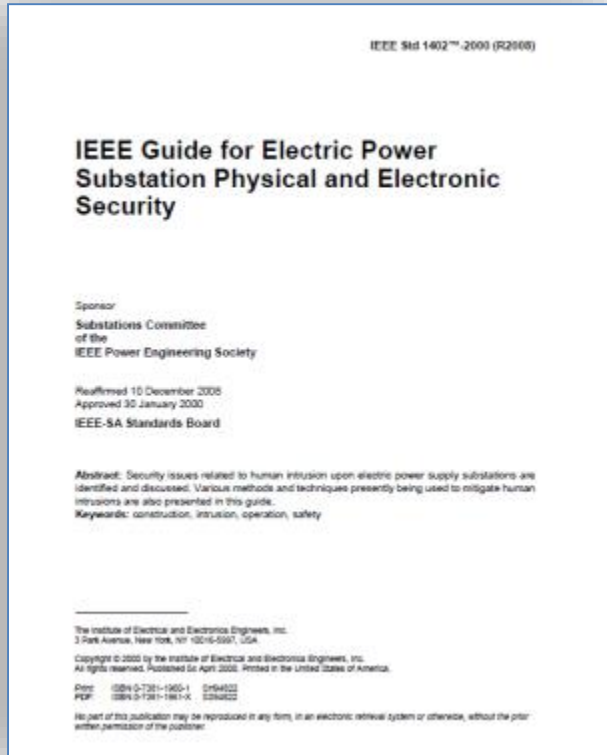
-  24,600 MW of electric generation
-  500kV electric transmission system
-  12,200 miles of natural gas transmission, gathering and storage pipeline
-  928 billion cubic feet of natural gas storage operated
-  Cove Point LNG Facility
-  2.5 million electric customers in VA and NC
-  1.3 million natural gas customers in OH & WV
-  1.2 million non-regulated retail customers in 13 states (not shown)



**250+ MW of contracted solar generation in 6 states (not shown)**

# Take Advantage of Worldwide Experiences

## Engineers Active with IEEE and Cigre



# Key Considerations for Recovery

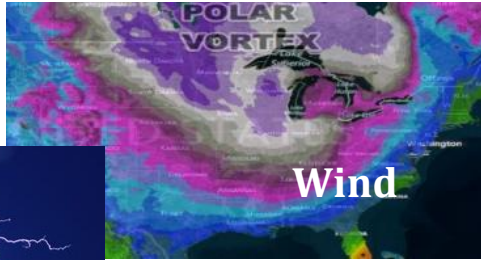
## Customer Expectations for Extreme Events



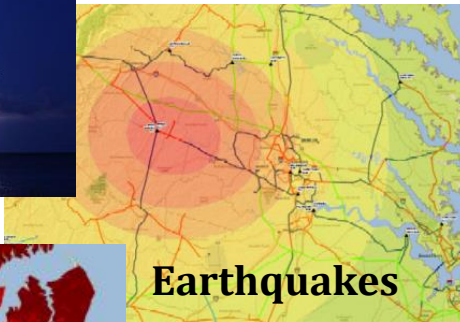
- **Transmission restoration**
  - Network integrity is initial focus
  - Must provide offsite power to nuclear plants
  
- **Transmission service to Distribution substations**
  - Provide power within 3 days (Customers accept)
  - Provide power within 5 days (Customers not happy)
  - Provide power greater than 7 days (Utility has failed mission)
  
- **Dominion looks for 7 days as maximum transmission restoration for *ALL* events – natural or man-made**

# Dominion's Approach

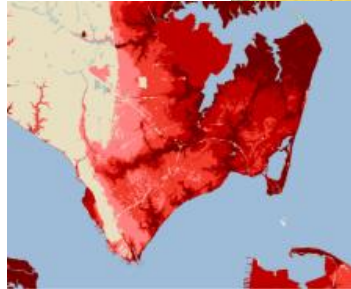
Must consider *all* hazards not just storms



Lightning



Earthquakes



Floods



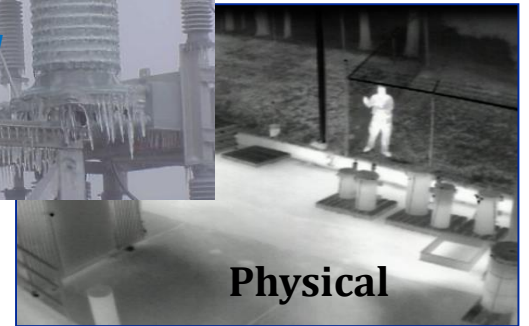
Geomagnetic Disturbances



Icing



Cyber



Physical

# Changing Business Landscape

## Renewable Energy Impacting Designs and Operations



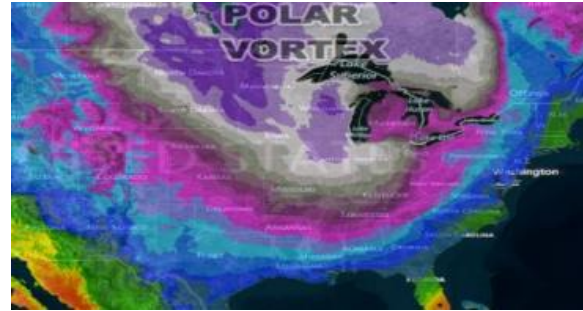
- **Rapidly blurring lines between Transmission and Distribution growing similarities**
  - Network designs
  - Network operations
  - Markets
- **Investment will be needed to communicate and support renewable integration to maximize their benefit**
- **Renewable promise must be balanced with understanding of overall grid architecture**
  - Inertia is important
  - Frequency
  - Voltage
  - Restoration
- **Consumers will ultimately decide the future**
  - Mix will be based on perceived value

# Maintaining Safety, Reliability and Resiliency Among Today's Electric Grid Challenges



## — Natural Events

- Hurricanes, Tornadoes, Derecho Events
- Geomagnetic Disturbances
- Earthquakes
- Polar Vortex



## — Man-made Events

- Terrorism (Physical/Cyber)
- Electromagnetic
- Copper Theft



## — Changing Location and Mix of Generation

- Increase in Renewables, Distributed Generation

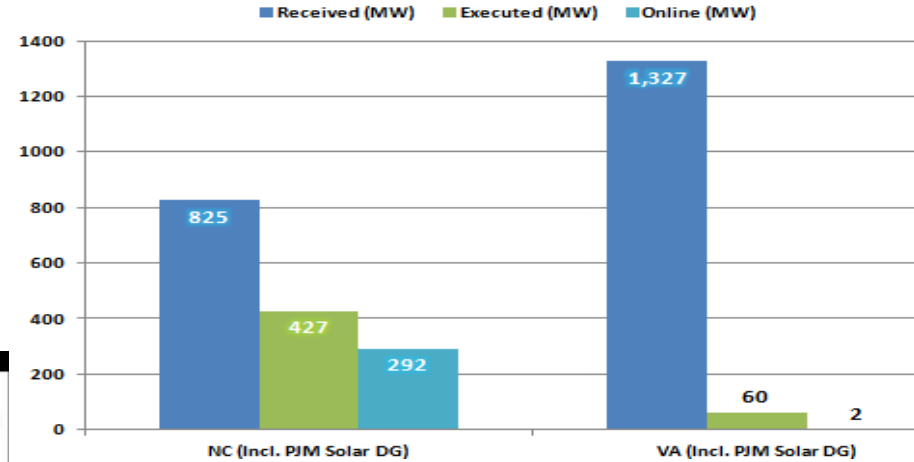
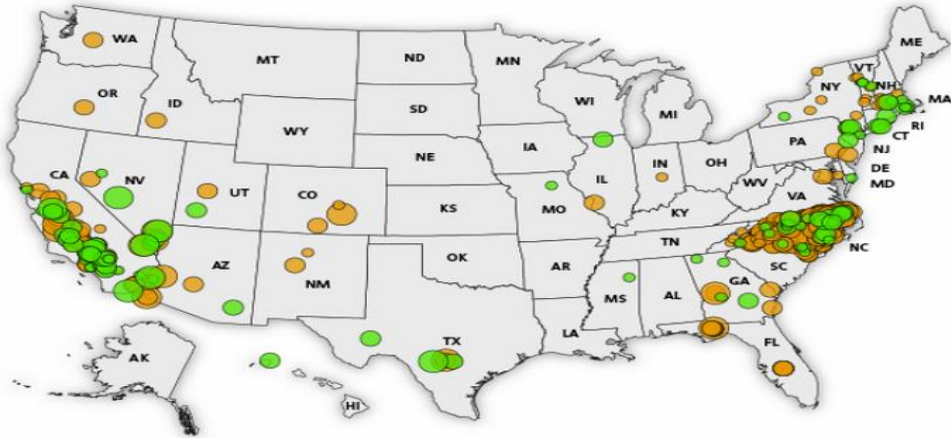


# Increasing Renewable Penetration on DVP Transmission and Distribution grids



- Increase in utility-scale solar in our service area on both Transmission and Distribution grids

US planned utility-scale solar projects in advanced development or under construction



- Peak solar does not coincide with peak load period due to solar incidence in our service area



# Increasing Renewable Penetration on DVP Transmission and Distribution Grids



## — Impacts on safety and system operations:

- Anti-islanding and transfer trip
- Overvoltage protection
- Customer and utility equipment protection
- Response of inverters for varying events

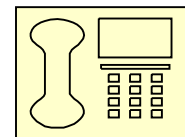
### *Choices of communication mediums*



Fiber optic



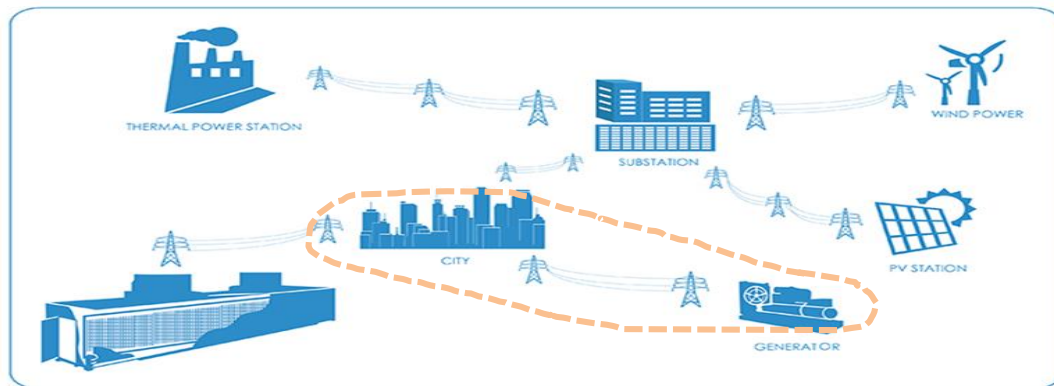
Radio,  
uwave



Phone

**South Australia hit by state-wide power outage**

The whole of South Australia, an area four times the size of the UK, has been left without power as a major storm hits.

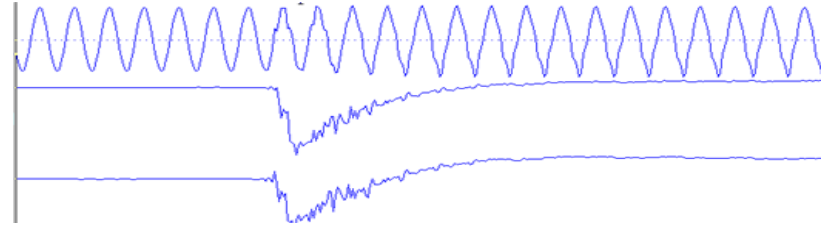


# Increasing Renewable Penetration on DVP Transmission and Distribution Grids



## — Impacts on safety and system operations:

- Power quality
- Reverse power – feeding back to transmission
- Impact on rotating machine life and requirements for new generators
- Utility personnel safety – headways, tagging, system restoration
  - Hurricane Matthew, additional steps for restoration
  - Solar sites submerged in rising water

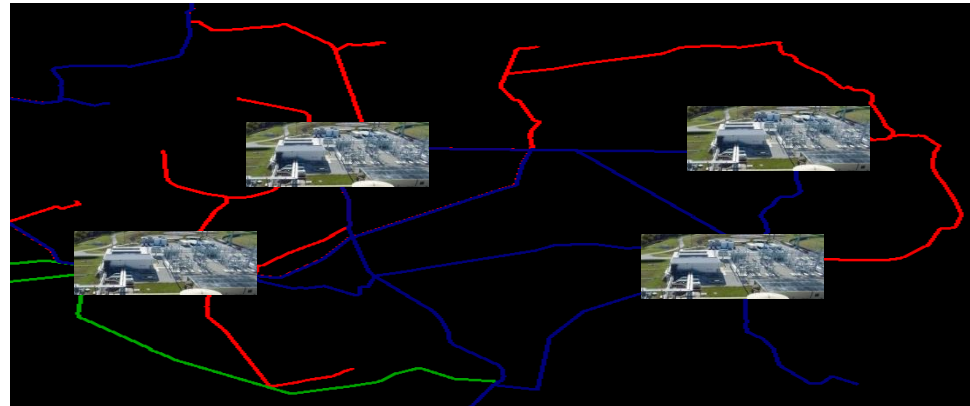
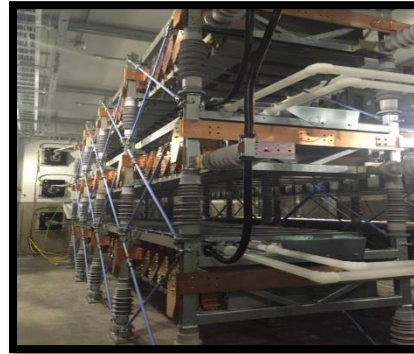


# Deploying New Technology to Address Operations

## - From Daily Events to Extreme Contingencies



- **FACTS devices on both the transmission and distribution systems**
  - STATCOMS
  - SVCs
- **Increasing resiliency by distributing STATCOMs around the transmission system**
- **Understanding response for all events of inverters is critical to:**
  - Prevent blackout from unexpected response
  - Not hinder restoration



# Deploying New Technology to Address Operations – From Daily Events to Extreme Contingencies



## – Mobile equipment and mobile substations

- Rapid restoration of service
- Unusual/emergency system conditions



# Conclusions

- **Use industry best practices and new technology to ensure:**
  - Safety
  - Reliability
  - Resiliency
- **Engineers are needed that understand complexity of integration with increasing renewable penetration**

