# Wind, Solar, Storage and the Future of Reliability

## Based on work of WG C1.27

P Jeffrey Palermo

3 November 2016

# New technologies affecting reliability

- Large wind and solar
- Distributed generation—all types
- Battery energy storage
- Electric vehicles
- Other storage
- Demand-side options
- Micro grids, smart grids, nano grids

# How new technology might affect reliability

- Storage becomes significant
- Rise of active demand
- Large wind and solar
- Changing planning standards
- Implications for future definition of reliability

# Impact of key variables and assumptions

- Operating new technologies
- The scale of individual installations
- Split between static storage and EVs
- Central control and visibility
- Impact on reliability

# Conclusion 1—Reliability

*A measure of the ability of a ~~bulk~~ power system to deliver electricity to all points of ~~utilization~~ consumption and receive electricity from all points of supply within accepted standards and in the amount desired.*

Moving toward 2-way power flows

# Conclusion 2—Adequacy

A measure of the ability of a power ~~the electric~~ system to meet ~~supply~~ the ~~aggregate~~ electric power and energy requirements of its ~~the~~ customers within acceptable technical limits ~~at all times~~, taking into account scheduled and unscheduled outages of system ~~facilities~~ components

# Adequacy—where

- ***Power system*** *includes all elements of the generation, transmission, and distribution systems, and customer facilities that supply or use power, energy, or provide ancillary services;*
- ***Customers*** *include all parties that supply power, energy or ancillary services, as well as those who consume them;*
- ***Requirements of customers*** *include their basic power and energy needs, and also any special requirements, their ability to supply power, and provide ancillary services to the system;*
- ***Acceptable technical limits*** *and* ***scheduled and unscheduled outages*** *are those specified in the applicable planning criteria; and*
- ***System components*** *include all elements of the supply, delivery and utilization systems regardless of ownership or control.*

# Conclusion 3—new data streams

- Many new data streams with enormous amounts of data
  - New customer elements such as DG, controllable devices in homes and businesses, and electric vehicles
  - New methods of data collection and sharing will be needed among stakeholders
- Need to define data and methods of organizing and sharing
  - Among system operators, market operators, distribution operators, distribution and transmission owners, generators, and load customers

# Conclusion 4—End-to-end analyses

- Need to include the entire supply and delivery chain in reliability analyses
- Concepts and tools must be developed
- Must incorporate coordination among transmission, distribution, generation, and load participants
- No longer evaluate generation, transmission, and distribution in separate silos

# Need 1: Probabilistic techniques

The flood of data will challenge the credibility of conventional deterministic analysis methods. Combinations of solar and wind generation patterns, including dg, and customers who can tolerate system outages that may vary by time of day—will introduce a range of geographic and temporal patterns.

Customers dg will change power flow patterns across the *network* introducing new times/conditions to challenge system reliability.

Now multiple dimensions of load and generation regarding time and location must be considered in system reliability analysis. “N-1” type analyses will not provide adequate reliability analyses for customers.

# Need 2: inertia & black start

With a large share of inverter-based generation there will be increased problems in with system frequency because these inverter-based systems do not provide rotating inertia. This will affect rocof, short-circuit ratios, fault currents, voltage stability related to inverter operation, and low-voltage ride-through.

System black-start capability will be significantly reduced if black-start scenarios are not considered in system planning. Inverter-based systems are voltage and frequency ‘takers’ that stop operating whenever they lose their system voltage source and remain offline until voltage is restored. This could be catastrophic following a blackout

A new joint wg with c2 should examine these issues, identify evolving trends, and recommend assumptions standards and criteria that planners should use.

# Needs 3 & 4

- DG connection requirements that recognize system needs
- Handling back-feeding feeders

To contact the WG:

jeff@pjp-consulting.com

# THANKS