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Renewables Good Citizens of the GRID

Keeping the lights on is not only about building enough power plants. In addition to being able to provide sufficient power to supply consumersâ€™ energy demand, power plants must have other electrical attributes, often called Essential Reliability Services (ERS), that support the grid to ensure that power can be properly delivered at all times and that the system can recover after disturbances. Traditionally, these ERS have been provided by conventional generation, like nuclear, gas, and coal plants. It is generally more expensive to provide ERS with renewables than natural gas because there are no fuel savings associated with withholding output but as we move to a low carbon grid it will be important for renewables to play an increasing role in providing ERS.
Most renewables can be configured to provide most if not all Essential Reliability Services (ERS) and can do it as well as or better than traditional fossil generators if planned well, particularly in combination with each other. Careful deployment of a robust mix of renewable generation can ensure grid reliability and achieve GHG reductions at low cost. All renewables can provide grid reliability benefits today, and if we consider and value these benefits we can also foster innovation and do much more over time.
Below are the grid reliability benefits relating to each renewable technology:

Wind
1. Capacity value from Effective Load Carrying Capability (ELCC) analysis
2. Wind farm level voltage and VAR control
3. Frequency response, governor response and inertia
4. Dispatchability

PV DG
1. CPUC Rule 21 Interconnection â€“ December 2015 requirements for solar voltage frequency ride through
2. Capacity value from ELCC
3. Smart inverter features added for local voltage and VAR control
4. Later stage communication and control from Rule 21 will also allow power output setback and the associated dispatchability and governor frequency response.

PV Large Scale
1. Capacity value from ELCC
2. Voltage and VAR control
3. Governor and frequency response capabilities
4. Dispatchability

Concentrating Solar Power
1. Traditional synchronous machine with all voltage/frequency features including governor response capabilities
2. Capacity value through ELCC analysis (even higher with storage)
3. If storage is added, near zero energy loss with dispatchability

Geothermal
1. Traditional synchronous machine with all voltage/frequency features including Inertia and governor response capabilities
2. Very high capacity factor
3. Partial dispatchability

Biomass
1. Traditional synchronous machine with all voltage/frequency features including Inertia and governor response capabilities
2. Very high capacity factor
3. Partial dispatchability

Hydro
1. Traditional synchronous machine with all voltage frequency response features
2. Dispatchability
3. Inertia & Governor Response

Energy Storage (Batteries)
1. Frequency/voltage ride through
2. Dispatchability and voltage control

Energy Storage (Pumped Hydro)
1. Traditional synchronous machine with all traditional voltage/frequency features
2. Dispatchability

Flexible New Gas
1. Traditional synchronous machine with all voltage/frequency features including governor response
2. Dispatchability
3. Should be configured for quick start and low minimum load
4. New generation of gas turbines (both combined cycles and peakers) can be designed specifically to start in less than 10 minutes and â€œidleâ€ at a minimum load of less than 20%. This is a roughly 50% improvement over what recently built machines can do and provides roughly twice the â€œflexibilityâ€ of todayâ€™s fleet for a very modest price increase.
5. Installation of clutch between the gas turbine and the generator allows the unit to supply many of the ERS attributes without burning gas during light load hours while preserving reserve capacity for peak hours. This feature will add flexibility, avoids crowding out renewables and forcing curtailments while preserving reliability. IF done during initial construction, the cost is negligible but retrofits once constructed are difficult and expensive. It should be noted that LADWPâ€™s Haynes facility has already installed a clutch and their Scattergood facility is currently being upgraded with a clutch as well.

ERS Definitions
1. Capacity Value from Effective Load Carrying Capability (ELCC): a method of calculating capacity value taking into account the portfolio of all other resources on the grid. At low penetrations of wind and solar resources the ELCC value can be approximated by simple short cut methods such as exceedence methods used today. At high wind and solar penetration the full methodology must be used to achieve accurate results of determining capacity value.
2. Voltage and VAR control/support: adequate â€œvoltage supportâ€ is also called â€œvar controlâ€ is required to minimize transmission and distribution losses and control power flows. It can be supplied by active generation/ power factor correction or by smart inverters or by various electronic devices such as capacitors, synchronous condensers or static var compensators. Location of all of these devices is critical and variety of these sources of voltage is important. Supply from non-combustion sources is important for GHG reductions.
3. Frequency response: (equipment) the ability of a system or elements of the system to react or respond to a change in system frequency. (System) The sum of the change in demand, plus the change in generation, divided by the change in frequency, expressed in megawatts per 0.1 Hertz (MW/0.1 Hz)
4. Governor response: an automated control system like cruise control on your car that responds to frequency

variations. When frequency goes down power increases, when frequency goes up power backs down. Often described as a spring, which resists change during a disturbance and keeps the grid on in its current state for a short period of time. Governor response buys time to react to a disturbance

5. Inertia: like a shock absorber where the rotating mass of generator dampens short-term frequency swings.

6. Dispatchability: the ability to change power output (up or down) upon command.

7. Voltage and/or Frequency Ride Through: the ability to stay connected to the grid during a disturbance (voltage or frequency) thus being able to assist recovery from that disturbance.

8. Power output setback: also called â€œheadroomâ€ , when a facility is intentionally operating below its maximum capacity and that plant increases its energy output to assist in an energy disturbance. Governor response is a form of power output setback.

9. Traditional synchronous machine: traditional power generator that includes all voltage and frequency features including inertia and governor response capabilities. Synchronous machines can be fueled either by fossil, geothermal, biomass, nuclear or hydro. Generally speaking solar, batteries or DC transmission cannot provide synchronous attributes to the grid. Wind has â€œsyntheticâ€ inertia capabilities that can be designed into the power control system of a wind farm.

10. Ancillary Services: services that are necessary to support the transmission of capacity and energy from power generation facilities to loads while maintaining reliable operations of the interconnected transmission system. Due to the essential role ancillary services play in maintaining reliability, they are considered a subset of essential reliability services (ERS).

11. Partial dispatchability: intentionally reducing electrical output. It is also known as curtailment. Renewable dispatchability provides no fuel savings like natural gas dispatchability.