Frequency Control and Grid Resiliency

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Discussion Outline

1. An Introduction to ERCOT

2. Primary Frequency Control and Grid Resiliency

3. Standards vs Guideline

4. Summary
The ERCOT Region

Peak Demand Record: 71,110 megawatts (MW)
- Aug. 11, 2016, 4-5 p.m.

Weekend Peak Demand Record: 68,368 MW
- Saturday, July 29, 2017, 4-5 p.m.

Winter Peak Demand Record: 65,915 MW
- Jan. 17, 2018, 7-8 a.m.

Minimum Demand Record: 22,355 MW (2011 date)
- April 17, 2011, 4-5 a.m.

Wind Generation Records (instantaneous)
- Output: 17,541 MW
  - Feb. 19, 2018, 10:05 p.m.
- Penetration (load served): 54%
  - Oct. 27, 2017, 4 a.m.
  - Total Load = 28,416 MW

ERCOT connections to other grids are limited to ~1250 MW of direct current (DC) ties, which allow control over flow of electricity.
Changing Resource Mix – Installed Capacity (MW)

1999
- Gas Steam: 30,553
- Coal: 16,962
- Gas CC: 2,867
- Nuclear: 4,982
- Gas CT/IC: 3,150
- Wind: 160

2018
- Gas CC: 35,976
- Coal: 16,700
- Nuclear: 5,268
- Gas CT/IC: 6,521
- Wind: 20,573
- Solar: 948
- Gas Steam: 12,297

*as of Feb. 2018
ERCOT Installed Capacity (1999-2018)

- **Gas CC**: 35,465 MW
- **Wind**: 20,770 MW
- **Coal**: 16,700 MW
- **Gas Steam**: 12,297 MW

Years: 1999-2018

- Nuclear
- Coal
- Other
- Gas CC
- Gas Steam
- Gas CT/IC
- Wind
- Solar

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Wind Generation Capacity – May 2018

- Steady growth continues, with some spikes.
- Largest annual increase: 3,294 MW in 2015 (A close second: 3,220 MW in 2008)
- Incentives, uncertainty and other factors affect construction decisions and schedules.
- Not all planned projects will get built.
- Texas continues to lead U.S. in wind capacity.

The data presented here is based upon the latest registration data provided to ERCOT by the resource owners and can change without notice. Any capacity changes will be reflected in current and subsequent years' totals. Scheduling delays will also be reflected in the planned projects as that information is received. This chart reflects planned units in the calendar year of submission rather than installations by peak of year shown.

Financial security posted for funding interconnection facilities does not include CREZ security deposits, which are refunded to the Interconnecting Entity when an IA is signed.

As of May 31, 2018
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As of May 31, 2018
Primary Frequency Control & Resiliency

Resilience

The ability to withstand and reduce the magnitude and/or duration of disruptive events, which includes the capability to anticipate, absorb, adapt to, and/or rapidly recover from such an event.

Primary Frequency Response (commonly referred to as Frequency Governor Response)

The immediate (without intentional delay) proportional increase or decrease in real power output provided by resources (generators, energy storage, load and others). This proportional response is in the direction that stabilizes frequency. Primary Frequency Control comes from actions of local control systems.
Frequency Event – Generator Forced Outage (1250 MW)
Frequency Event – Generator Forced Outage (1250 MW)
Frequency Event – Generator Forced Outage (1250 MW)
Frequency Event – Generator Forced Outage (438 MW)
Wind Unit Response to Low Frequency

Wind

Frequency

MW
Wind Response to High Frequency
Wind Unit Response to High Frequency
BAL-001-TRE-1 Standard

1. Purpose
   – To maintain Interconnection steady-state frequency within defined limits.

2. Requirements for Generation Owners:
   – Specifies Droop and Dead-band settings
   – Rolling 12-month performance requirements for generation resources

3. Requirements for the Balancing Authority/ERCOT:
   – Reporting transparency and changes to measuring Frequency Measurable Events
   – Calculations for Frequency Response measurements (PFR and IMFR)
   – Calculation of 12-month rolling performance averages for each Generator
Installed Wind Capacity versus CPS1 (BAL-001)
Wind Installed Capacity vs Reg-Up (MW)

Wind Installation Capacity (MW) v.s. Averaged Hourly Reg-up Requirement

- Wind Installation Capacity (MW)
- Averaged Hourly Reg-up Requirement (MW)

MW

ERCOt
Key Points

1. Inverter Based resources can provide Primary Frequency Response
   - Faster
   - Sustained

2. Frequency control from diverse set of resources makes grid more resilient
   - Generators providing continuous proportional response
   - Demand Resources providing Under-Frequency Relays triggered response in cycles
   - Energy Storage is suitable to provide faster response in cycles more often than demand response

3. Regional NERC Standard BAL-TRE-001 versus Guidelines
   - ERCOT saw big improvement in its primary frequency capability following implementation of BAL-TRE-001 Regional NERC Standard.

4. Frequency control must be coordinated
   - Primary Frequency Response must be coordinated with Secondary Frequency Controls
   - Generation dispatch must take wind and solar ramps into account in addition to load ramps.
QUESTIONS?