DER101:
Distributed Energy Resources basics

May 4, 2017

Agenda

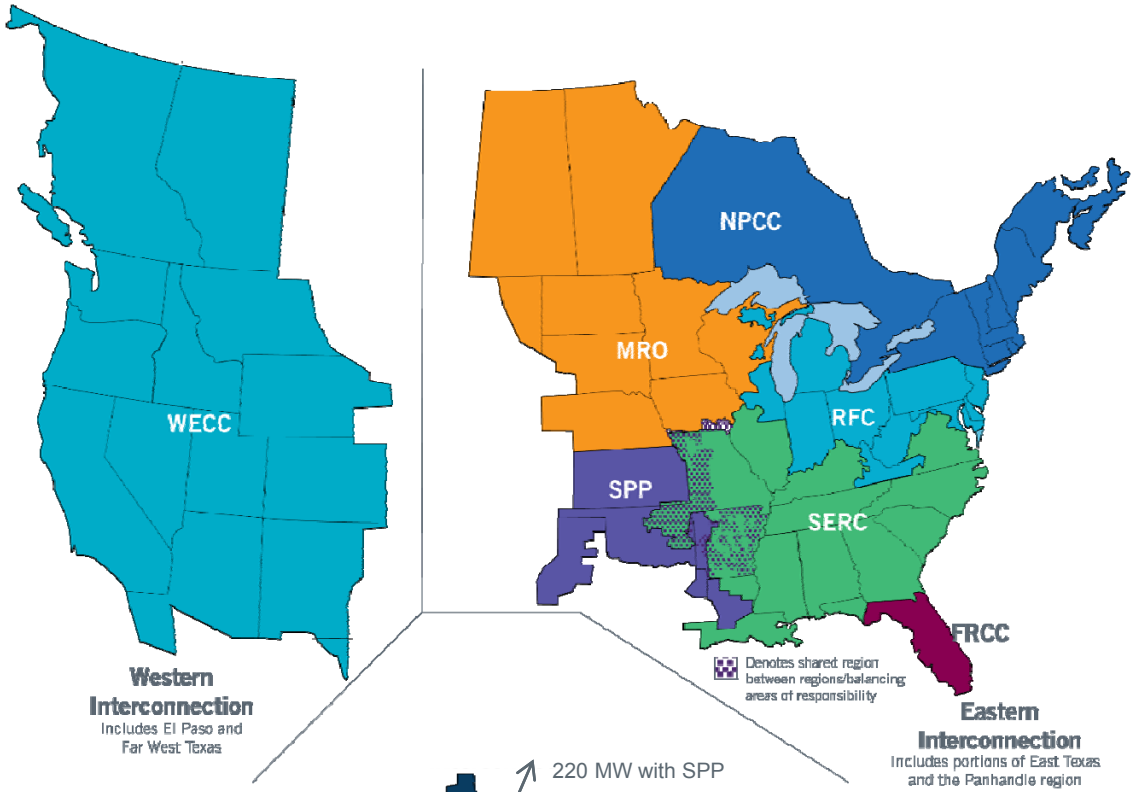
- Introduction
- Definitions
  - Abbreviations
  - Types
- Why it is important
- Common Misconceptions
- DER System Basics
  - References, Codes and Standards
  - Interconnection Basics
  - Future Efforts

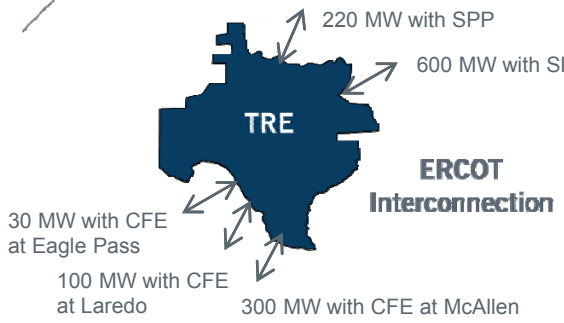
ercot

The ERCOT Region

The interconnected electrical system serving most of Texas, with limited external connections

- 90% of Texas electric load; 75% of Texas land
- 71,110 MW peak, August 11, 2016
- More than 46,500 miles of transmission lines
- 570+ generation units

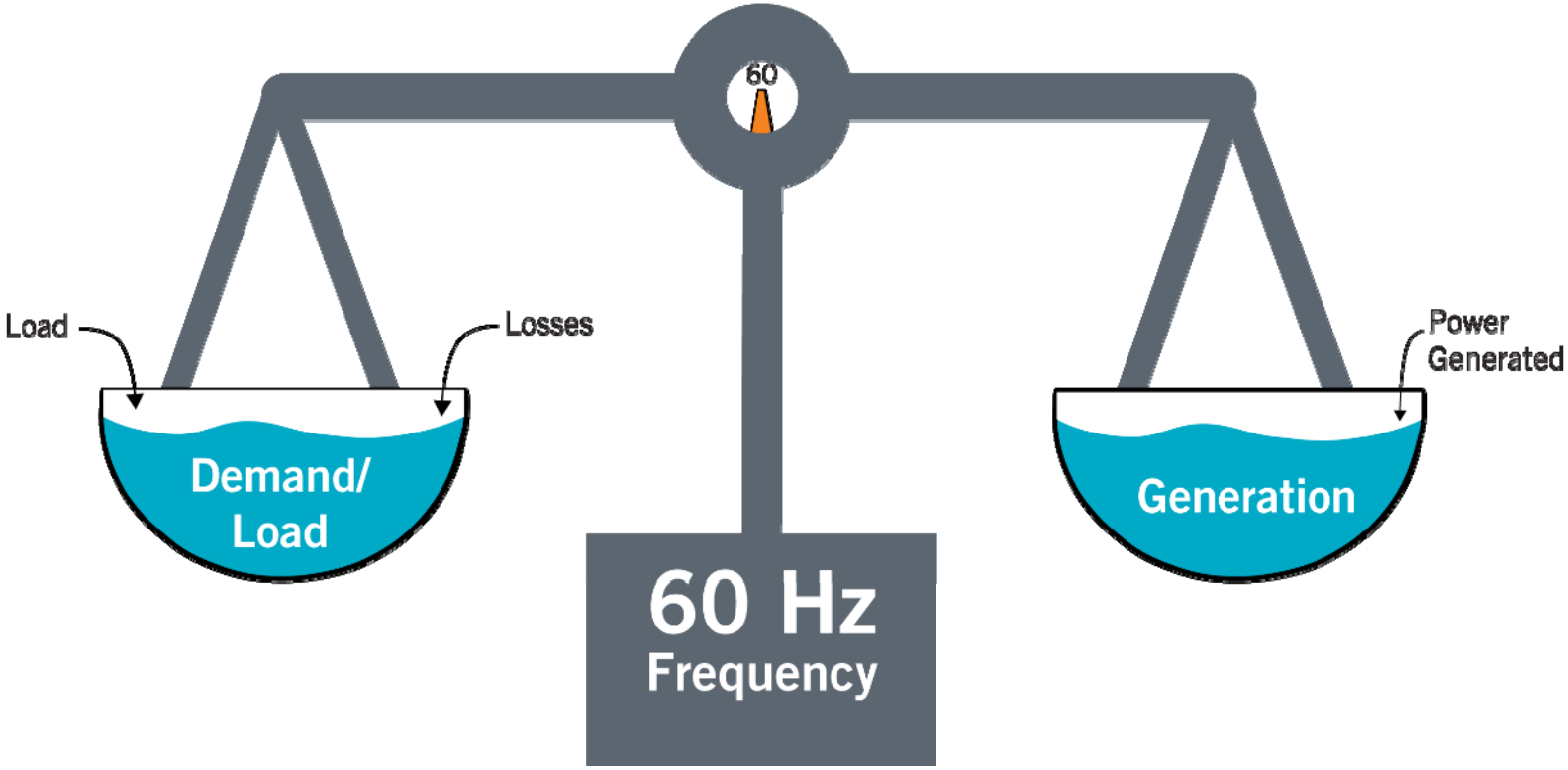




ERCOT connections to other grids are limited to ~1,250 MW of direct current (DC) ties, which allow control over flow of electricity

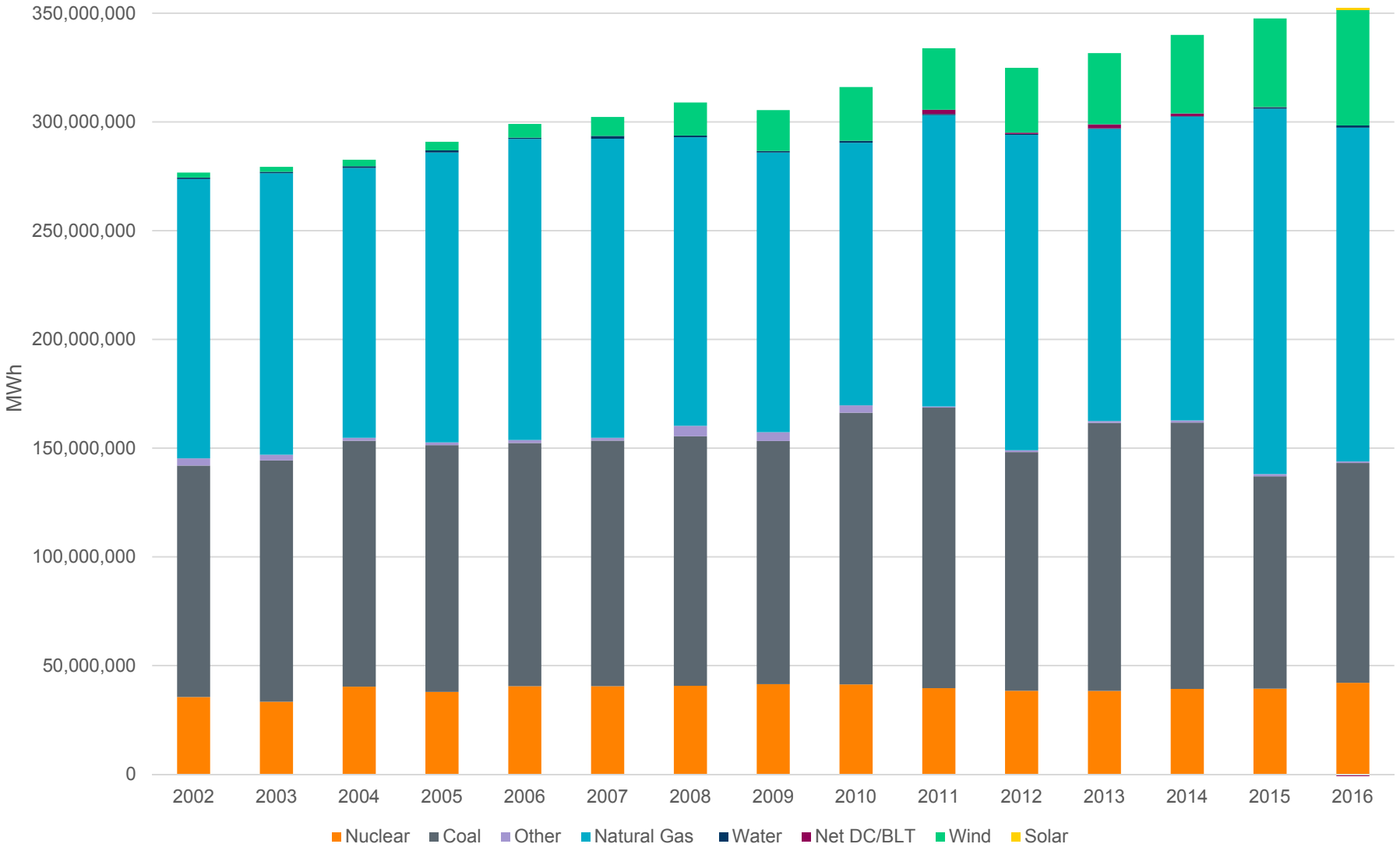
Power Supply (Generation) Must Match Load (Demand)

- The fundamental concept behind ERCOT operations is that generation has to match load at all times



- In other words, a 1 MW reduction in load has the same effect on the grid as a 1 MW increase in generation.

Energy Fuel Mix 2002-2016 (MWh)



*Source: Historical ERCOT Demand and Energy Reports

Definitions

- Distributed Energy Resource (DER)
  - Generation, energy storage technology, or a combination of the two that is interconnected at or below 60 kV and operates in parallel with the distribution system. (Does not currently include demand response.) **
  - **IEEE1547 Draft 6.7** Distributed energy resources (DER): Sources [and groups of sources] of electric power that are not directly connected to a bulk power transmission system. DER includes both generators and energy storage technologies.
    - NOTE—Controllable loads used for demand response are not included in the current definition of DER.

**Other DER definitions DO include demand response (CAISO, NYISO, IRC)

PUCT Definitions

- Distributed Generation (DG)
  - *§25.211* An electrical generating facility located at a customer's point of delivery (point of common coupling) of ten megawatts (MW) or less and connected at a voltage less than 60 kilovolts (kV) which may be connected in parallel operation to the utility system.

- Distributed Renewable Generation
  - *§25.217* Electric generation equipment with a capacity of not more than 2,000 kilowatts provided by a renewable energy technology, as defined by Public Utility Regulatory Act §39.904(d), installed on a retail electric customer's side of the meter.

Definitions

- Connected Capacity
  - The output capability of a Distributed Generation (DG) facility before applying any protective or operational limitations. This is most often the nameplate capability of the generating system or the rated capability of the inverter.

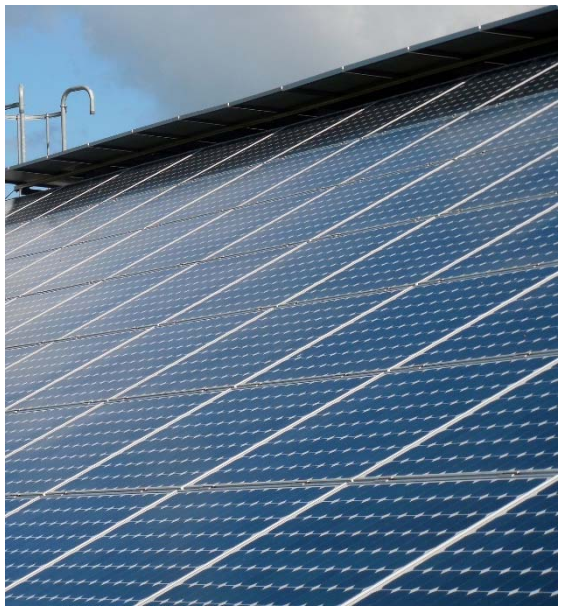
- Operating Capacity
  - The output capability approved by the Distribution Service Provider for parallel operations with the utility system. In some cases, customers operate their DG Facilities with only a portion of the Connected Capacity at a given point in time. Other customers may have spare generating capacity and limit what is used at a given point in time.

Abbreviations

- BES – Bulk Electric System
- CAES – Compressed Air Energy Storage
- DERMS – DER Management System
- DR – Demand Response/Demand Reduction
- DSP – Distribution Service Provider
- ERS – Emergency Response System
- ESS – Energy Storage System (Battery)
- IC – Internal Combustion
- PCC – Point of Common Coupling
- POI/POC – Point of Interconnection
- PV – Solar Photovoltaics

DER Types

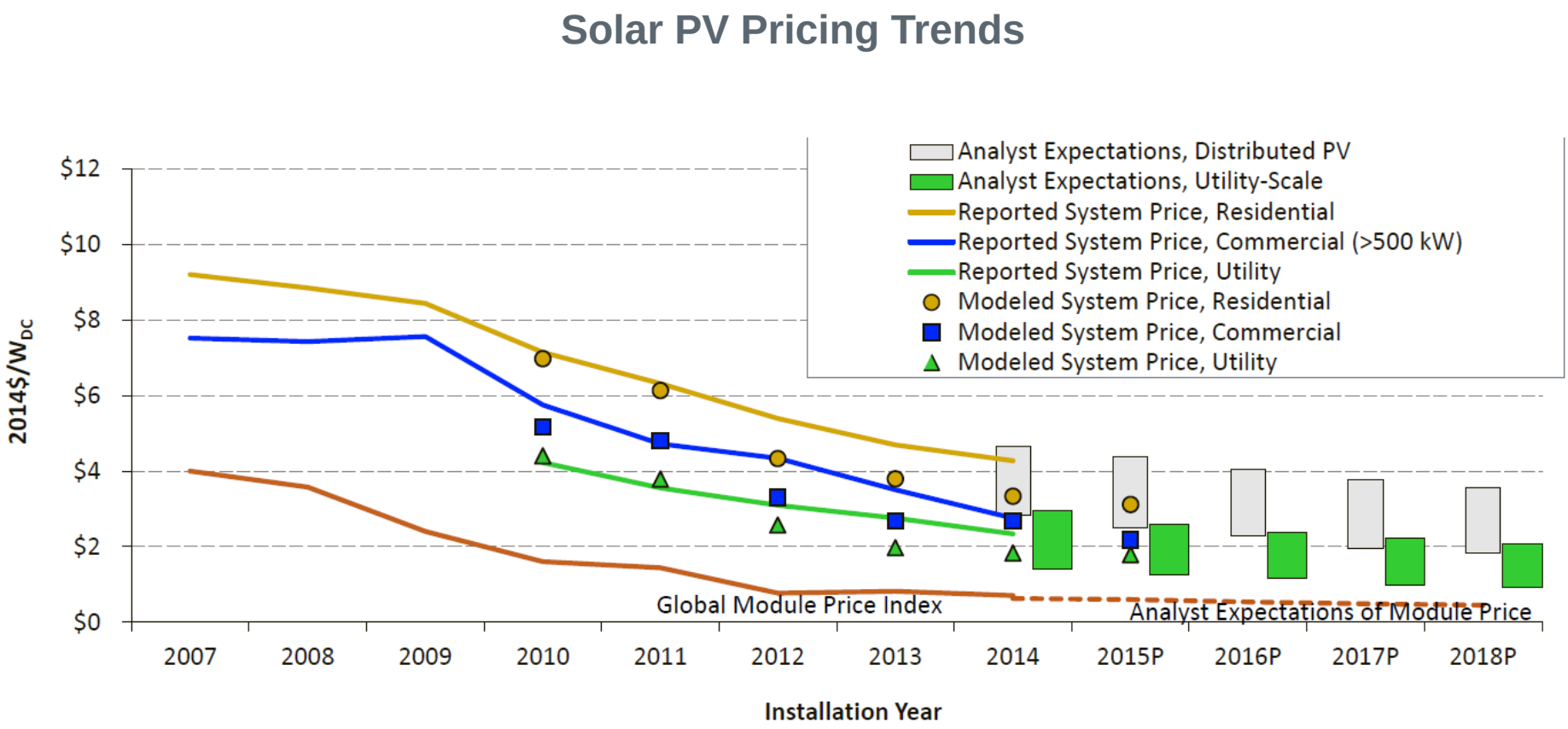
- What it is:
  - Inverter-based generation
    - Typically Solar PV
    - Micro turbines
  - Fuel-based generation (typically synchronous)
    - Gas turbines, IC, Biogas
  - Energy Storage (batteries, pumped hydro)
  - Small wind turbines
  - Small hydro turbines
  - Geothermal



Definitions

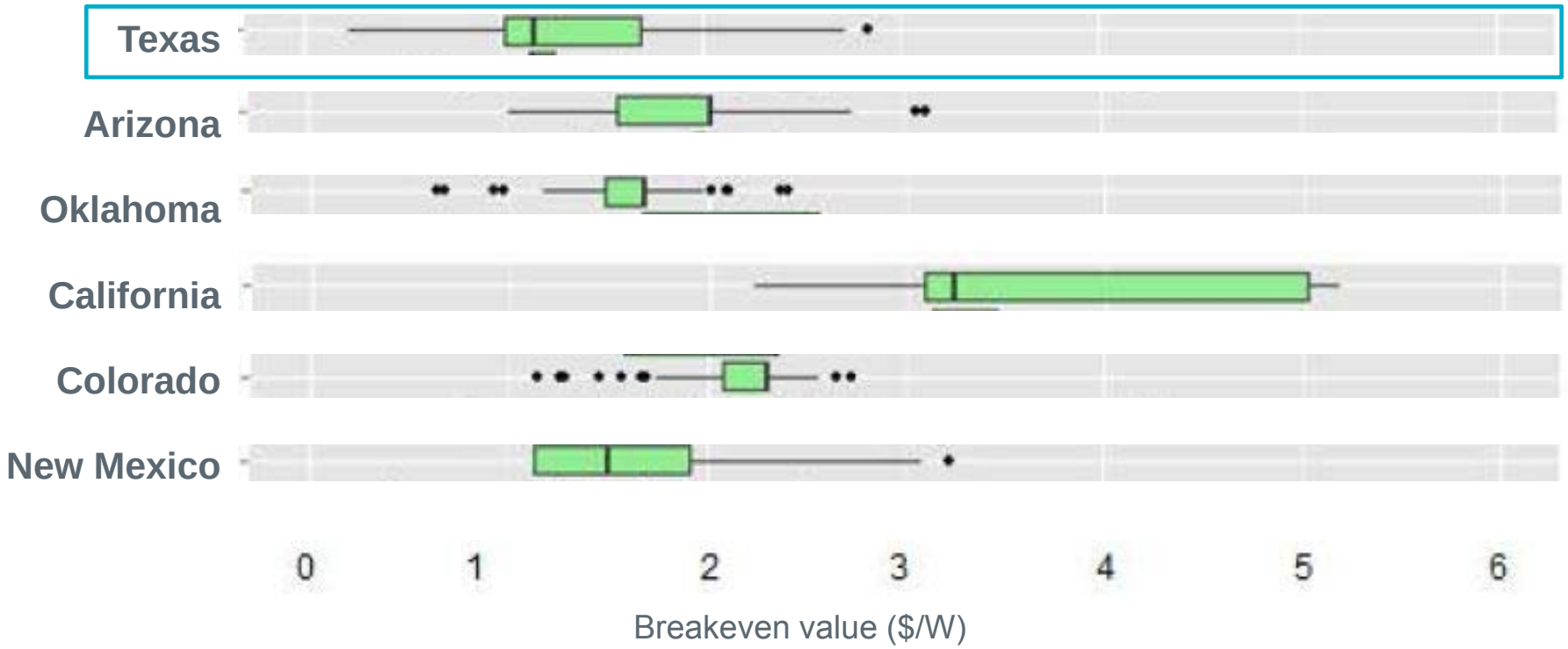
- What it isn't:
  - Emergency/Standby generation –"BUG"
    - These are typically not paralleled with grid. (exception – ERS)
    - Typically connected to intentionally islanded systems
      - Hospitals, data centers, "microgrids," etc.
  - Energy Efficiency/Peak Demand reduction
    - i.e., programmable thermostats, solar water heating, etc.
  - Demand Response
    - Thermostat/hot water heater controls (i.e. NEST, etc.)
  - Load-shifting techniques
    - Thermal energy storage, "off peak" EV charging

Why it is important



Source: NREL, www.nrel.gov/docs/fy15osti/64898.pdf

Key Solar PV Price point for Texas

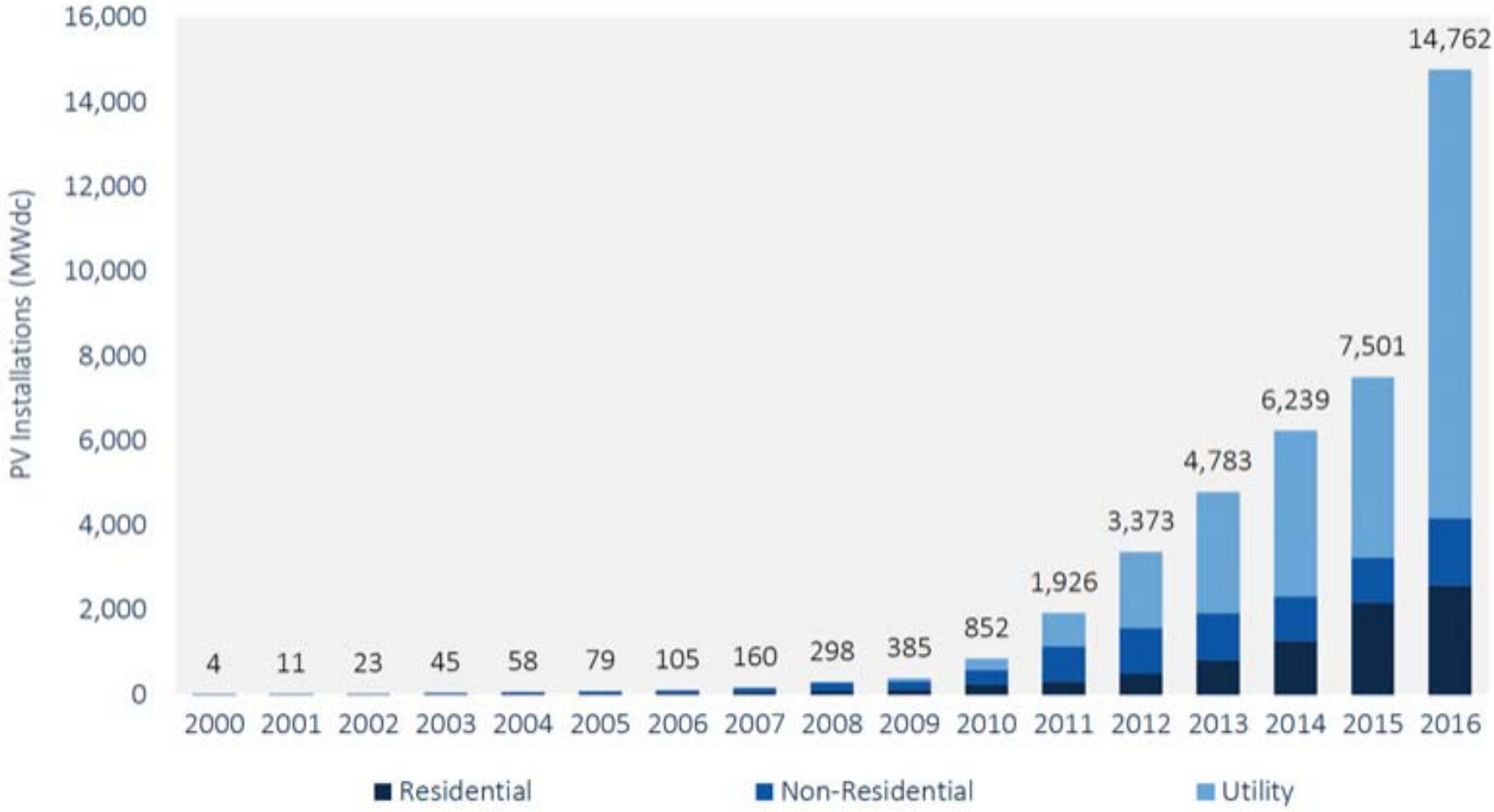


Break-even point for Texas commercial customers ~$1.00-$1.25/W.

Source: NREL, http://www.nrel.gov/docs/fy16osti/64793.pdf

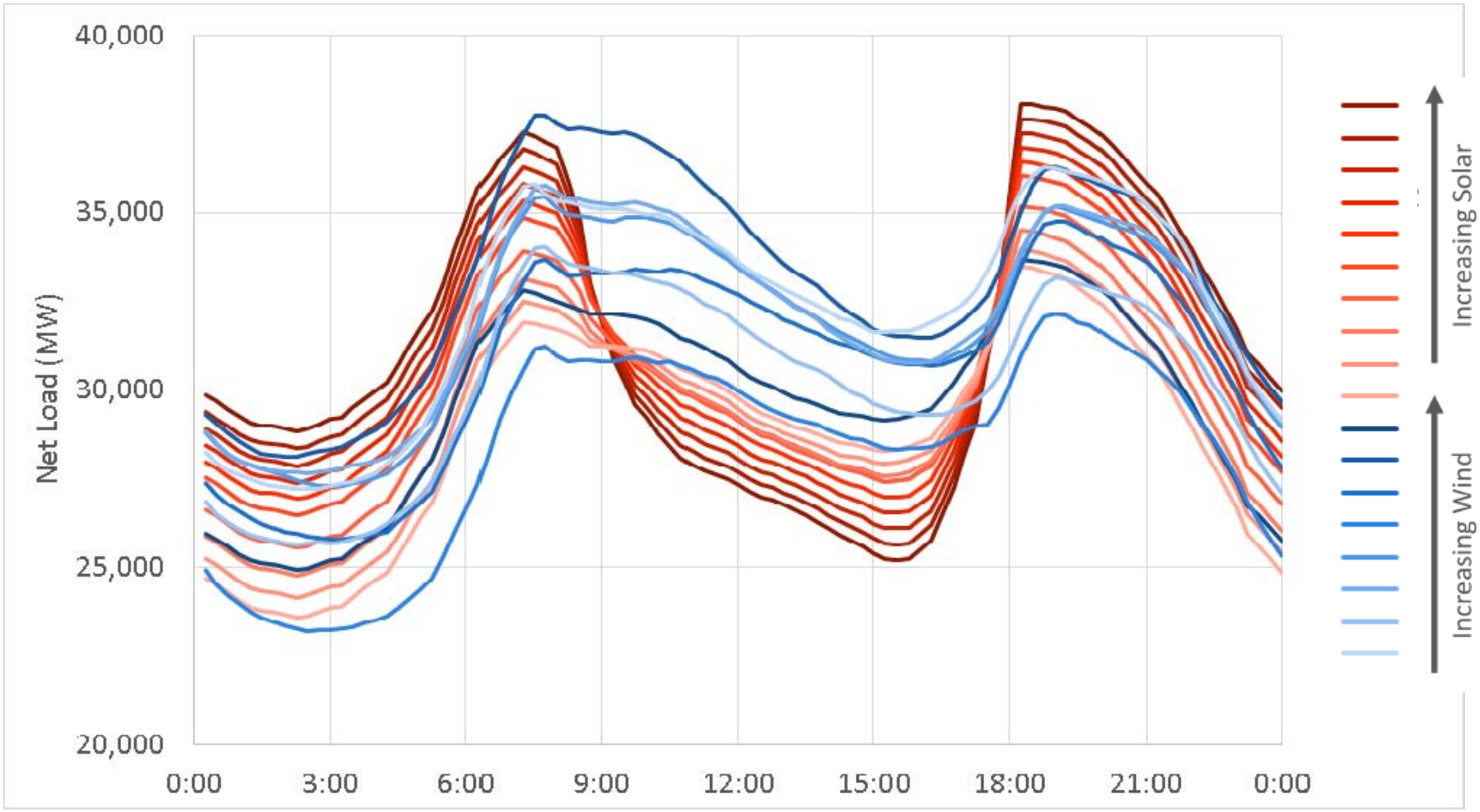
Solar is a growing technology

Annual U.S. Solar PV Installations, 2000-2016



Source: SEIA solar industry data

Possible ERCOT Winter Day with Increase in Solar PV



Thomas A. Deetjen, Joshua D. Rhodes, Michael E. Webber. The impacts of wind and solar on grid flexibility requirements in the Electric Reliability Council of Texas. Energy 123 (2017) 637--654

Common Misconceptions by Customers

- "Once I install my (PV) system, I will be independent of the grid."
  - Since the sun doesn't shine at night (and during cloudy/rainy periods), it would be very expensive to install enough batteries to provide the same benefit that the grid provides.

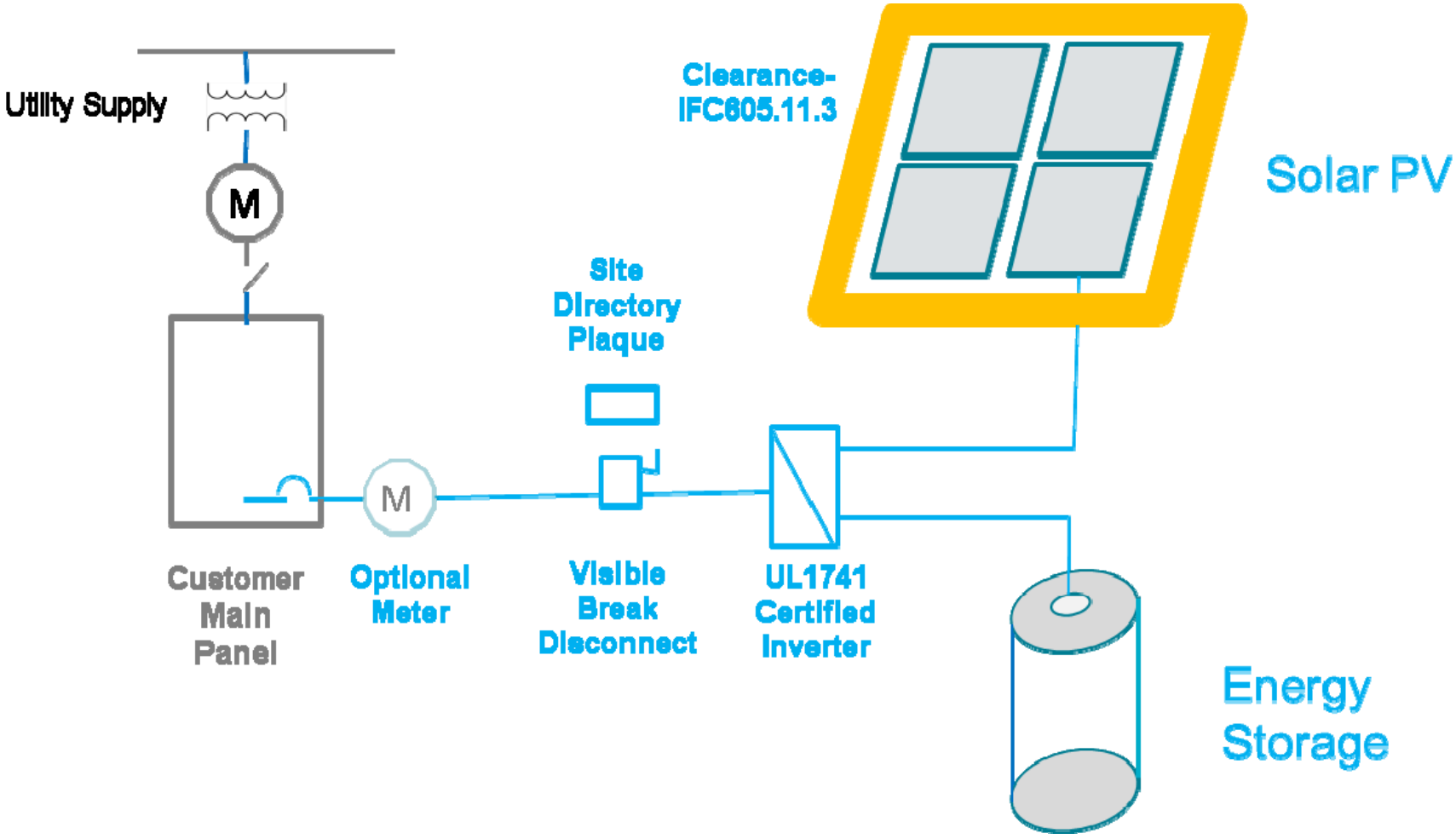
- "When there is a power outage, and everyone else is out of power, I will still have electricity from my system."
  - The vast majority of DER systems must be connected to the grid to operate. DERs not allowed to backfeed a de-energized utility system.
  - "anti-islanding" — note: see emergency/standby generation.

- "If my system over-generates early in the day, I will just use the grid to 'store' it, and then use it later in the day."
  - The grid must be balanced and does not *store* electricity. When there is over-generation during the day, some generators shut off to balance supply with demand. Similarly, when the sun goes down, some generators start up to provide generation needed at that time.

Common Misconceptions by Customers (cont)

- "It's best to install the biggest system possible and sell excess back to the grid."
  - In many areas, energy sold back to the grid gets significantly lower rates than energy that offsets consumption**. The optimum system size matches power generated to power consumed by the load.
- "Utilities should provide a significant credit to solar generators since they can install fewer/smaller wires and save money."
  - Typically, when there is a significant amount of DER, the utility installs LARGER wires to carry the electricity and maintain system voltage. However, there are many benefits from DER which have been captured by numerous "value of solar" studies.
- "Just buy panels and inverter from ___, and do it yourself."
  - State of Texas (and many utilities) require systems to be installed by a Licensed Electrical Contractor.

Basic Small DER Installations / Requirements



References, Codes and Standards

- Local DSP Interconnection Requirements
- Local AHJ Electrical Code

- PUCT Substantive Rules §25.211 and §25.212
- Texas Electrical Licensing and Safety act

- IEEE Standards
  - 1547 – 2003, 2014a, 2017(est)
  - Other IEEE standards –DG and Energy Storage(batteries)
- International Fire Code
- UL Standards
  - UL1741 Inverters, Rapid Shutdown, etc
  - UL 1642, 1973, 1989, 9540 Batteries/Energy Storage
- National Electrical Code (NEC)
- National Electrical Safety Code (NESC)
- { California Rule 21 / Hawaii rule 14H }

Interconnection Basic Processes

System Size affects the interconnection process

- Small/Residential (typically **<10 kW**)
  - Usually an abbreviated process with nominal studies/cost involved
    - AHJ Electrical Inspection plus DSP review/inspection
- Medium/Commercial (typically **<500kW**)
  - Usually a slightly longer process with additional costs/permits involved
    - Structural inspections
    - Electrical upgrades — transformer, etc.
- Larger System (typically **1 MW-10 MW**)
  - Usually interconnection studies with even more costs/permits involved
    - Mitigation may be required
    - Transfer trip
    - Metering changes
    - Registration with ERCOT (See ERCOT Distributed Generation)

Future BES Efforts for DER reliability concerns

- "*DER Reliability Impacts and Recommended Changes*"
  - Whitepaper published March 22, 2017

- Modeling efforts to understand DER issues (**BES)**
  - Map Registered DER > 1 MW
  - Map "significant" accumulations of DER — TBD
  - Note Distribution issues are usually handled at Distribution level
    - Interconnection process!

- Technology Improvements
  - DERs to provide BES support functions

Technology Improvements

- IEEE-1547 – 2017 (est) (BES)
  - **Frequency and voltage ride-through**
    - **Category I (Synchronous Gens)**
    - **Category II or III (Inverter Gens)**
  - **Primary frequency Response**
  - Voltage support (volt/VAR functions, fixed p.f.)
  - Communication
  - **Ramping and startup**

- IEEE1547 Ballot Registration Process has begun
  - Sign up ends May 12, 2017
  - Voting to begin in May!
  - Goal is for standard to be approved in 2017!

Questions?

clayton.stice@ercot.com