Energy Evolution in ERCOT

US Department of Energy 2016 Quadrennial Energy Review

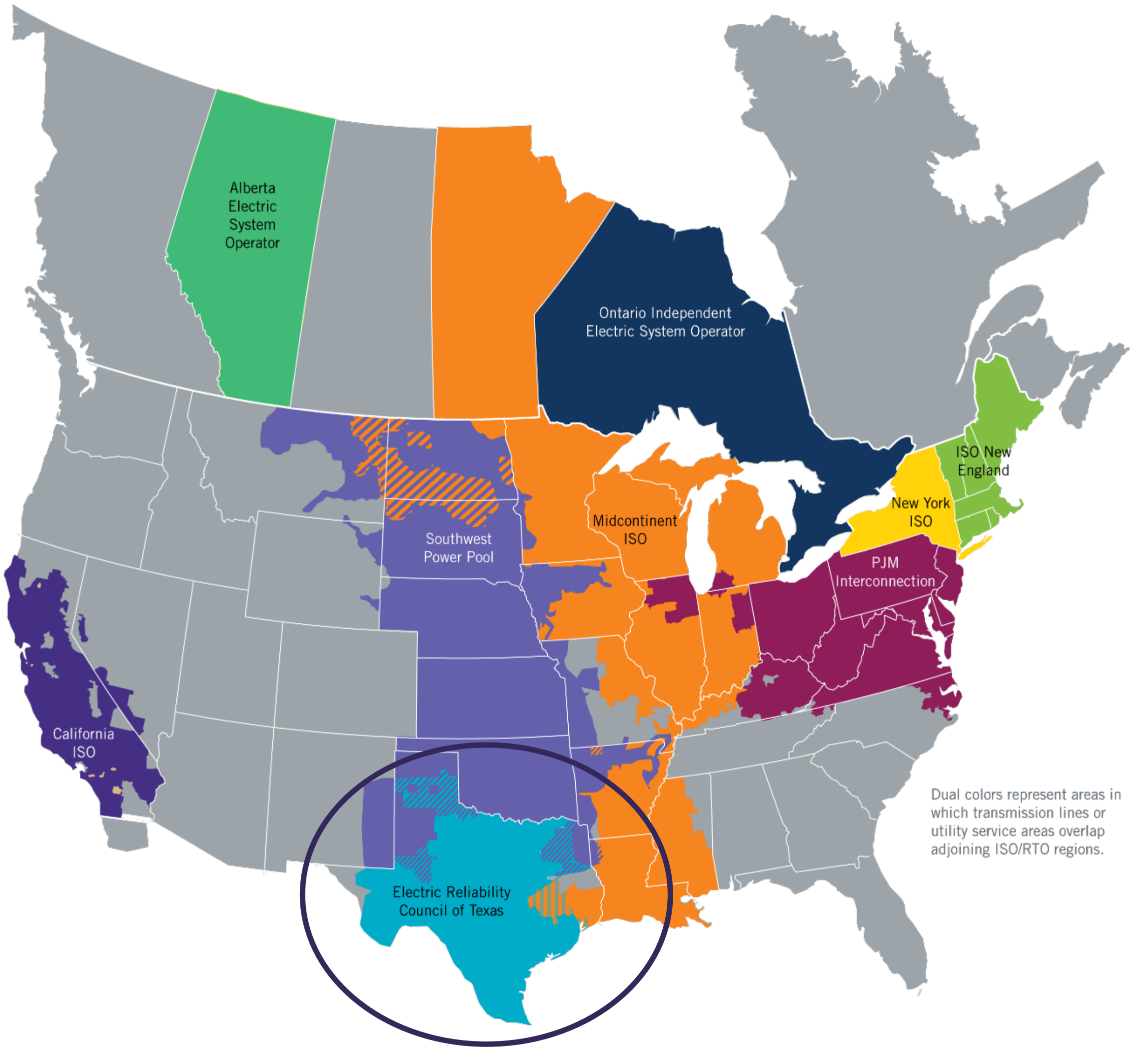
Cheryl Mele, SVP and COO ERCOT

May 9, 2016

North American ISOs and RTOs

Independent System Operators and ***Regional Transmission Organizations*** are the 'air traffic controllers' of the bulk electric power grids

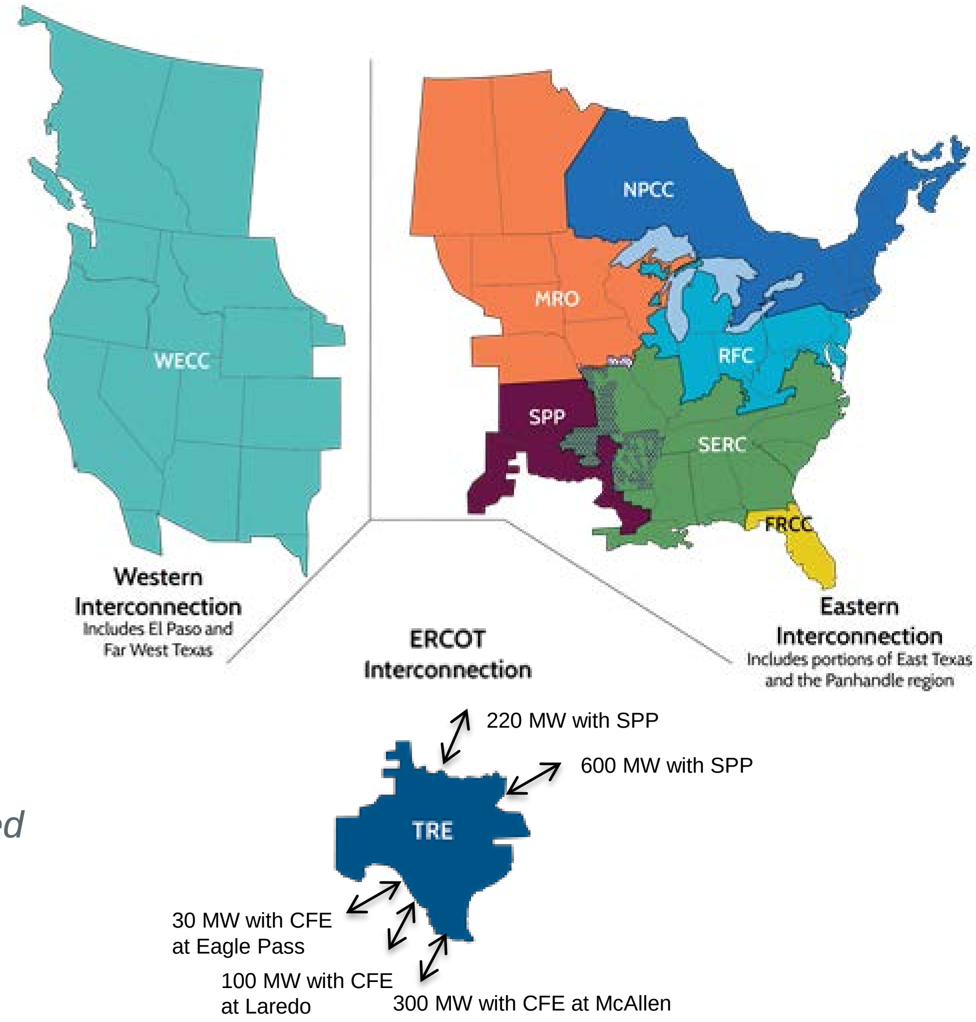
(69kV and up)



The ERCOT Region

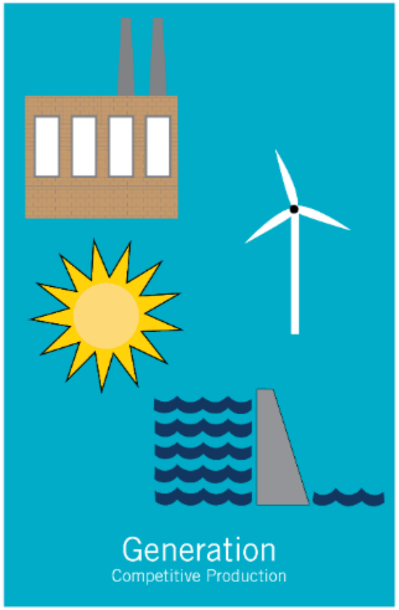
The interconnected electrical system serving most of Texas, with limited external connections

- 90% of Texas electric load; 75% of Texas land
- 69,877 MW peak demand (set August 10, 2015)
- More than 46,500 miles of transmission lines
- 550+ generation units

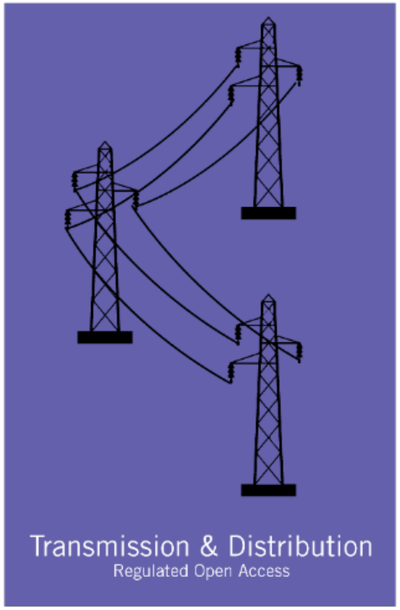


ERCOT connections to other grids are limited to ~1,250 MW of direct current (DC) ties, which allow control over flow of electricity.

ERCOT Competitive Model



- ERCOT schedules and dispatches power on the electric grid.
- Generators compete at resource node to serve load.
- ERCOT performs financial settlement.



- ERCOT manages flow of power to 24 million Texas consumers.
- Transmission and distribution lines and related facilities are owned and operated by regulated utilities.

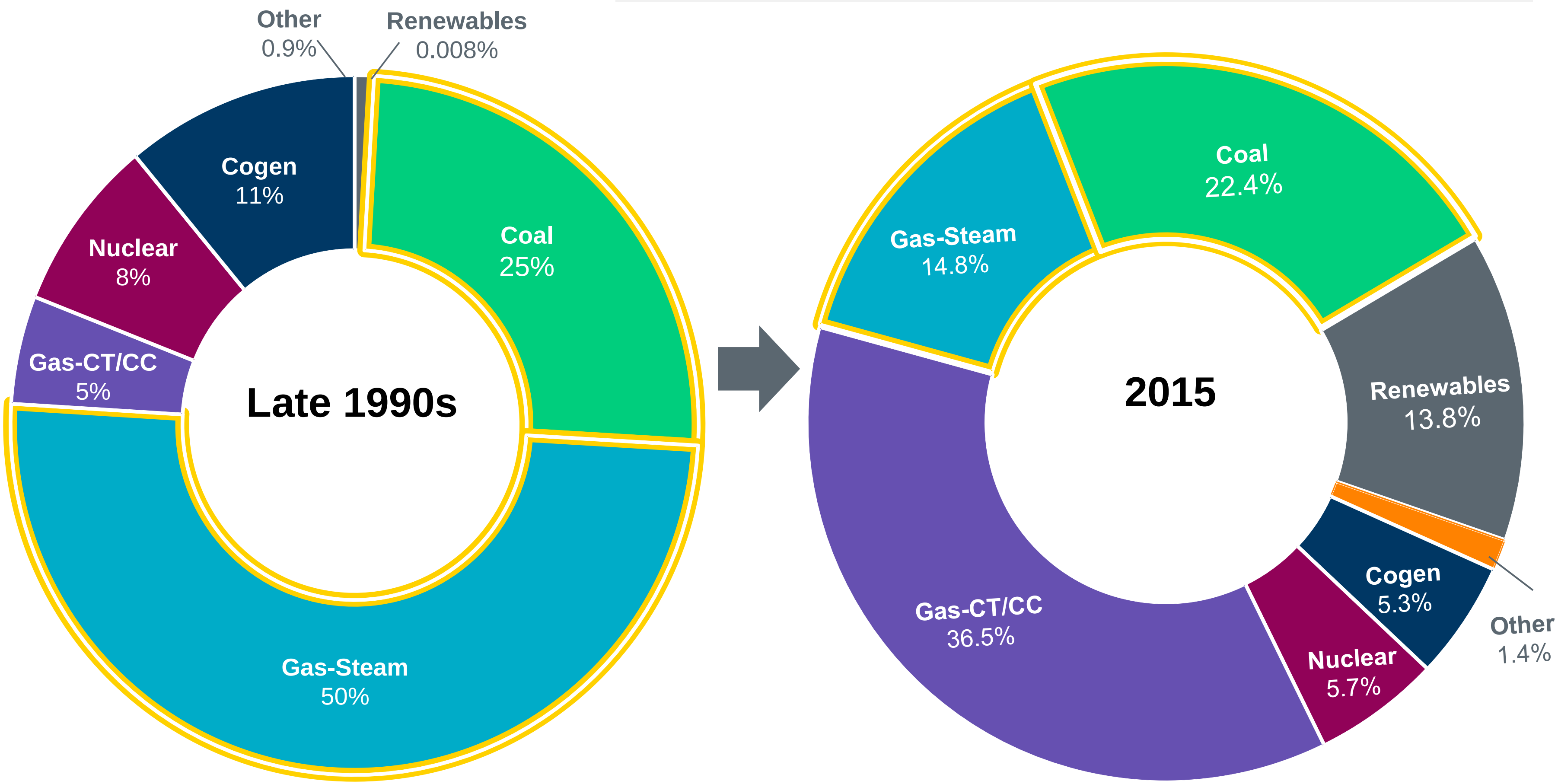
- ERCOT administer retail switching for 7 million premises in competitive choice areas.
- Retailers compete to serve consumers, except in muni/co-op areas.

Challenges and Initiatives

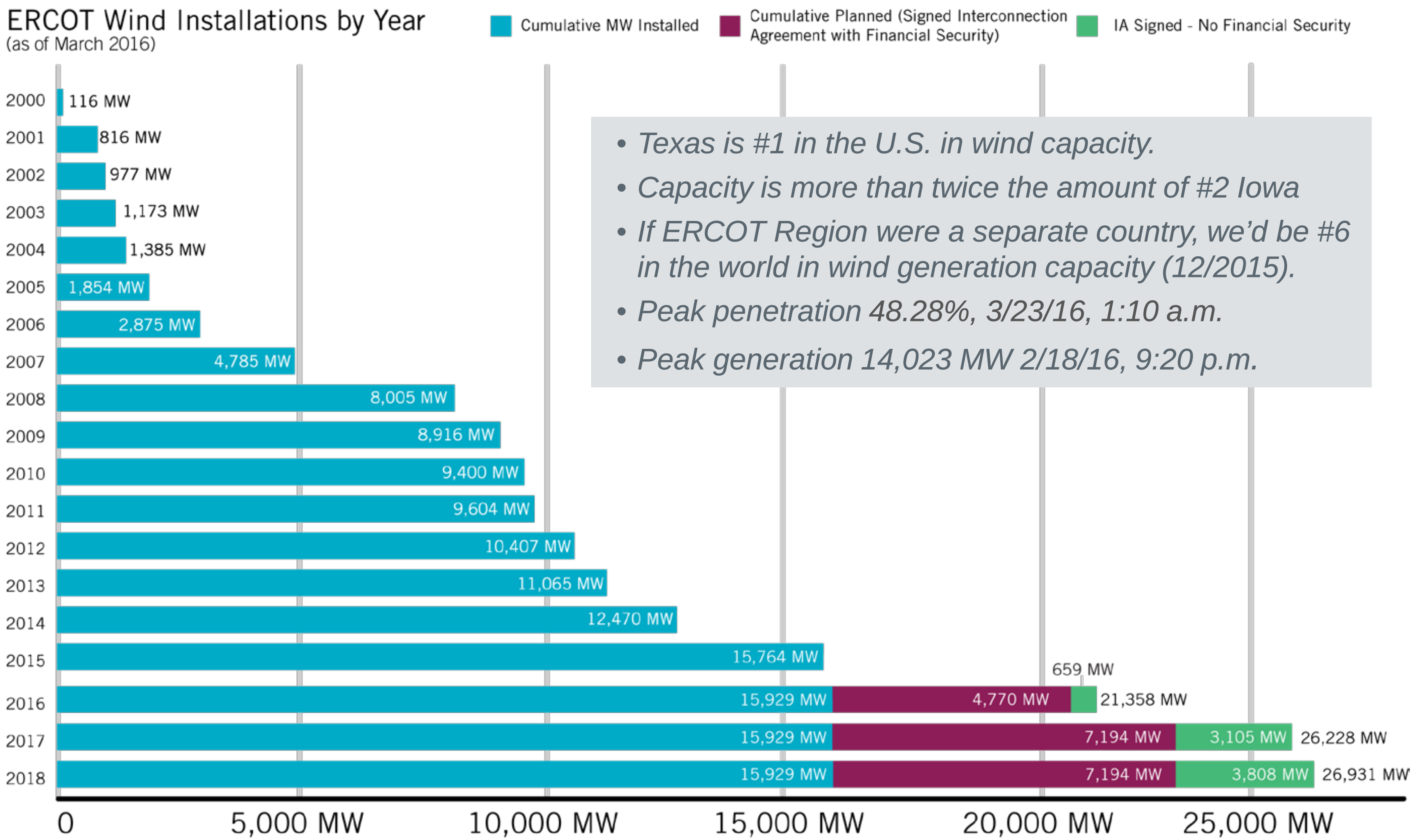
1. Strategically adapting to changing resource mix:
   - Generation Resources
   - Demand Response
   - Distribution Level Resources
2. Providing thought leadership in support of continued improvements to operational reliability and markets
3. Continue to analyze potential impacts of environmental regulations on resource adequacy
4. Continually enhancing our cyber and physical security posture

Changing Resource Mix

Since Dec. 2015 - 990 MW of wind and solar capacity approved for commercial operations, equivalent to a summer peak capacity contribution of about 254 MW. Natural Gas investments continue but outpaced by renewables.

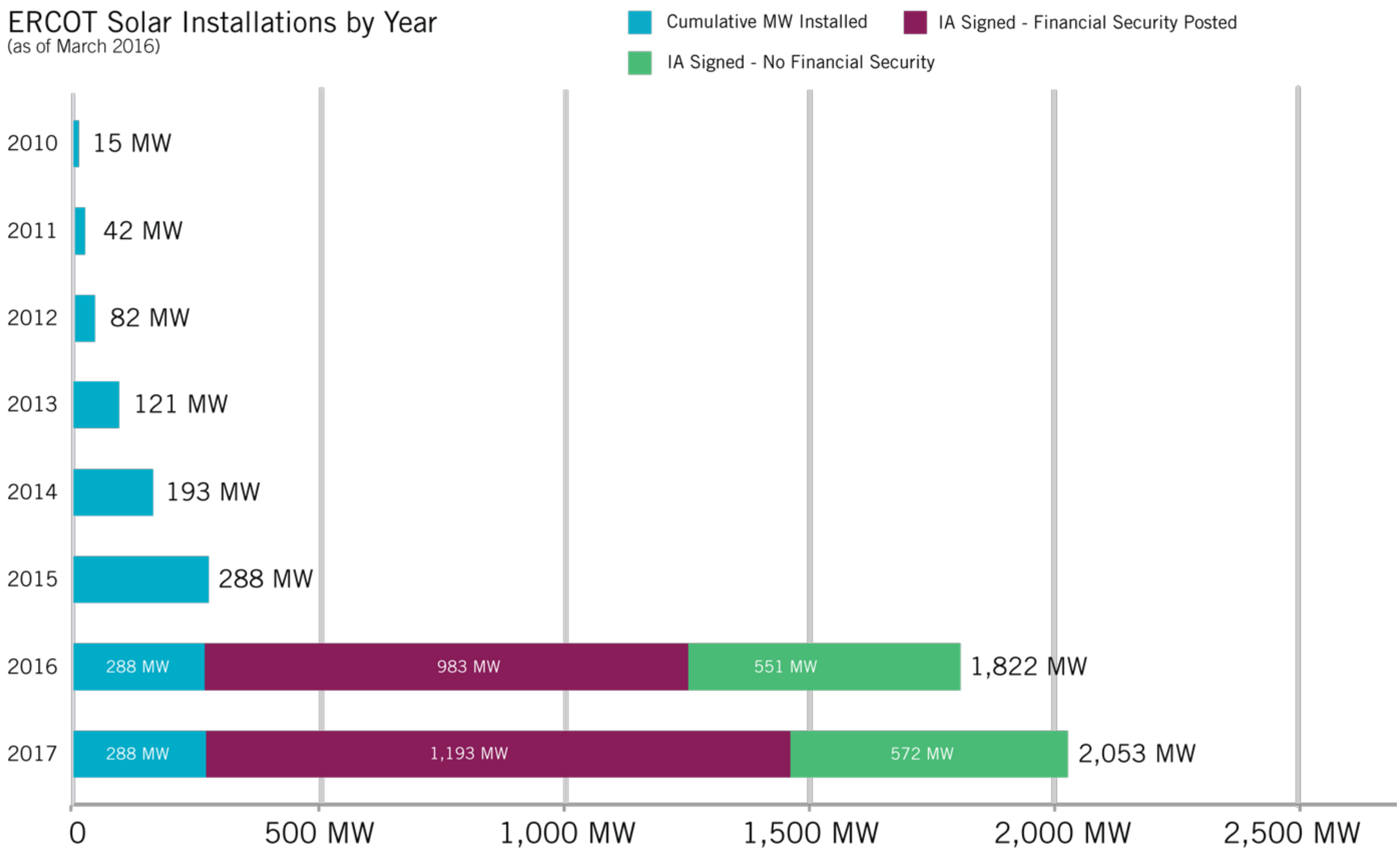


Wind – March 2016



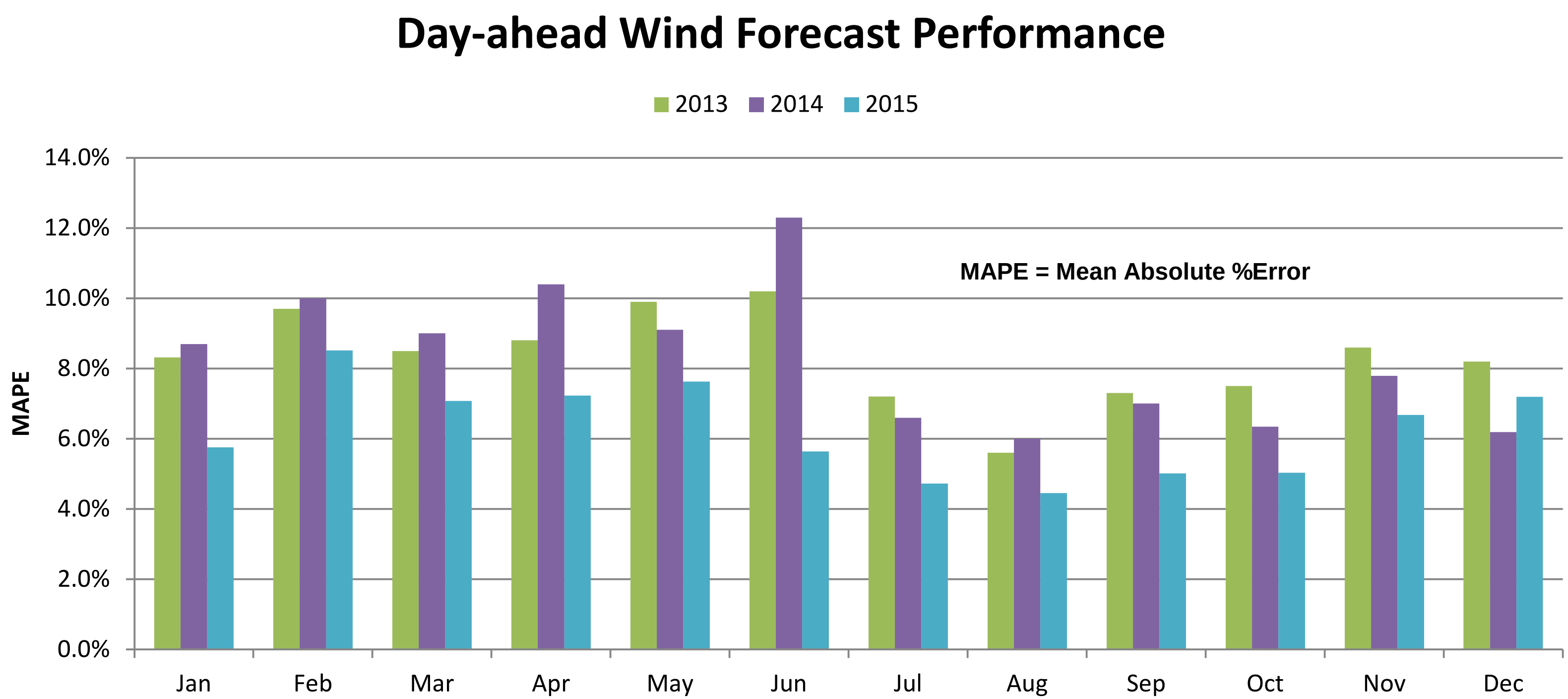
- *Texas is #1 in the U.S. in wind capacity.*
- *Capacity is more than twice the amount of #2 Iowa*
- *If ERCOT Region were a separate country, we'd be #6 in the world in wind generation capacity (12/2015).*
- *Peak penetration 48.28%, 3/23/16, 1:10 a.m.*
- *Peak generation 14,023 MW 2/18/16, 9:20 p.m.*

Utility Scale Solar Generation – March 2016



Integrating and Managing Renewables

- Added 7-day wind forecast and improved performance of wind forecast
- Inclement weather preparation
  - Added new capability to manually overwrite wind forecast for icing events
  - Hosted 2015 Texas RE and ERCOT Wind Generation and Winter Preparation Webinar
- Recently implemented a utility-scale solar forecast



Proposed Future Ancillary Services (FAS)

Current

Regulation Up
Fast-Responding Regulation Up

Regulation Down
Fast-Responding Regulation Down

Responsive

Non-Spin

Proposed

Regulation Up
Fast-Responding Regulation Up
Regulation Down
Fast-Responding Regulation Down
Mostly unchanged

Fast Frequency Response 1 — *59.8 Hz, Limited duration*
Fast Frequency Response 2 — *59.7 Hz, Longer duration*
Primary Frequency Response
Contingency Reserves 1 — *SCED-dispatched*
Contingency Reserves 2 — *Manually dispatched*

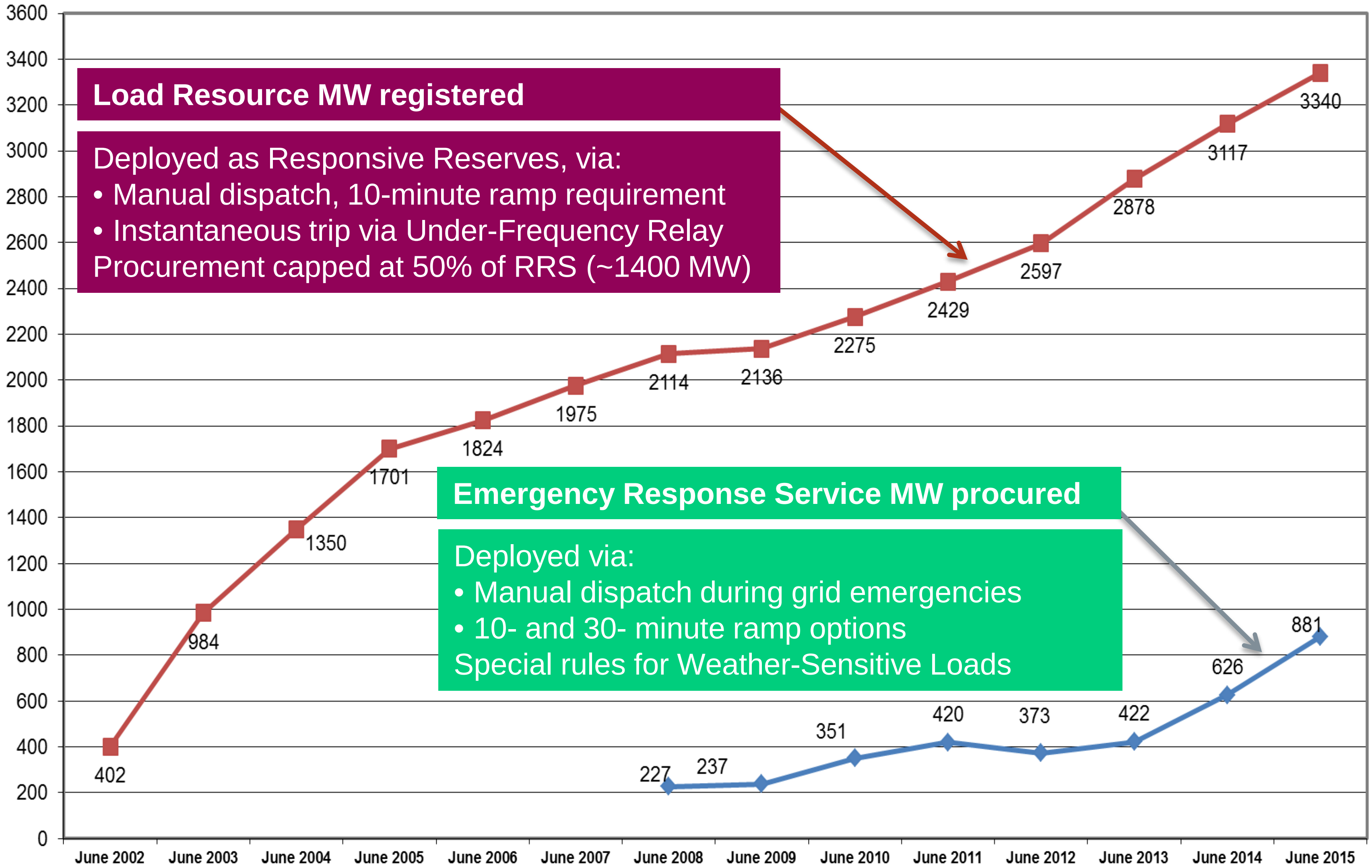
Supplemental Reserves 1 — *SCED-dispatched*
Supplemental Reserves 2 — *Manually dispatched*

Synchronous Inertial Response — *Ongoing development*

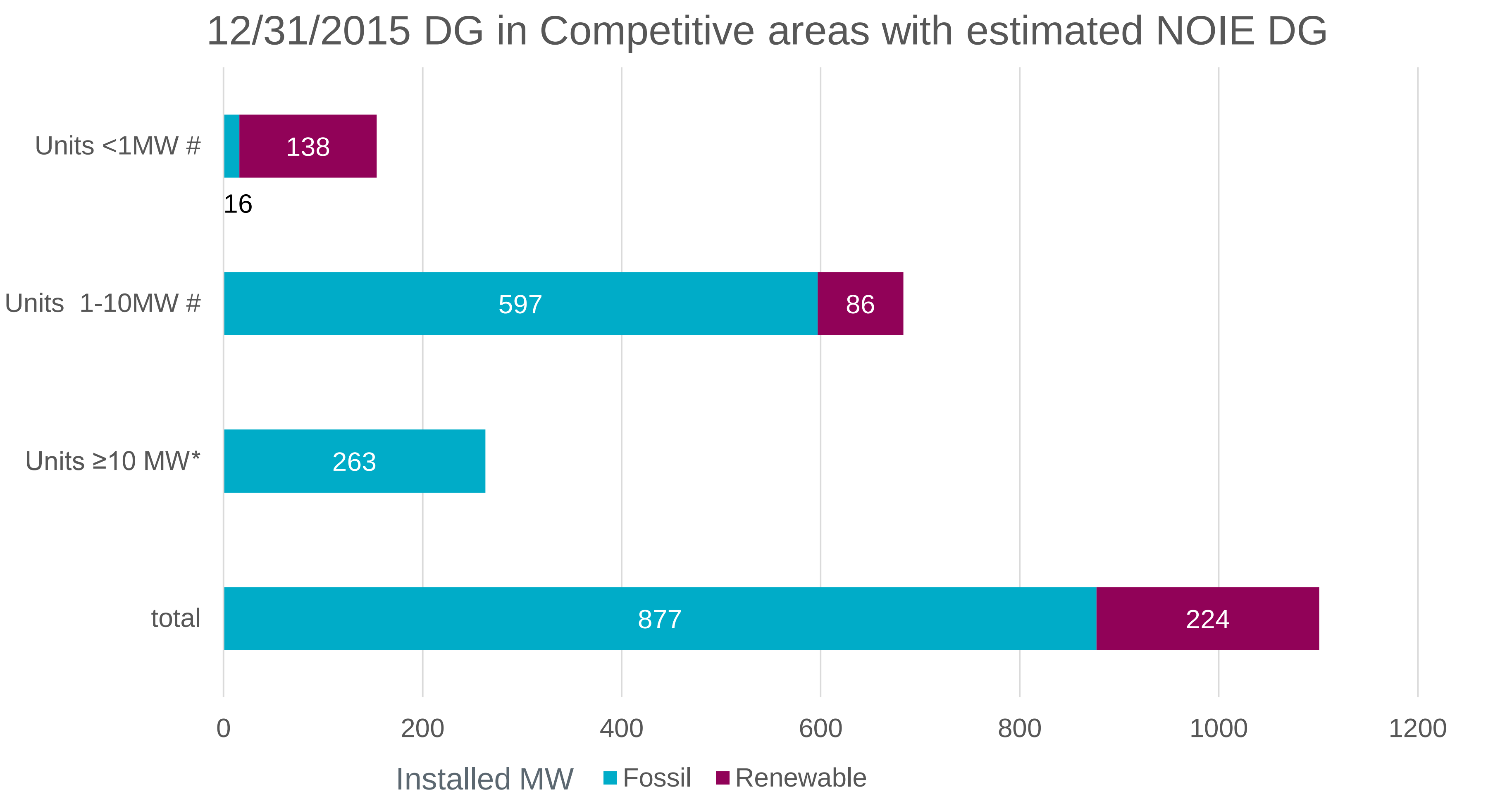
Distribution and Customer Activity

- New technologies becoming available at competitive costs encourage customer participation in load management and distributed resources
- Leveraging smart grid initiatives

Operational Demand Response



Distributed generation

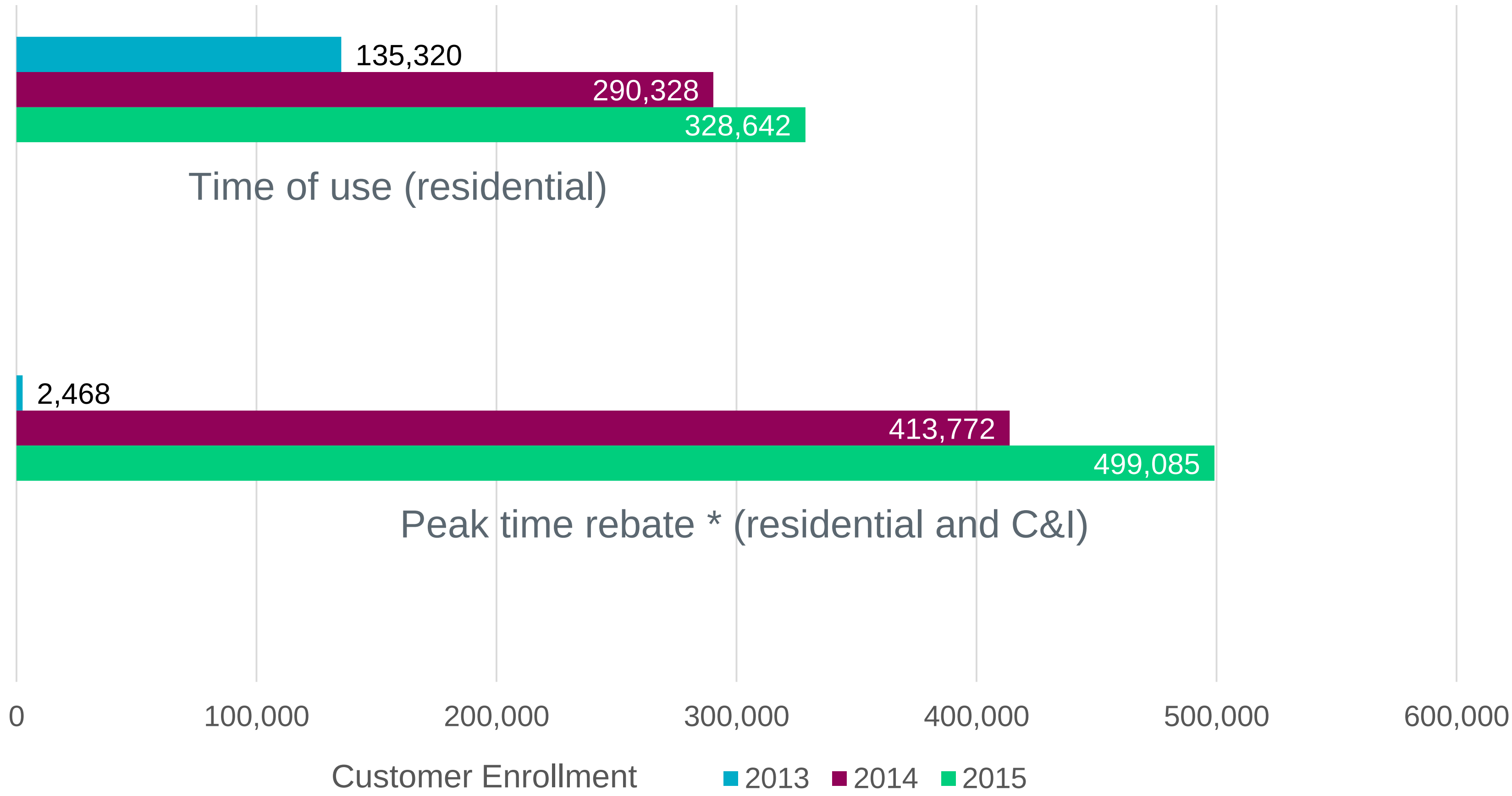


* An unknown number of these units may be among the 77 units registered with PUC as Self-Generators.

Anecdotal as reported by Austin Energy & CPS Energy only. NOIEs are not required to report unregistered DG to ERCOT unless >50kW and injects to grid.

Retail Dynamic Price Offerings & DR

Enabled by advanced metering, a significant percentage of the retail market now has some kind of incentive for demand response, price response, or a behavioral shift from on-peak to off-peak



* Events not necessarily called, rebates not necessarily issued. Numbers are based on 9/30/15 snapshots submitted by REPs to ERCOT