



Intelligent Efficiency in Texas

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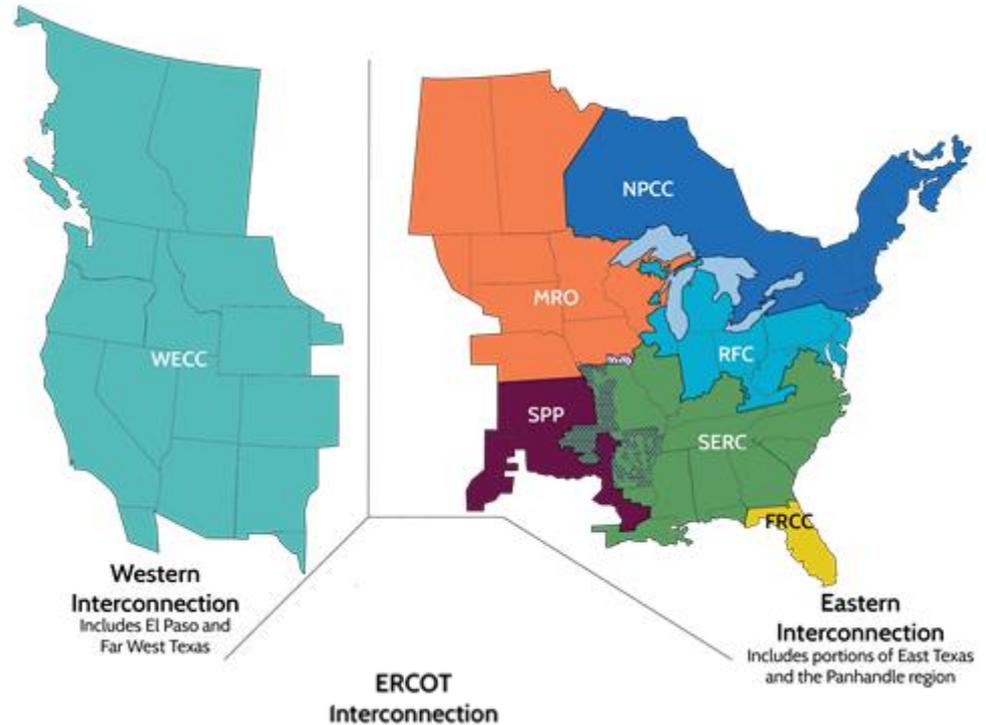
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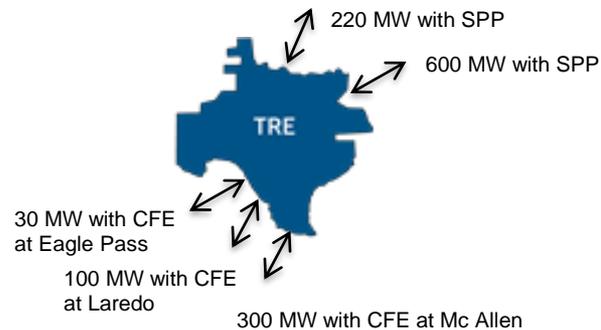
The ERCOT Region

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

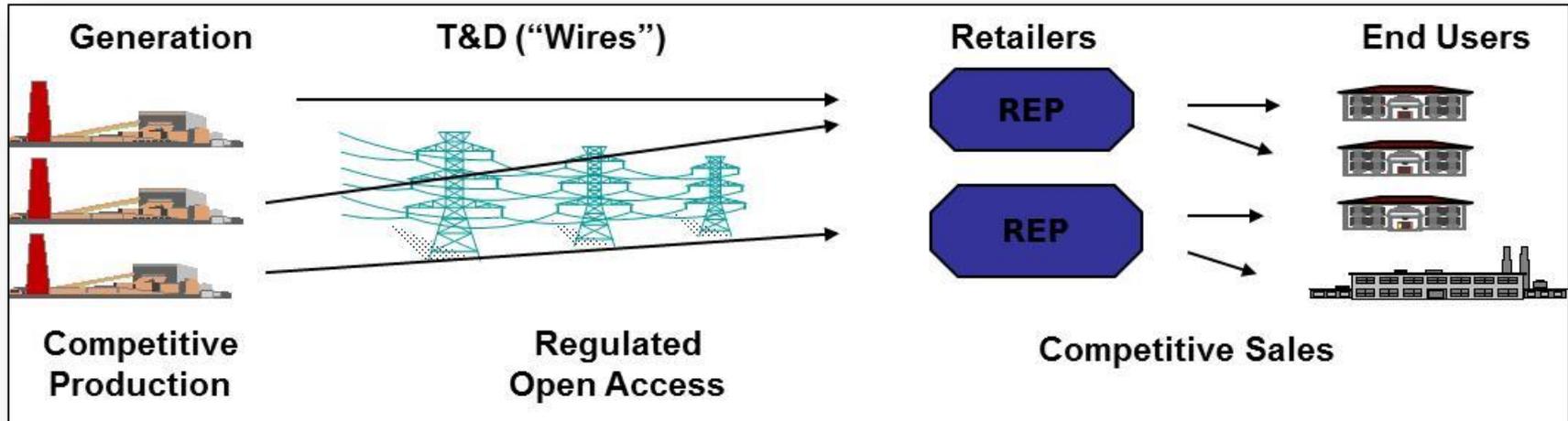
- 90% of Texas electric load; 75% of Texas land
- 71,093 MW peak, August 11, 2016
- More than 46,500 miles of transmission lines
- 550+ generation units



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



Texas Competitive Model



Wholesale

- Fully unbundled Wholesale market
- ERCOT operates a single Balancing Area
- 5-Minute security constrained economic dispatch with Day-Ahead and Ancillary Services markets
- Generators are paid Locational Marginal Prices (LMPs) at node.
- Load-serving entities pay averaged load-zone prices.
- Voluntary Day-Ahead Market

Transmission

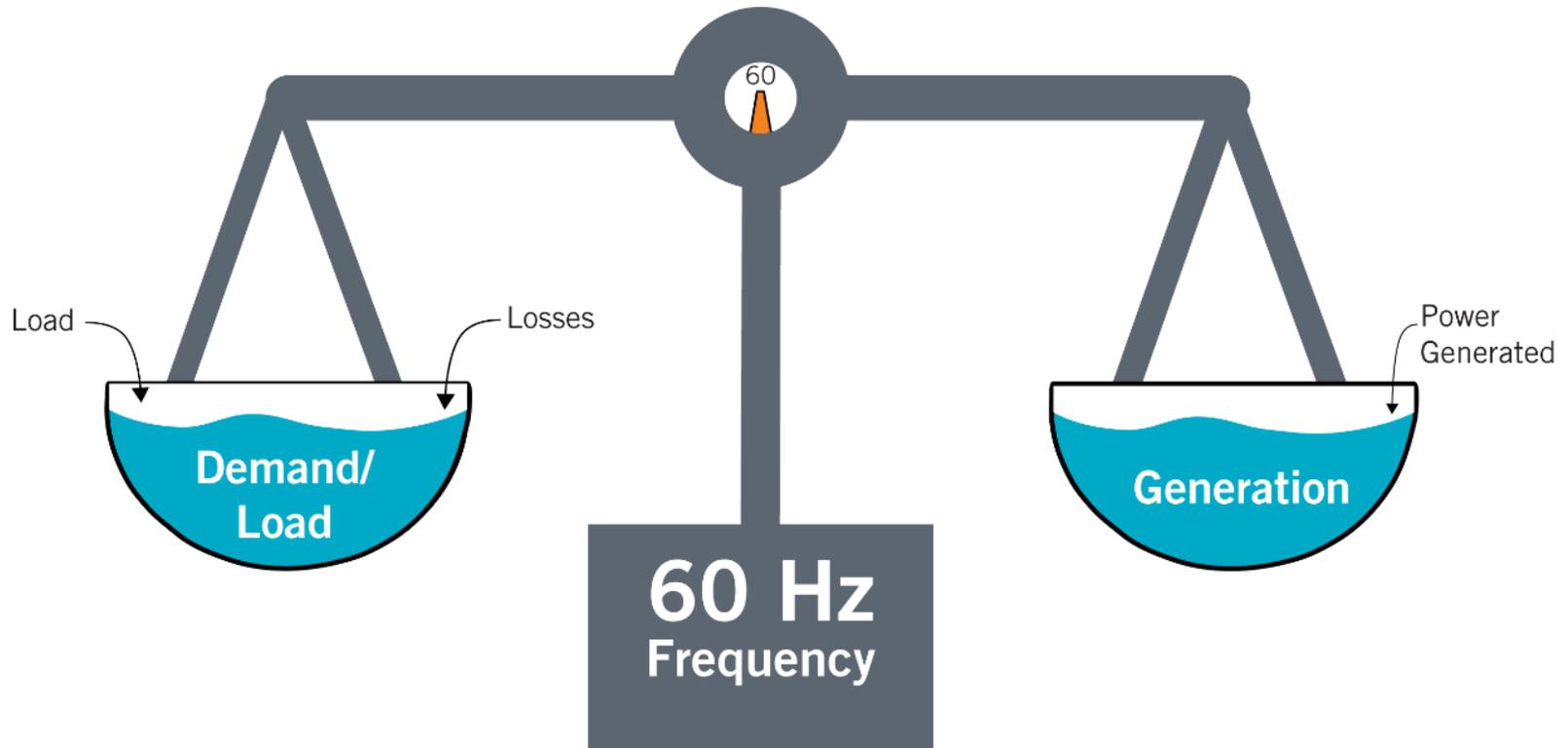
- All transmission costs are rolled in to single postage-stamp rate paid by load.
- Any transmission owner that transmits power for another entity is a regulated utility under state law.
- No transmission service market

Retail

- Full Retail competition for all customer types
 - Except in municipal and cooperative utility areas
 - Customers choose retail provider and terms of contract
- Smart meters (which measure time of consumption) installed on all customer types – about 7 million meters

Power Supply (Generation) Must Match Load (Demand)

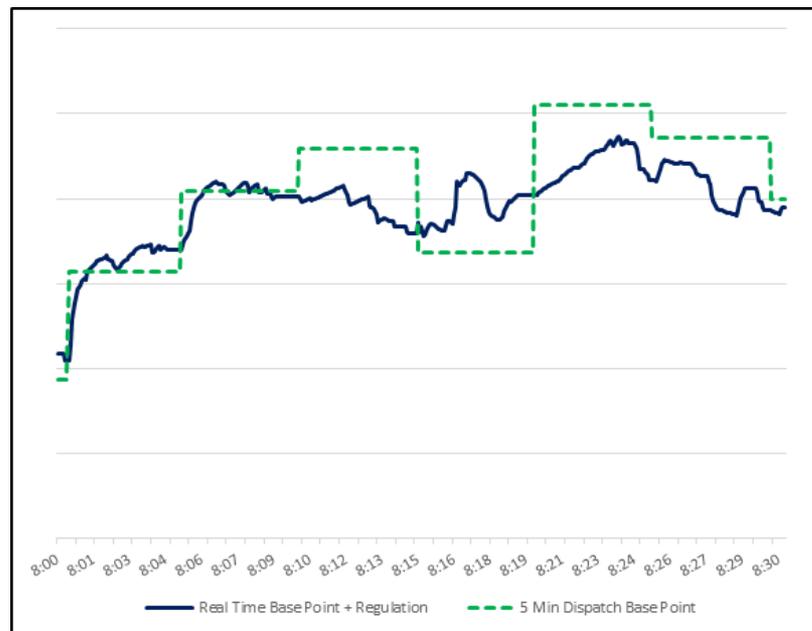
- The fundamental concept behind ERCOT operations is that generation has to match load at all times.



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

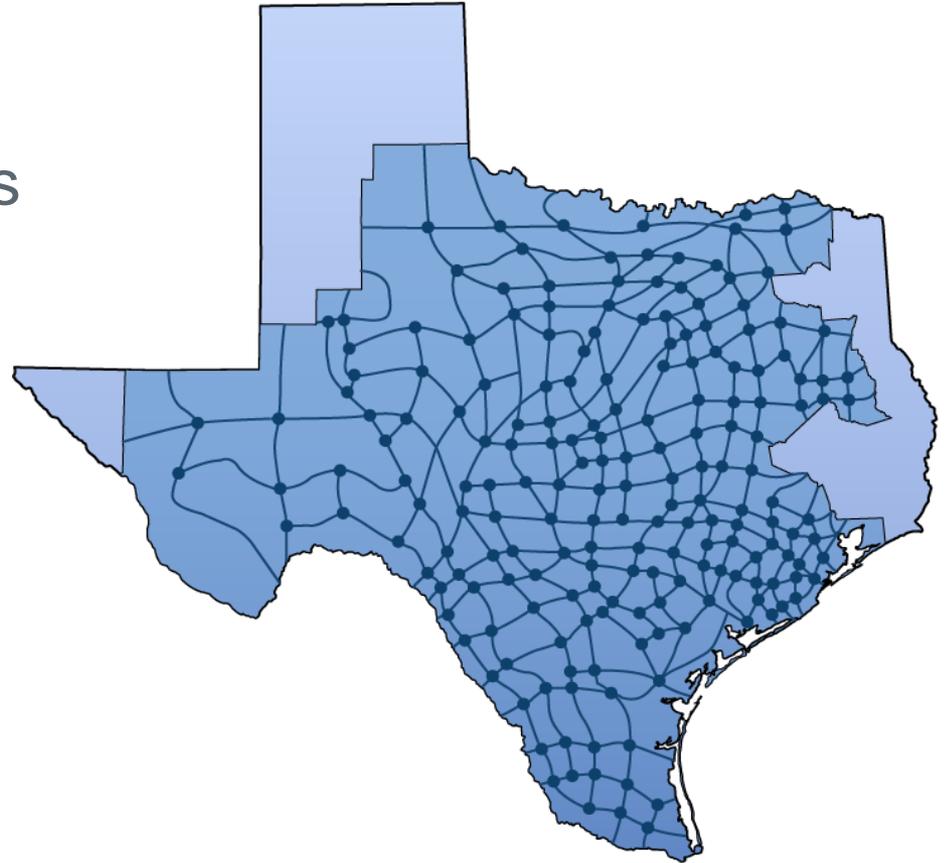
Ancillary Services

- Load and generation are constantly changing, requiring continual rebalancing, due to:
 - Daily load patterns
 - Instantaneous load variation
 - Changes in intermittent generation output
 - Generators tripping offline
- Ancillary Services are procured to ensure sufficient resources are on-line, or able to be brought on-line in a timely manner, to balance the variability that cannot be covered by the 5-minute energy market.
- ERCOT is in process of redefining the Ancillary Services framework to make these services more efficient and technology neutral.



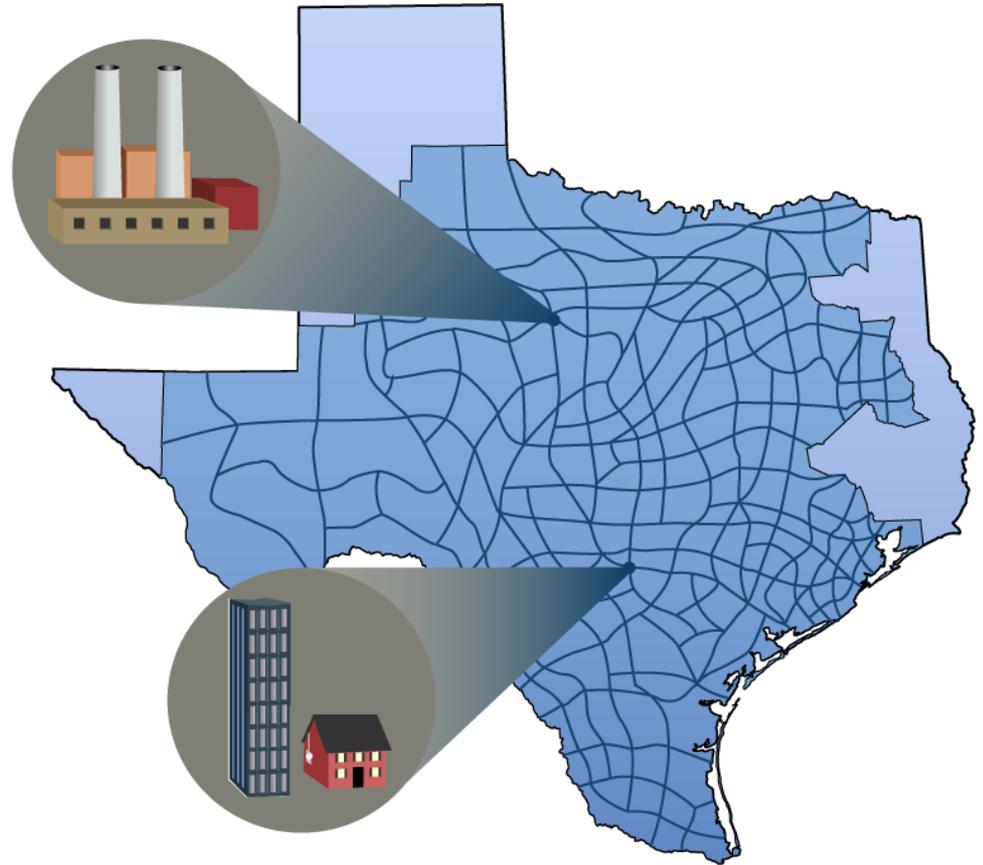
Commercial Markets

- Bilateral Market
- ERCOT Facilitated Markets
 - Day-Ahead Ancillary Services Market
 - Day-Ahead Energy Market
 - Real-Time Energy Market



Congestion Costs

- All costs are directly assigned
- Congestion Revenue Rights available for hedging



Energy-Only Market: What does that mean?

It's all about the recovery of costs to build (and operate) generation.

In ERCOT, these costs must be recovered with revenues from energy production and operating reserves.



Energy-Only Market: What does that mean?

Energy Pricing must support investment in new generation. A much higher clearing price \$9,000/MW or MWh in ERCOT.

Scarcity pricing – higher energy prices during periods where energy reserves are scarce

Operating Reserve Demand Curve – reflecting the cost of deploying reserves (Ancillary Services) in the energy price.



Looking into the future

- More intermittent renewables
- More distribution level resources
- Less conventional, thermal generation
 - Coal and Nuclear under market pressure from:
 - Low natural gas prices
 - Renewable resources
 - Added regulation
 - Renewable portfolio standards
- Storage?
- Distribution level thermal resources?
- Changes to the Retail Market

ERCOT seeks...

- Better visibility and accounting of distribution level resources for operational reliability and planning
- Improvements in ancillary services to accommodate the changing resource mix.
- Optimal pricing of energy to create the correct incentives.