The ERCOT Grid and Beyond

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

- 90% of Texas electric load; 75% of Texas land
- 73,473 MW peak, July 19, 2018
- More than 46,500 miles of transmission lines
- 600+ 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
What is ERCOT?

The Texas Legislature restructured the Texas electric market in 1999 and assigned ERCOT four primary responsibilities:

- **System reliability**
- **Competitive wholesale market**
- **Open access to transmission**
- **Competitive retail market**

ERCOT is a nonprofit organization that is regulated by the Public Utility Commission of Texas, with oversight by the Texas Legislature.

ERCOT is not a market participant and does not own generation or transmission/distribution wires.
The Texas Legislature restructured the Texas electric market in 1999:

- Generating units are owned by privately owned companies
  - Except for municipal and cooperative units
- Compete in ERCOT market to serve load
  - Market is overseen by PUC.

- Transmission and distribution lines and related facilities are owned and operated by regulated utilities.
  - Utilities are regulated by PUC.

- Retailers compete to serve consumers' electric load in ~75% of state
  - Except 25% in municipal and cooperative utility areas
- Active retail competition
  - 92% have switched
  - ~15% switches in a year
  - Nearly 100% smart meters
2 models within ERCOT

Municipals & Cooperatives (NOIEs)

Non-Opt in Entities (NOIEs) are still vertically integrated

Many have existing and developing smart grid initiatives:
-- AMI
-- Smart thermostats
-- Demand response

Possible triggers:
Demand charge avoidance, real-time prices, congestion management

73%
27%

Share of total ERCOT Load

Competitive Choice

‘Utility’ a mostly obsolete term

Dozens of REPs competing for residential and commercial accounts

Terms typically range from 3-24 months

Some pre-paid, renewable options

>99% advanced metering

The two worlds have very different smart grid incentives (more on this later)
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 Market

• Market participants bring generation on-line; ERCOT may start additional generation needed to maintain reliability.

• Market participants submit offers for generation output.

• ERCOT clears the market every five minutes, using the generation with the lowest bids to serve the load, subject to transmission constraints.

• Prices received by generators signal whether more or less output is needed from generators in that area at that time.

• In general, the set of generator output levels produced by this process is the lowest cost way that doesn’t overload the transmission system to meet the system load for each five minute interval.
Nodal Energy Market

- ERCOT clears the real-time energy market every five minutes, dispatching generation with the lowest offers to serve the load, subject to transmission constraints.
- Locational marginal prices (LMPs) are produced every ≤5 minutes at >11,000 nodes, including >600 Generation Resource Nodes.
- If there is no congestion on the system, all LMPs will be equal (set by the marginal unit).
- Generators are paid the LMP at their specific Resource Node.
- Load Serving Entities are billed the weighted-average price at the Load Zone.
Energy-Only Market & Scarcity Pricing Mechanism

• Features of the Energy-Only Market Design:
  – No forward capacity market
    • Energy and AS revenues are the incentives for future investment
  – System-Wide Offer Cap of $9,000/MWh
    • Highest in northern hemisphere
    • Applies to energy and Ancillary Service offers
    • Energy market cleared at the SWCAP for two 5-minute intervals in Spring of 2018
  – Operating Reserve Demand Curve
    • Assigns values to reserve capacity based on Loss of Load Probability
    • System-wide Price Adders increase as reserves decline
Peaker Net Margin (PNM)

• The PNM is a calculation designed to measure the annual net revenue of a hypothetical peaking unit.

• If the PNM for a year reaches a cumulative total of $315,000, the system-wide offer cap is then reduced to the higher of $2,000 per MWh or 50 times the daily natural gas price index.

• This threshold (defined in PUC Subst. Rule §25.505) has never been met.


2018 PNM = $62,293
Prices exceeded $75/MWh in 1.6% of intervals over 3 years.
Current Records

Peak Demand Record: 73,473 megawatts (MW)
- July 19, 2018, 4-5 p.m.

Weekend Peak Demand Record: 71,445 MW
- Sunday, July 22, 2018, 5-6 p.m.

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

Wind Generation Records (instantaneous)
- Output: 19,672 MW
  - Jan. 21, 2019, 7:19 p.m.
- Penetration (load served): 56.16%
  - January 19, 2019, 3:10 a.m.
  - Total MW Served by Wind = 17,406 MW

Recent Monthly Peak Demand Records

2018
- January: 65,915 MW (Jan. 17, 7-8 a.m.)
- May: 67,265 MW (May 29, 4-5 p.m.)
- June: 69,123 MW (June 27, 4-5 p.m.)
- July: 73,473 MW (July 19, 4-5 p.m.)
- November: 56,247 MW (Nov. 14, 7-8 a.m.)

2017
- April: 53,486 MW (April 28, 4-5 p.m.)
- October: 62,333 MW (Oct. 9, 4-5 p.m.)
Annual Energy and Peak Demand (2008-2018)
Historic Summer Reserve Margins (May CDR Reports)

December 2018 update: 8.1%
Since release of the Dec. update, unofficially revised to 7.4%
Wind and solar values are based on nameplate capacity (not adjusted for peak capacity contribution)
Energy Fuel Mix 2003-2018

*Source: Historical ERCOT Demand and Energy Reports
Ancillary Services

- Load and generation are constantly changing, due to:
  - Daily load patterns
  - Instantaneous load variation
  - Changes in variable generation output
  - Generators tripping offline

- Ancillary Services are procured in the Day-Ahead Market to ensure extra capacity is available to address variability that cannot be covered by the five-minute energy market.

Ancillary Service Products

- **Regulation Service**
  - ERCOT sends a signal every four seconds to increase or decrease output to the generators providing Regulation.

- **Responsive Reserve Service**
  - Capacity from generators or load resources that is readily available to respond to frequency events

- **Non-Spin Reserve Service**
  - Capacity that can be started in 10 or 30 minutes to cover forecast errors or ramps
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.
Utility Scale Solar Generation Capacity – December 2018

ERCOT Solar Installations by Year (through December 31, 2018)

- **2011**: 42 MW
- **2012**: 82 MW
- **2013**: 121 MW
- **2014**: 193 MW
- **2015**: 288 MW
- **2016**: 556 MW
- **2017**: 1,000 MW
- **2018**: 1,719 MW
- **2019**: 1,719 MW, 1,216 MW, 900 MW, 3,835 MW
- **2020**: 1,719 MW, 1,996 MW, 2,341 MW, 6,056 MW

*Future outcomes uncertain*
CREZ Transmission

Competitive Renewable Energy Zones (CREZ)
Docket No. 35665
Attachment A

Source: Oncor
Distributed Energy Resources
Distributed Energy Resources

- Distributed Energy Resources (DERs) include solar photovoltaic (PV) installations, small wind turbines, batteries, small generators, and advanced demand response.

- Identify potential future impacts of DERs on ERCOT’s functions – including but not limited to load forecasting, network modeling, real-time grid operations, metering and settlement.

- Identify and, when possible, eliminate barriers to DER participation in ERCOT markets, including developing ways for appropriate wholesale market price signals to be delivered to DERs.
Examples of Distributed Energy Resources (DERs)

Capable of Providing:
- Backup (emergency) power
- Demand charge reduction (e.g., 4CP)
- Response to wholesale market prices
- ERCOT Emergency Response Service
- An offset to energy consumption
- Ancillary Services

Photos courtesy Acclaim Energy
NPRR 917 pricing proposal

• NPRR 917 would extend applicable nodal pricing to SODGs and SOTGs
  – This would provide incentives for behavior consistent with Nodal market design and the reliability needs of the ERCOT system
• In the Real-Time Market, a nodal price is calculated for each electrical bus in the system at every SCED run
  – There are ~13,100 electrical buses in the system
• The NPRR would establish nodal pricing as follows:
  – SODGs (distribution-connected generators) would be paid the time-weighted price created at the Load point (electrical bus) to which the unit is mapped, per NPRR 866
  – SOTGs (transmission-connected generators), which are already fully modeled, would be paid the time-weighted price at the electrical bus determined by ERCOT in review of the meter location in the Model
    • There are 4 SOTG units with a total of 35.5 MW on the system today
### Settlement Only DG in ERCOT 2010-2018

#### SODGs

<table>
<thead>
<tr>
<th>Type</th>
<th>No. of Units</th>
<th>MW</th>
</tr>
</thead>
<tbody>
<tr>
<td>Non-Renewable</td>
<td>160</td>
<td>498</td>
</tr>
<tr>
<td>Renewable</td>
<td>55</td>
<td>320</td>
</tr>
<tr>
<td><strong>TOTALS</strong></td>
<td><strong>215</strong></td>
<td><strong>818</strong></td>
</tr>
</tbody>
</table>

SODG formerly known as Registered DG

- **73 units totaling 148 MW added since 1/1/18**

![Graph showing accumulation of DG units by type and MW, with a significant increase since 1/1/18.](https://example.com/ercot-graph.png)
Demand Charges
Summer Weather Impacts on Load by Customer Type

Thursday, March 1, 2018
5:00 p.m.
ERCOT Load: 37,997 MW
Temperature in Dallas: 62°

Thursday, July 19, 2018
5:00 p.m.
ERCOT Load: 73,539 MW
Temperature in Dallas: 108°

>35,000 MW of weather-sensitive load -- 48% of peak

- Customer class breakdown is for competitive choice areas; percentages are extrapolated for municipals and co-ops to achieve region-wide estimate
- Large C&I are IDR Meter Required (>700kW)
- 15-minute demand values
Demand Charge Avoidance (4CP Response)

- The Four Coincident Peaks (4CP) in ERCOT are the highest system-wide load 15-minute settlement intervals in each of the four summer months: June, July, August, September

- These intervals are the basis of various Transmission & Distribution (T&D) charges for:
  - Non-Opt In Entities (municipally-owned utilities and electric cooperatives), at the boundary meter level
  - Retail choice customers with peak demand \( \geq 700 \text{ kW} \) (Interval Data Recorder Meter required)

Combined, more than 47\% of total ERCOT load is subject to 4CP charges

Chart represents percentages of load at IE 1700 on June 27, 2018, ERCOT’s all-time system peak at the time

“Large C&I” = IDR Required
Transmission Charge Increases

- Final 2019 postage stamp rate is $54.57 per 4CP kW

Major factors:
1. CREZ
2. Natural load growth
3. Far West load growth

Coming soon:
1. Freeport Master Project
2. Lubbock Power & Light Integration
Advanced Metering & Retail DR
Advanced Metering Origins

- 2005 Texas legislation enabled TDSPs to receive accelerated cost recovery (via surcharge) for Advanced Metering Infrastructure (AMI)

- PUC rule implemented the law in 2007, with these purposes:
  - Implement the legislation by authorizing the surcharge
  - Increase the reliability of the regional electrical network
  - Encourage dynamic pricing and demand response
  - Improve the deployment and operation of generation, transmission and distribution assets
  - Provide more choices for electric customers

- Key elements of the rule:
  - Applies to investor-owned TDSPs only (NOIEs not affected)
  - AMI meters must measure consumption in 15-minute intervals
  - Interval data shall be used in wholesale market settlement at the ESI ID level
15-Minute Metering

Pre-AMI | AMI
---|---

Energy data points per month

1 | 2,880

Applies to residential premises without on-site distributed generation.
Advanced Metering benefits

• >7 million advanced meters now active in the competitive choice areas of ERCOT
  – >99% of ERCOT Load is now settled on 15-minute interval data
    • includes AMI, competitive IDR, and NOIE IDR

• TDSP benefits:
  – Reduced meter-reading costs
  – Advanced outage detection
  – Faster switching and move-ins/move-outs
Advanced Metering benefits

• **Retail Electric Provider (REP) benefits:**
  – Settlement accuracy (no more load profiles; see next slide)
  – Real money if customers reduce load during high-priced periods

• **ISO benefits:**
  – Settlement timeliness & accuracy

• **Customer benefits:**
  – Access to granular energy usage data
  – A wider selection of REP products to choose from
Why settlement is important

• In settlement, LSE purchases are reconciled with generators’ sales
• Prior to the AMI implementation, REP obligations for residential and small commercial customers were based on Load Profiles
  – Profiles are estimates of average individual usage, based on statistical samples of data from ‘like’ customers
  – A Profile for each customer type was created for each Operating Day, using weather & other inputs
  – Interval-level values were then assigned to each customer according to their Profile type, scaled based on monthly kWh usage
• A profile assumes customers of this type on average have the profiled Load shape
  – The load magnitude is adjusted (scaled) based on the customer’s monthly kWh consumption

• Prior to AMI, REP Load was settled based on this estimate
Why settlement is important

• Settlement based on Load Profiles would be accurate at the REP aggregate load level only if its customers were not deviating from the profiled shapes
  – REP must accept the settlement outcome even if its customers were making significant changes to their load shapes

• In other words…
  – Profiles are oblivious to intelligent load management
  – Profiles are hard barriers to price elasticity of demand
  – Profiles kill demand response
Why settlement is important

• Settlement on actual 15-minute data cures this problem

  – When customers are settled on their actual usage, the benefits of any action taken to reduce Load during a period of high wholesale prices will accrue directly to the LSE

  – This gives the LSE (in this case, the REP) an incentive proportional to real time prices to promote intelligent load management and demand response for its customers
Retail Price/Demand Response

• If retail DR and price response penetration are a key metric in measuring the success of the ERCOT retail market and the AMI investment, how are we doing?

  *PUC Subst. R. 25.505 (e)(5)*
  Load serving entities (LSEs) shall provide ERCOT with complete information on load response capabilities that are self-arranged or pursuant to bilateral agreements between LSEs and their customers.

• Leveraging this rule language, ERCOT has worked with REPs since 2013 to collect data on various product offerings, including:
  – Time-of-Use
  – Peak rebates
  – Real-Time pricing
  – Block & Index pricing
  – Other load control products

• REPs take snapshots of their customer base on Sept. 30 each year
Examples of Product Options

- **Comfort & Control**: We are offering the 3rd generation Nest Learning Thermostat.
- **Power-To-Go Free Weekends**: Enjoy 48 hours of free Texas electricity with your prepaid plan!
  - Power To Go Free Weekends (Electricity Facts Label)
  - Terms & Coverage
  - Your Rights as a Customer
- **Get a Nest Thermostat from Reliant at no cost.**
  First, you need a Nest Thermostat. It programs itself, automatically helps you save energy when you’re away and can be controlled from anywhere. Switch to the Reliant Lean & Conserve 24 plan and you’ll get a Nest Thermostat at no cost.
- **TXU Energy Free Nights.**
  Now choose what time your Free Nights start.

As a Bounce Energy customer, you can opt into our Bounce Back Energy Savings program and take pride in being a part of helping out when Texas needs it most. Enroll now to receive a $5 bill credit just for signing up! Just register for the program, lower your energy use to the specific level we request during a “Peak Event,” and you’ll also get rewarded with a 5% discount on your next bill.

Enroll Now.
ERCOT Communications
ERCOT Communication Channels

ERCOT website – www.ercot.com
- Today’s Outlook and grid conditions
- Daily and seasonal weather
- Market information, prices and more

Social media – join us!
- Twitter: @ERCOT_ISO
- Facebook: Electric Reliability Council of Texas
- YouTube: ERCOTISO

ERCOT mobile app
- Real-time updates
- Wholesale pricing
- Information sharing
Questions?