




Inside the Promise

2016 State of the Grid Report



The Electric Reliability Council of Texas (ERCOT) manages the flow of electric power to 24 million Texas customers — representing about 90 percent of the state's electric load. As the Independent System Operator for the region, ERCOT schedules power on an electric grid that connects more than 46,500 miles of transmission lines and 550 generating units. ERCOT also performs financial settlement for the competitive wholesale bulk-power market and administers retail switching for 7 million premises in competitive choice areas. ERCOT is a membership-based 501(c)(4) nonprofit corporation, governed by a board of directors and subject to oversight by the Public Utility Commission of Texas and the Texas Legislature. ERCOT's members include consumers, cooperatives, generators, power marketers, retail electric providers, investor-owned electric utilities, transmission and distribution providers, and municipally owned electric utilities.



Message from Leaders

Bill Magness
President and CEO

Craven Crowell
Chair, ERCOT Board of Directors

In 2016, ERCOT celebrated 75 years as an interconnected system, 20 years as an Independent System Operator (ISO), and 15 years since the market restructured. Notably, 2016 also was Bill's first year as president and CEO.

Through all those decades, the ERCOT market and grid operations have emerged and evolved. So have the technology and energy infrastructure that make this complex system work as one to help drive the Texas economy.

But the most defining feature of ERCOT is the people behind those tools. In this ever-changing energy landscape, what remains constant is the sincere commitment, deep understanding and unwavering leadership of the policymakers, employees and stakeholders who define and deliver on ERCOT's promise. They truly are the energy behind this tightly orchestrated effort to provide power for most of Texas in the most reliable, efficient manner possible.

During this past year, the ERCOT system broke previous demand and energy use records, reached several new milestones for wind generation, nearly doubled installed solar capacity, and saw average wholesale market prices reach new lows. ERCOT experts began refreshing and replacing our aging technology tools, completed a major upgrade of our Energy Management System, and explored a number of market rules to ensure our protocols and procedures still make sense in a changing environment.

In this State of the Grid Report, we invite you to take a closer look inside ERCOT's promise to the region and economy that rely on its success.

Keep reading to learn more about some challenges ERCOT faced in 2016 and the types of changes the people of ERCOT are preparing to manage in the years ahead.

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* as of January 1, 2017

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Vice President, Grid Planning & Operations

Chad Seely
Vice President, General Counsel & Corporate Secretary

Diane Williams
Vice President, Human Resources



Inside the Promise

ERCOT serves as a catalyst for a healthy economy in Texas. About 24 million Texans rely on the Independent System Operator (ISO) to fulfill its promise to keep the power flowing across the electric grid while operating efficient and competitive wholesale and retail electric markets.

With strategic planning and coordination, ERCOT has created a competitive marketplace that is recognized by the energy industry worldwide for its efficient design, low prices and excellent system reliability.

ERCOT does not own electric generation or transmission resources. Its promise as the ISO is to coordinate the operation of the grid and market that serve electric consumers. A refreshed brand, introduced in 2016, reflects that promise.

To fulfill its mission effectively, ERCOT must monitor and study changes to the electric industry, determine how those changes may affect its grid and market

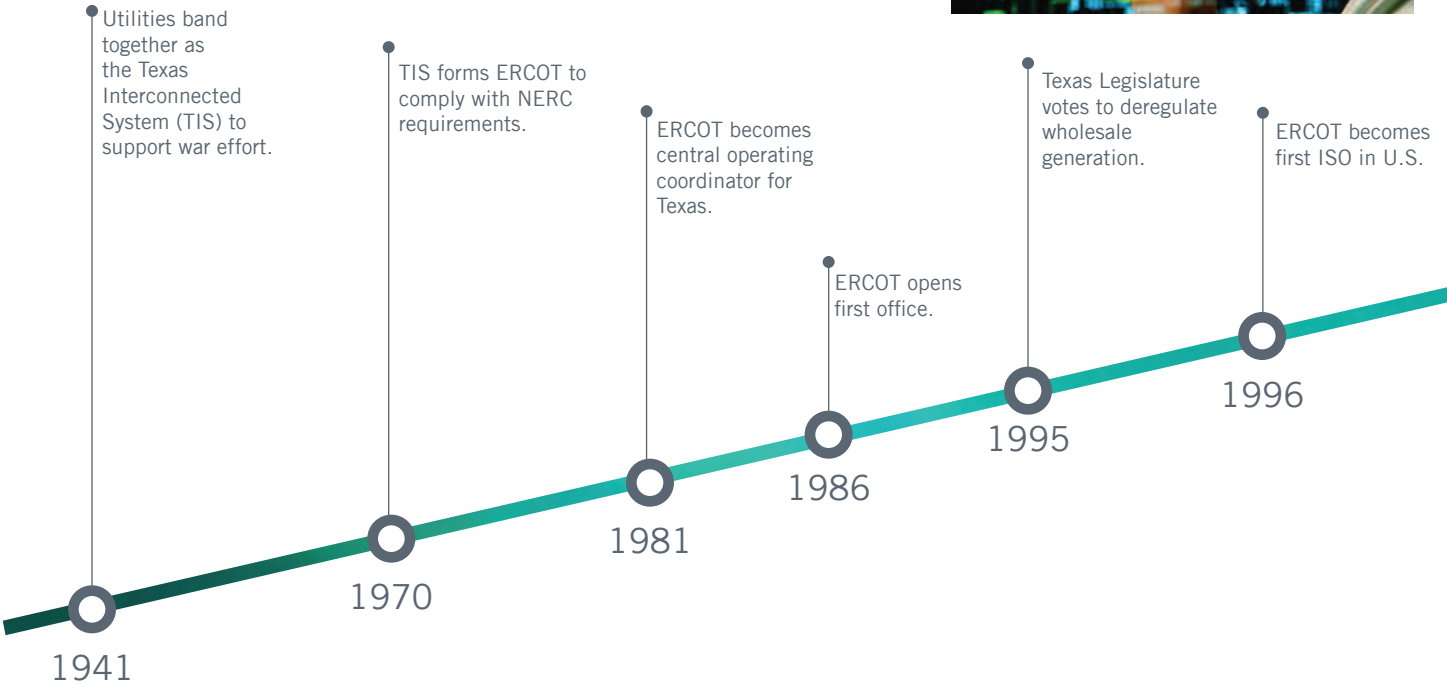
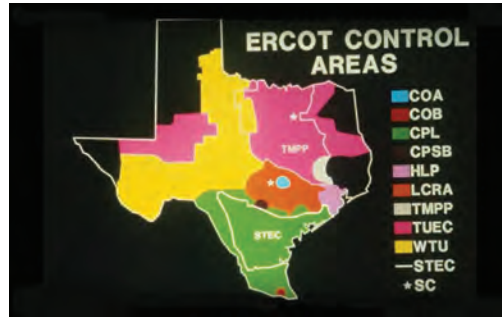
operations, and ensure it has effective rules and innovative technologies in place to adapt to evolving challenges and opportunities.

Its commitment to innovation has established ERCOT as a thought leader in the industry, and the ISO continually invests in new technologies to enhance its core functions. In 2016, ERCOT implemented new tools to help manage more renewables and upgraded aging equipment for increased functionality. ERCOT also worked closely with stakeholders to update criteria used to determine the need for new transmission projects and improvements.

Just as all the generation and transmission resources in the region must work together smoothly to maintain a reliable electric grid, the people behind those resources — from staff and market participants to lawmakers and regulators — all play important roles in fulfilling this promise.

ERCOT history

In 2016, ERCOT celebrated 75 years as an interconnected system, 20 years as an ISO and 15 years as a single control area. Today ERCOT maintains its independence as one of three electric grid interconnections located in the North American Electric Reliability Corporation (NERC) area.



Learn more about ERCOT history
on our website:
www.ercot.com/about/profile/history



Texas Legislature votes
to deregulate the retail
electric market.



Nodal market launches.

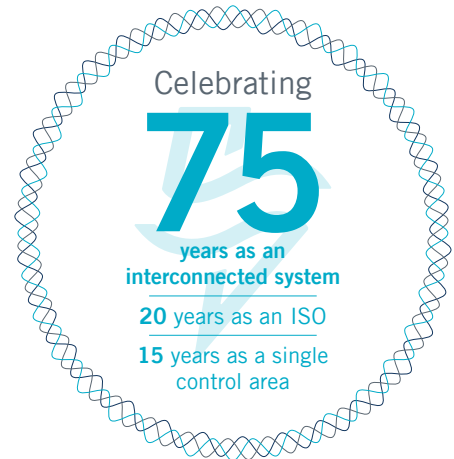
2010

2016

1999

2001

Ten control centers
merge into one
control center.



What is ERCOT?

While ERCOT does not own generation or transmission infrastructure, it does manage how those resources work together to provide about 90 percent of the electricity used in the state. ERCOT's primary job is to balance generation with load at all times, maintaining a frequency level at or near 60 Hz. Its unique energy-only market structure, in which resources are paid only for the energy they provide, is the foundation for that process.

ERCOT also performs financial settlement for the competitive wholesale bulk-power market and administers retail switching for 7 million premises in competitive choice areas.

The Public Utility Commission (PUC) of Texas regulates ERCOT, with oversight by the Governor and the Texas Legislature.

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

- Maintain system reliability.
- Facilitate a competitive wholesale market.
- Ensure open access to transmission.
- Facilitate a competitive retail market.



Market operations at a glance



Market participants may submit offers to buy and sell energy on an hourly basis in the voluntary Day-Ahead Market. Results help ERCOT operators and market participants plan for real-time operations the following day.



In the Real-Time Market, market participants submit offers to provide generation output and bring generation on-line as needed. ERCOT may request additional generation if needed to maintain system reliability.



Every five minutes, ERCOT's Security-Constrained Economic Dispatch system selects the most efficient generation resource options to serve customer demand effectively within the limits of the transmission system.

This process helps power the ERCOT region in the lowest cost way without overloading the transmission system.



Energy prices reflect the availability of resources during each interval, adjusting as needed to reflect the value of energy during scarcity conditions.



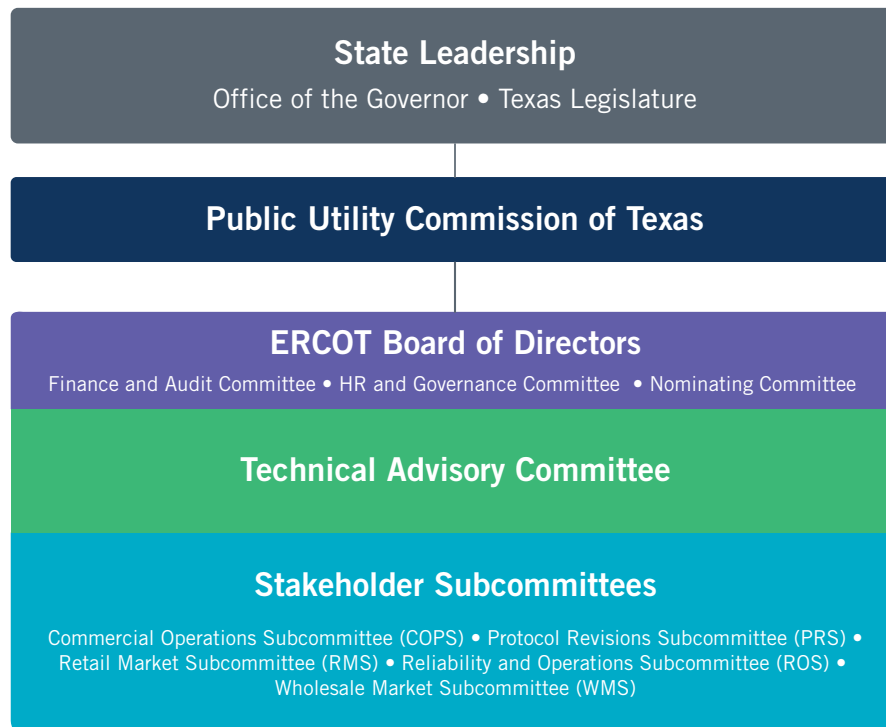
The Real-Time Market is settled every 15 minutes. Generators are paid settlement point prices, which reflect locational prices. Load-serving entities pay load zone prices, which can include costs associated with transmission congestion.

People make the promise work

Elected officials, regulators and market participants all contribute to ERCOT's success by ensuring the right laws and rules are in place to support the efficient, reliable movement of electric power across the region. Some standards are determined at the federal level, while others are determined through ERCOT's stakeholder process and PUC rules. Market participants help shape the more detailed protocols and procedures that govern the ERCOT system and its wholesale and retail markets.

ERCOT stakeholders serve on working groups, task forces and subcommittees to analyze specific issues, which then are addressed by the Technical Advisory Committee and ultimately the ERCOT Board of Directors.

ERCOT's promise is to provide a transparent process and reliable information that help policymakers at all levels make informed decisions that guide market and grid operations.



“ERCOT’s stakeholder process is key in developing transparent rules that foster a reliable and fair electricity market. In 2016, stakeholders from all market segments evaluated and approved more than 90 rule changes.”

– Ann Boren
Manager, Market Rules and Stakeholder Support





The energy industry is evolving.

Keeping our promise to plan and prepare for future needs

Hundreds of market rules guide ERCOT activities to protect the reliability and efficiency of the electric system in much of Texas. As conditions and needs change, ERCOT staff and stakeholders work to ensure that the market rules are keeping up with those changes.

Current trends indicate a likely shift toward more natural gas and renewable generation. ERCOT continues to monitor regulatory and market trends that could accelerate these changes and have significant impacts on future generation resources.



Planning for future reliability

ERCOT works to ensure its protocols and processes used to determine the need for transmission system improvements are based on reasonable criteria. In 2016, the Board of Directors approved two market rule changes adjusting the criteria used for transmission planning.

ERCOT executes RMR agreement

In 2016, ERCOT executed its first Reliability Must-Run (RMR) agreement in several years. Increasing customer demand in and around Houston has resulted in localized system constraints. The RMR agreement will keep a unit, which was proposed for retirement, available to support transmission system reliability in the Houston area.

The execution of the RMR agreement spurred discussion about the role these agreements play in local system reliability and the impacts they have on the wholesale energy market. As part of this discussion, ERCOT and its stakeholders analyzed the criteria used to determine whether a unit is needed for system reliability. In late 2016, the ERCOT Board approved changes to the criteria to help ensure RMR agreements are executed only when absolutely necessary.

Planning for transmission needs

After three years of stakeholder discussions and coordination, ERCOT also modified the criteria used to determine the need for new transmission projects. Planning Guide Revision Request 42, approved in December, defined considerations for selecting the most appropriate customer demand forecast in planning studies. It also defined how to address

switchable and mothballed units in planning cases, and provided guidance on considering new generation units that have interconnection agreements but have not achieved all of the requirements to be included in transmission planning studies.



Greens Bayou unit

RMR agreements are short-term solutions to address the need for generation resources to support local transmission system reliability. In June 2016, ERCOT entered into a multi-million dollar RMR agreement with NRG Texas Power to keep Greens Bayou Unit 5, a natural gas generation unit, available to support transmission system reliability in the Houston area during summer peak months. The RMR agreement is currently scheduled to continue until completion of the 345-kilovolt Houston Import Project in the summer of 2018.

Considering new connections to other grids

In 2016, ERCOT staff, stakeholders and the PUC began considering proposals to expand the grid's direct current (DC) tie connections, which allow controlled transfers of power between electric grids. A new law, passed by the Texas Legislature in 2015, amended the Utilities Code requiring the PUC to review transmission interconnections that enable imports or exports from the ERCOT power grid.

In the first proceeding to result from this new requirement, the PUC is considering appropriate conditions for interconnecting the proposed Southern Cross DC tie to the ERCOT grid. The Southern Cross Project includes a new transmission line that could move power from ERCOT to the Eastern Interconnection.





ERCOT must protect reliability as energy needs grow and resources change.

Keeping our promise to maintain system reliability

The energy landscape is evolving constantly, with the integration of more variable generation and other resources. ERCOT collaborates with its market participants to ensure the bulk electric system and market design are equipped to keep up with these changes while ensuring reliability and efficiency.

In 2016, the ERCOT region produced a record amount of energy, and peak demand surpassed 70,000 MW on five separate occasions.

ERCOT set its new all-time systemwide hourly peak demand record of 71,110 MW between 4 and 5 p.m. on Aug. 11, 2016. During this time, as much as 5,000 MW came from wind generation. The increasing role of wind generation makes it more important than ever to ensure the system has the tools needed to respond to variable output levels in a variety of operating conditions.

As wind generation capacity and energy production continue to grow, ERCOT continues to invest in Ancillary Services, better wind forecasting tools and knowledgeable staff. ERCOT operators must plan contingencies to ensure the electric grid maintains its system frequency, regardless of any sudden changes in generation output.

ERCOT's planning assessments — including its semi-annual Capacity, Demand and Reserves Report and the scenario-based Long-Term System Assessment — project renewables will play a larger role in ERCOT's future, including a sharp increase in utility-scale solar in the coming decade. This anticipated increase will make it more important for ERCOT to ensure the system is using its diverse resources and technologies in the most effective manner possible.

Meeting growing needs with changing resources

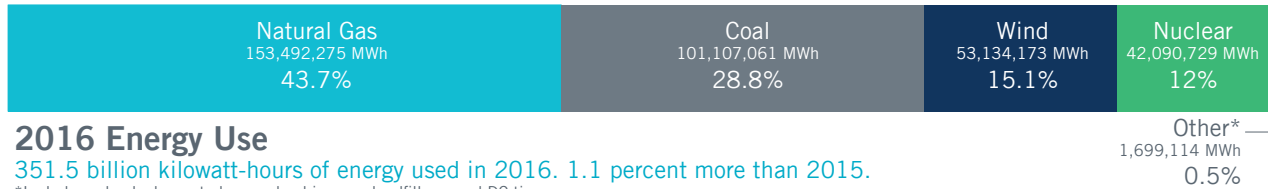
As energy use continues to grow in the ERCOT region, the diverse fuel mix used to generate power is shifting. In 2016, wind generation increased by 30 percent compared to 2015. In addition to its new all-time demand record in August, ERCOT set three other new monthly peak demand records and a new weekend peak demand record.

New monthly records

- Aug. 11, 2016 – 71,110 MW
- Sept. 19, 2016 – 66,949 MW
- Oct. 5, 2016 – 59,864 MW
- Dec. 19, 2016 – 57,924 MW

New weekend record

- Aug. 7, 2016 – 66,921 MW

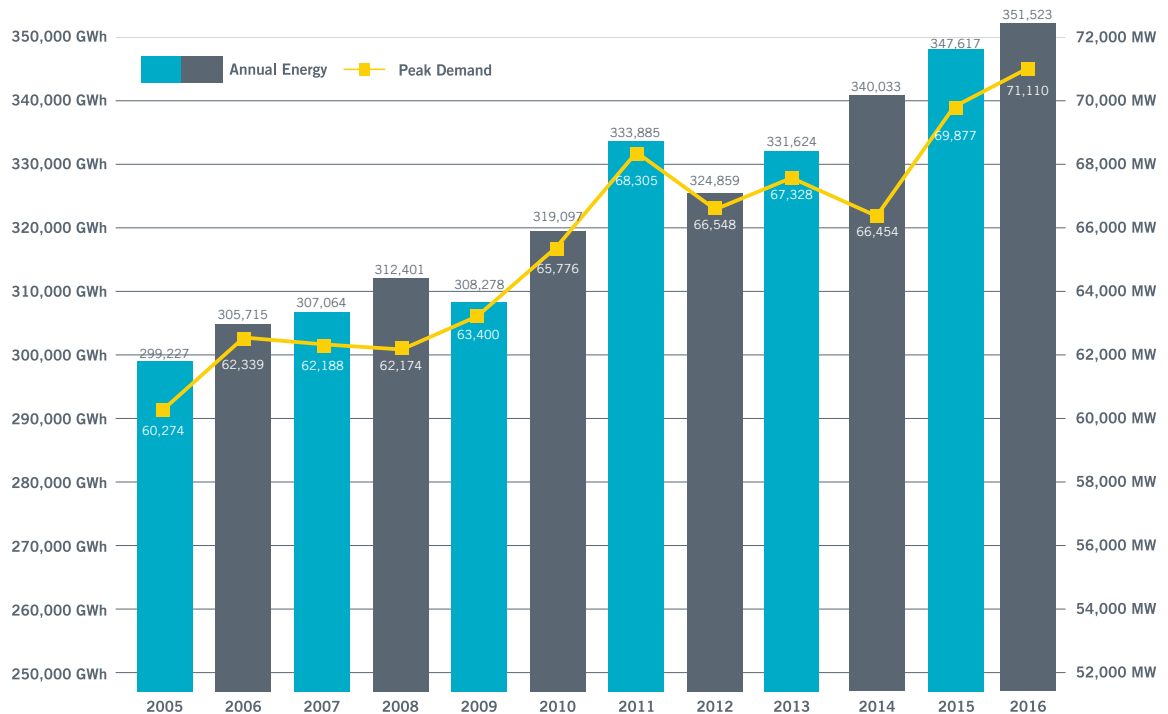


2016 Energy Use

351.5 billion kilowatt-hours of energy used in 2016. 1.1 percent more than 2015.

*Includes solar, hydro, petroleum coke, biomass, landfill gas and DC ties

Annual Energy and Peak Demand (2005-2016)



Addressing electric reliability concerns in the Lower Rio Grande Valley

ERCOT seeks to ensure there is sufficient transmission to serve load across the region. However, extreme load growth can sometimes outpace the system's ability to keep up, especially along the edges of the grid.

ERCOT continues to work closely with transmission providers in the Lower Rio Grande Valley to help keep pace with that region's growing electricity needs.



Rio Grande Valley

In 2016, Electric Transmission Texas and Sharyland Utilities completed and energized more than \$1.3 billion in improvements to the transmission system that delivers power into the area. This helped the system keep up with record Valley-area demand in 2016, even after a 524-MW power plant on the border with Mexico discontinued service

to the ERCOT grid. These projects have significantly improved the electric transmission in this area, but more improvements will be needed to help keep up with increasing electricity demand.

Recent generation additions are already helping with voltage stability. More generation is expected in summer 2017, and the ERCOT Board in June 2016 endorsed two new transmission projects that will provide additional voltage support.

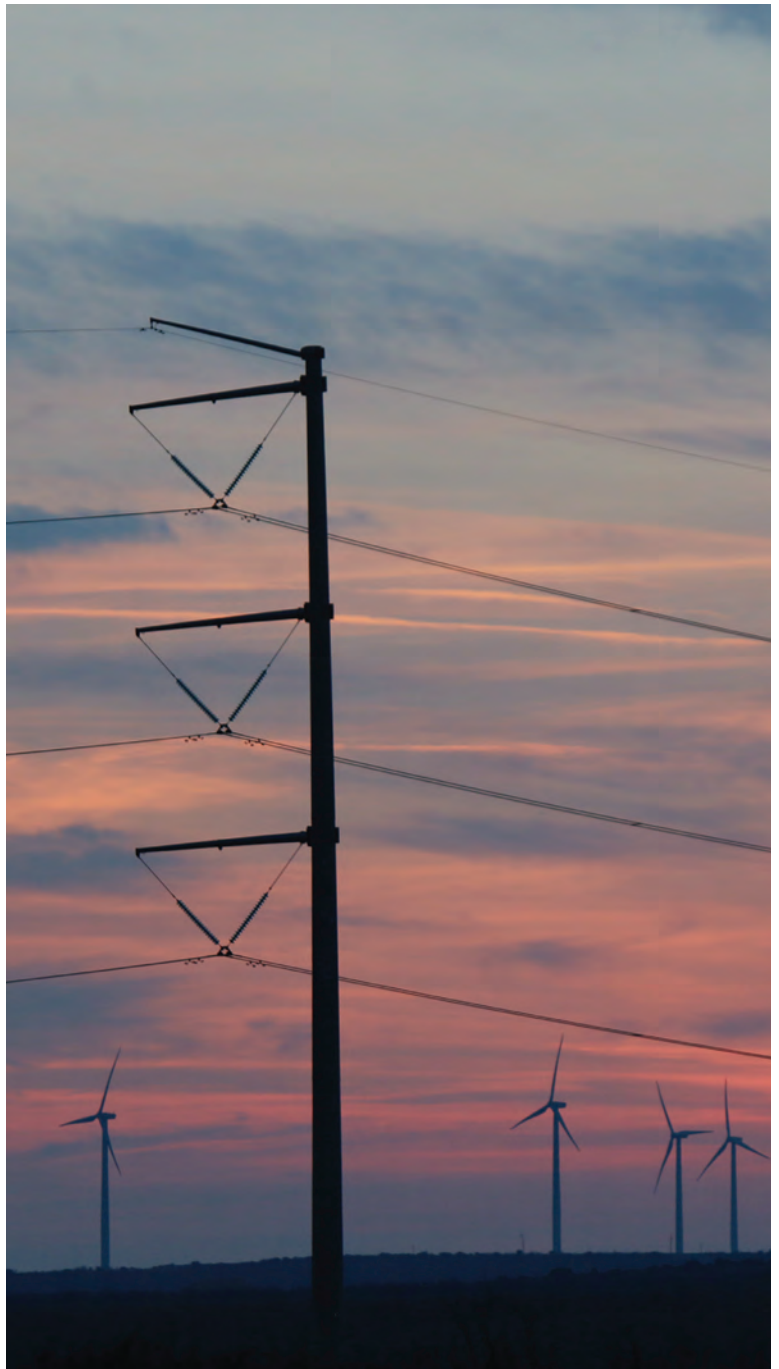
As electricity demand in the area grows, ERCOT will continue to operate the Valley-area system to maximize the value from available resources and will continue to work with stakeholders to identify additional solutions to support reliability in this unique and growing area of the electric grid.



West Texas and Panhandle growth

West Texas: Peak demand in West Texas has grown faster in the past seven years than the ERCOT system as a whole, primarily due to oil and gas development in the area. While recent transmission improvements and a slowdown in drilling activity have decreased congestion, recent ERCOT studies indicate the need for continued improvements to support additional growth in the Permian Basin region.

Panhandle: New wind generation development continues in the Panhandle, and interest in new grid-scale solar and storage facilities has emerged in this region. The Panhandle has an export limit in place to help maintain reliable operations, and ERCOT is studying a proposal to further increase the export capacity in the region. Some ongoing improvements are expected to be in service by 2018.



Utilities seek to join ERCOT

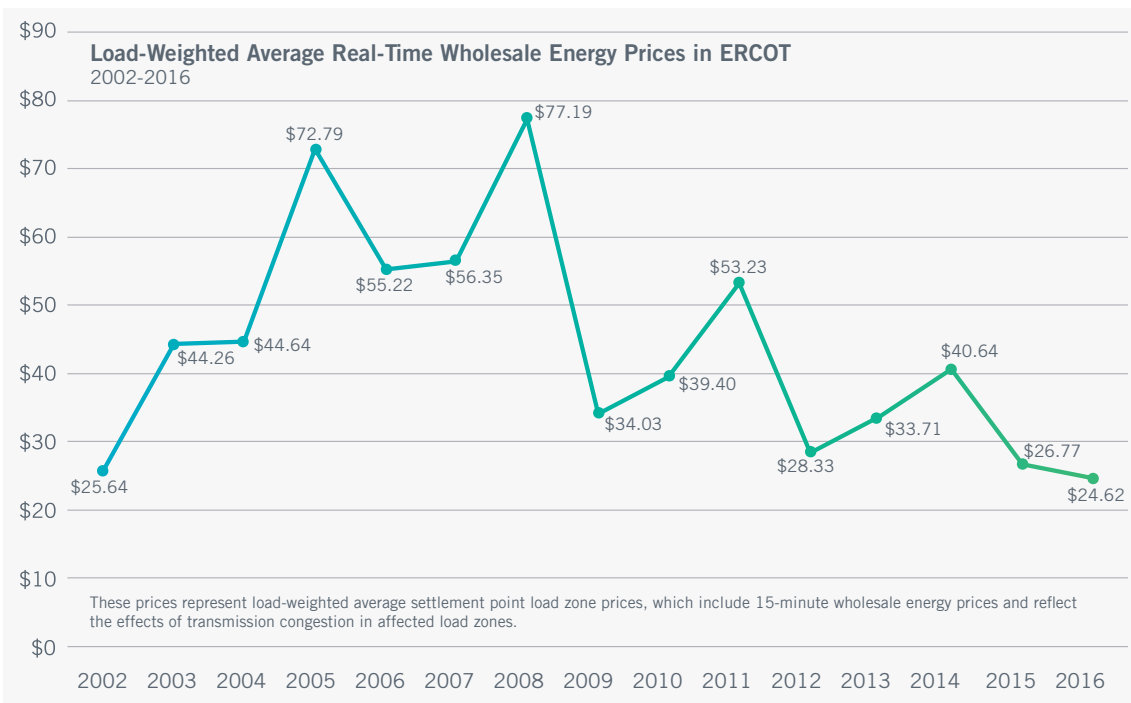
ERCOT's excellent reputation as a reliable and competitive market is noticed locally and around the world. This reputation is attracting the attention of some neighboring utilities, which seek to benefit from its low prices and inclusive governance.

In 2015, Lubbock Power and Light, which is currently in the Southwest Power Pool (SPP) region, requested to join ERCOT when its current power agreement ends in 2019. ERCOT and SPP are performing parallel studies to assess the potential impacts of this change. In 2017, the results of these studies will help the PUC determine the best course, keeping in mind the effects on the ERCOT system and the impact to the ratepayers of Texas.

Another utility, Rayburn Electric Cooperative, also seeks to integrate the portion of its load not currently served by ERCOT. The potential impacts of this request also are under study.

Wholesale energy prices hit record lows

Average wholesale energy prices in the ERCOT Real-Time Market hit all-time lows in 2016. While the efficiency of ERCOT's competitive wholesale market played a role, these record-low prices resulted primarily from very low natural gas prices, averaging \$2.45 per million Btu. Additional wind power production in 2016 also contributed to pricing.





Renewable energy is playing a larger role in the ERCOT fuel mix.

Keeping our promise to anticipate and adapt to a changing resource mix

In 2016, wind and solar projects accounted for the majority of new generation built in the ERCOT region. As renewable energy and other new technologies continue to grow in Texas, ERCOT is adapting to ensure the reliability and efficiency of the electric system.

ERCOT continues to improve its wind forecasts to prepare for daily operations. And, beginning in 2017, a new Reliability Risk Desk will help monitor and mitigate risks, including those associated with variable resources.

Variable resources create complex challenges for ERCOT grid operators, including the potential for sudden shifts in generation output and less inertia on the system. These are important considerations when maintaining system frequency.

The new desk will be equipped with expert staff and additional analytical tools to manage these and other issues.



Managing inertia

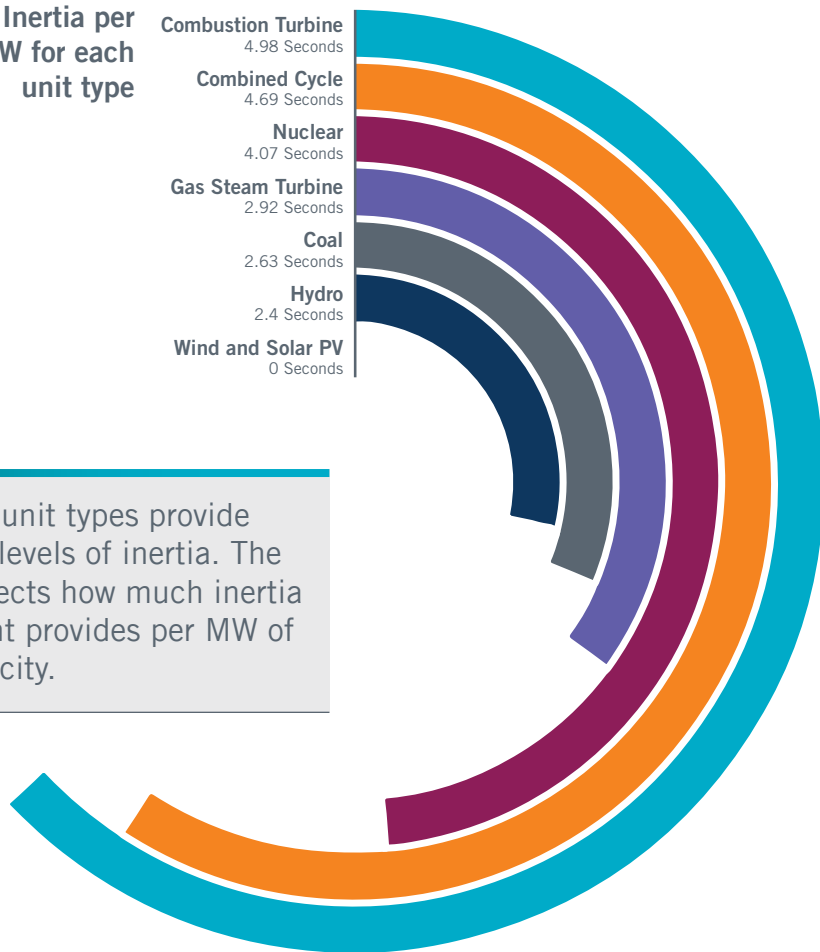
System inertia — part of the physics behind the electrical system — is affected by the amount of online synchronous generation. Only synchronous generation can provide inertia to maintain frequency following a sudden generation loss. Traditional thermal and hydroelectric resources provide this type of support, but wind and solar resources do not.

ERCOT will monitor inertia through the Reliability Risk Desk and will take any necessary actions defined in its procedures to maintain a reliable electric system.

Inertia per MW for each unit type

Combustion Turbine	4.98 Seconds
Combined Cycle	4.69 Seconds
Nuclear	4.07 Seconds
Gas Steam Turbine	2.92 Seconds
Coal	2.63 Seconds
Hydro	2.4 Seconds
Wind and Solar PV	0 Seconds

Different unit types provide different levels of inertia. The chart reflects how much inertia each plant provides per MW of unit capacity.



“Inertia controls how fast the frequency changes following a unit trip or other disturbance. ERCOT has to maintain enough inertia so that frequency does not drop too fast for Ancillary Services to work.”

– Dan Woodfin
Senior Director, System Operations

Wind and solar capacity on the rise

Since 2009, total installed wind capacity in the ERCOT region has nearly doubled to more than 17,000 MW. An additional 5,000 MW of wind generation may connect to the grid as soon as 2017, based on existing transmission agreements. While it is unlikely all those projects will get built, these resources will continue to grow. In fact, wind provided more than 15 percent of the energy used in the ERCOT region in 2016.

On Dec. 25, 2016, as a cold front blew in, wind generation output in the ERCOT system exceeded 16,000 MW for the first time, reaching 16,022 MW at 10:40 a.m. At the time, wind accounted for 47 percent of the total load.

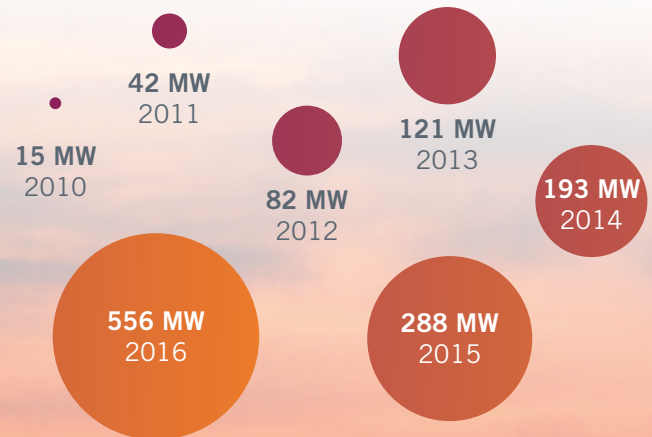
During the week of Aug. 8-12, 2016, wind generator output was in the 4,000 to 5,000 MW range during peak hours, helping to maintain a reliable electric grid during tight conditions. ERCOT experts are aware that the system cannot always expect this level of wind output during peaks. In 2016, ERCOT's Seasonal Assessment of Resource Adequacy added a low-wind scenario to help assess seasonal reliability risks associated with wind variability.

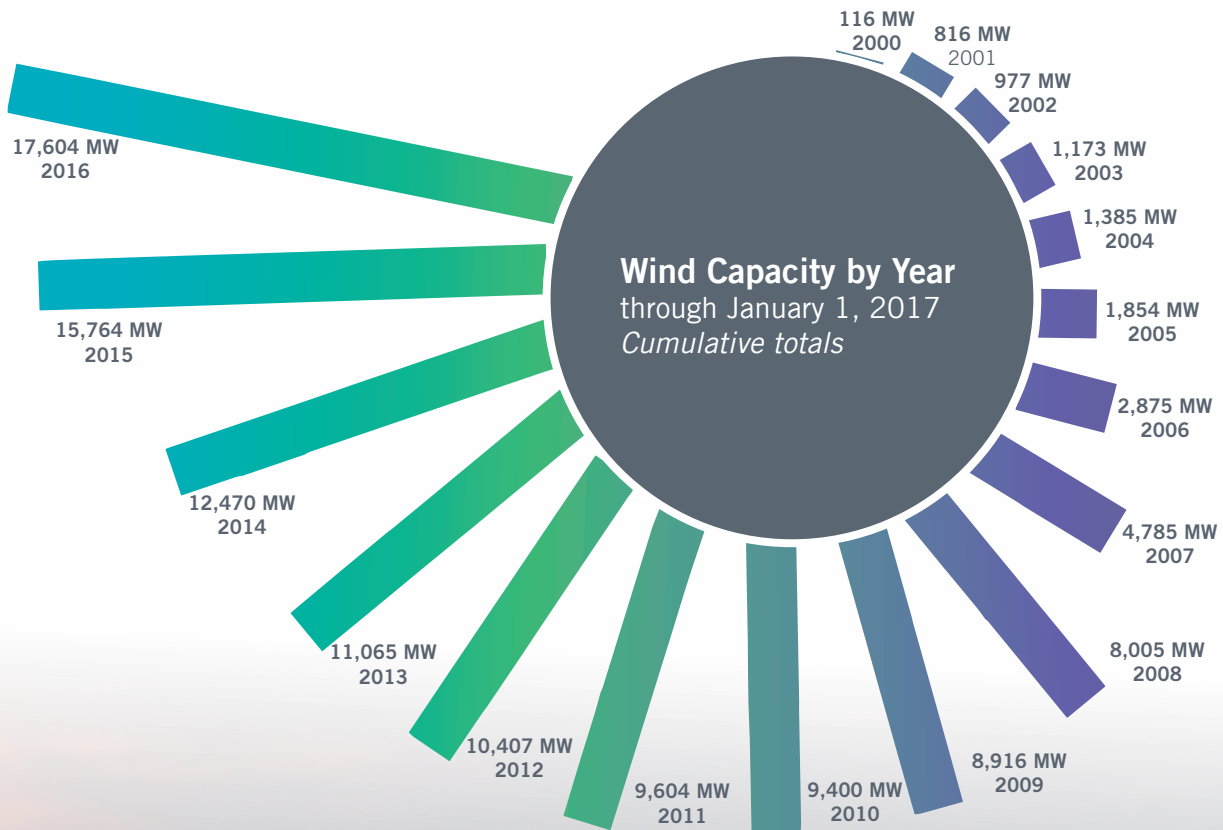
Utility-scale solar, which does not include rooftop installations or microgrids, also has become more prevalent in the ERCOT region. This resource nearly doubled to more than 500 MW of installed solar capacity in 2016. This is up from 288 MW in 2015 and just 42 MW in 2011. Another nearly 900 MW of utility-scale solar projects have agreements to connect to the grid as early as 2017.

2016 Wind Records

Feb. 18, 2016	– 14,023 MW
Nov. 17, 2016	– 14,122 MW
Nov. 27, 2016	– 15,033 MW
Dec. 17, 2016	– 15,195 MW
Dec. 25, 2016	– 16,022 MW

Utility-Scale Solar Capacity by Year through January 1, 2017 *Cumulative totals*





“The ERCOT region saw unprecedented wind capacity in 2016, and we expect this trend to continue in 2017. To address this growth, we are continually improving the performance of our wind forecasts and refining our Ancillary Services methodology to plan for any uncertainties.”

- Pengwei Du
Senior Operations Engineer

Ancillary Services support reliability

Every day, ERCOT secures reserve generation capacity from the market to help support reliability and maintain system frequency when conditions change quickly. These Ancillary Services are procured in the Day-Ahead Market to ensure extra capacity is available if needed for system emergencies.

In 2016, ERCOT modified its procurement process for Responsive Reserve Services (RRS) to address the increase in variable resources. Rather than purchase a fixed amount of RRS for every hour of every day, ERCOT began purchasing RRS based on the expected load and resource conditions.

Types of Ancillary Services

ERCOT purchases Ancillary Services to maintain grid reliability.

Regulation Services: ERCOT sends a signal to generators every four seconds to increase or decrease their output. The generators must already be running.

Responsive Reserve Services: Capacity is readily available if there is sudden generation loss and frequency level drops.

Non-Spin Reserve Services: Capacity can be started in 10 or 30 minutes.

Distributed Energy Resources gaining ground

More homes and businesses in the ERCOT region are adding their own electricity production. As these Distributed Energy Resources (DERs) grow in ERCOT, the ISO is considering their potential risks and benefits to grid operations. Specifically, ERCOT seeks to identify where those resources are — and how much power they can produce — to help ensure future reliability as they become more prevalent.

DERs can range from small solar rooftop installations to small fossil fuel generators or combinations of both. They also may include battery storage. DERs are connected to the distribution system at lower voltages than the bulk power grid. While ERCOT currently has limited visibility into the distribution system, it is working to improve its understanding of DERs and how they operate.





ERCOT relies increasingly on data and technology to ensure grid reliability and market efficiency.

Keeping our promise to provide the best tools for the job

Like any other company that relies on computer technology for its business operations, ERCOT continually upgrades its hardware and software to maintain system performance, efficiency and reliability.

In 2016, the ERCOT Information Technology department completed more than 40 projects, including major upgrades to the Energy Management System (EMS). The company also began a technology refresh for equipment used to manage and store information.



“ERCOT staff did an excellent job managing the complexities of the Energy Management System upgrade. Making sure our operators are equipped with the most advanced technologies is testament to ERCOT’s promise to ensure a reliable grid and efficient electricity market.”

- Steve White
Senior Manager, EMMS Production



Energy Management System receives major upgrade

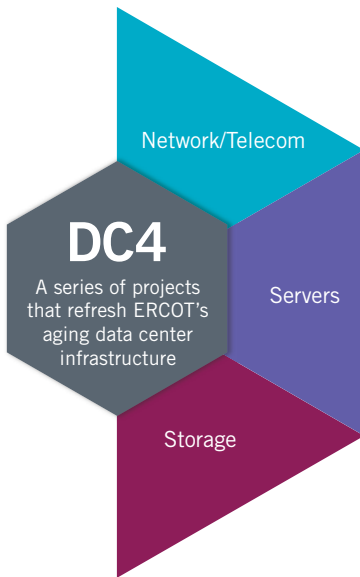
In June 2016, ERCOT transitioned to an upgraded Energy Management System (EMS) with more displays and navigation features. EMS is considered the backbone for ERCOT operations. It comprises a complex network of software applications that provide real-time generation and transmission data. This information allows operators to evaluate current grid conditions, maintain frequency on the system and send generation dispatch instructions. It also provides important information to market operations.

The EMS upgrade project spanned four years at a cost of nearly \$18 million. Approximately 170 employees spent 86,000 labor hours working to improve aging hardware and software that make up the EMS system.

Because EMS must be available 24/7 to operate the grid, the upgrade required building a parallel system that could be verified and tested while the old system continued to operate. More than 3,000 custom features complement the myriad systems used for grid operations.



Data center technology refresh begins



Similar to upgrading a smart phone with the latest operating system, ERCOT upgrades and replaces equipment as needed to help ensure reliability and performance, take advantage of new system features and maintain vendor support for the equipment. Until recently, ERCOT's last major technology upgrade had occurred during the transition to the Nodal market in 2010.

In 2016, ERCOT began a new project to address aging equipment. This Data Center Technology Refresh, Generation 4 (DC4) includes replacing and/or upgrading the ERCOT system network, computers, storage and telecommunications equipment companywide.

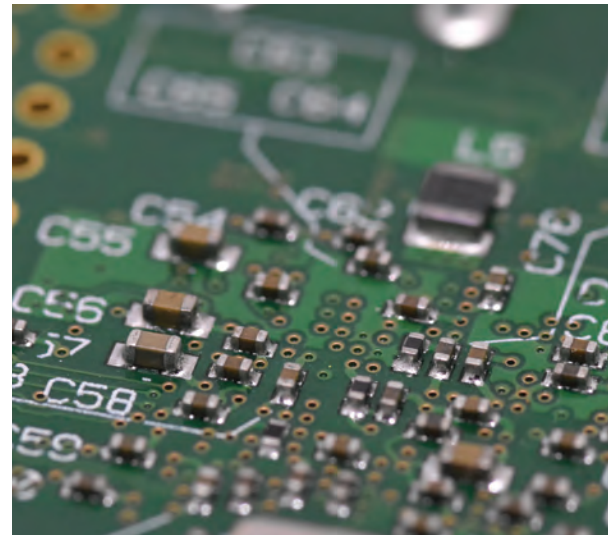
During year one of the four-year project, ERCOT negotiated new contracts and replaced 20 percent of the equipment. ERCOT is focused on new architecture that is faster, more resilient, flexible and capable of improving system reliability.

This undertaking is expected to cost about \$48 million over the life of the project. Twenty percent of the budget was spent in 2016, nearly doubling ERCOT's annual project budget. The scope, schedule and budget for this project are on track.

Outage scheduler improves

To help ensure sufficient generation resources are available for system reliability, ERCOT plans ahead for any pending maintenance outages. Those outages are scheduled in the Outage Management Scheduler for proper resource planning and other considerations.

ERCOT in 2016 made improvements to the system for increased efficiency, including the ability for generators to schedule their own maintenance outages. ERCOT spent the past few years meeting with Transmission Service Providers to identify and prioritize necessary upgrades.



Streamlined business processes enhance efficiency, improve workflow

ERCOT strives to manage and reduce costs where possible and has achieved millions of dollars in savings in recent years through vendor management and other strategic initiatives. In 2016, ERCOT replaced several of its internal Human Resources

and Finance systems with one unified application. The new solution is expected to result in significant annual cost savings due to improved efficiency, faster processing for routine administrative tasks and the elimination of some manual processes.



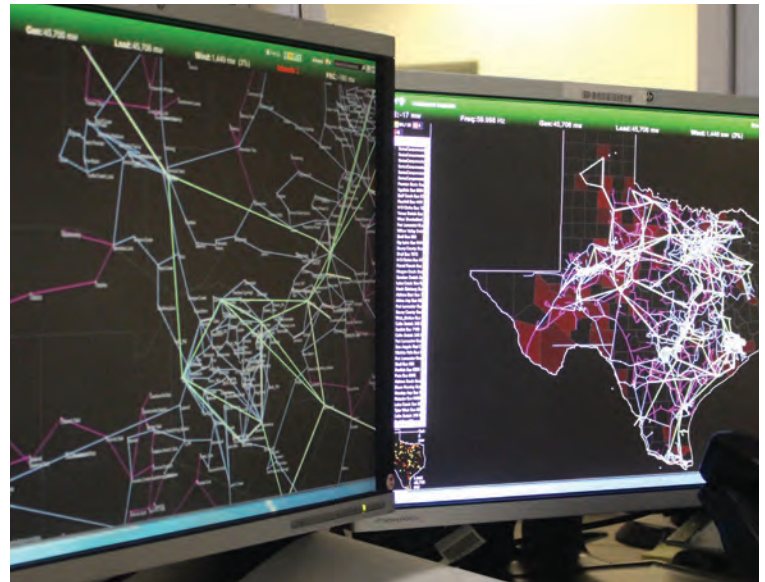


The security of the electric system is critical for reliability.

Keeping our promise to maintain a secure grid

ERCOT prepares year round for any type of threat to the electric system. Whether the threat is cyber or physical, ERCOT continually invests in trained staff and resources to help keep the electric grid safe.

From system redundancies to controlled access, ERCOT has multiple layers of protective measures to safeguard its critical infrastructure. This layered cyber and physical security approach is known as a defense-in-depth strategy.





Maintaining physical security

ERCOT has a top-notch Physical Security team that monitors activities at each ERCOT location. This team participates in ongoing training and preparedness exercises to stay current with industry trends.

Not only does ERCOT have a professional team that is trained to monitor, prevent and respond to security threats, but the organization also collaborates with relevant local and federal agencies to enhance its security presence.

Grid Security Collaboration:

Federal/National:

- U.S. Department of Homeland Security
- Federal Bureau of Investigation
- Department of Energy
- Federal Energy Regulatory Commission
- Department of State
- Department of Justice

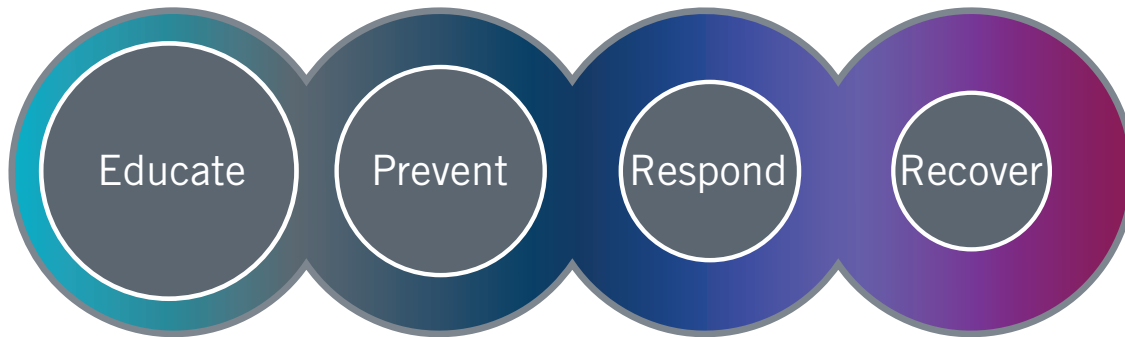
Prevention is first line of defense

ERCOT takes all prudent measures required by national reliability standards and best security practices in the industry to secure ERCOT's mission-critical networks and systems against attacks.

ERCOT's cyber security strategy starts on the front lines. All employees are trained regularly to identify potential cyber threats and to take prompt action to report concerns and help prevent attacks.

Highly trained cyber experts also continuously monitor the system for suspicious activity and attempts to circumvent its strong security protections.

Finally, ERCOT's defense-in-depth strategy is designed to take necessary steps to respond and recover if attacks occur.



Federal/National, cont.:

- United States Computer Emergency Readiness Team (US-CERT)
- Industrial Control Systems Cyber Emergency Response Team (ICS-CERT)
- National Electric Sector Cybersecurity Organization
- North American Electric Reliability Corporation
- Electricity Information Sharing and Analysis Center

State:

- Public Utility Commission of Texas
- Texas Department of Public Safety
- Texas Department of Information Resources

Industry:

- North American Transmission Forum
- Electric Power Research Institute
- ISO/RTO Council

National Labs:

- Idaho National Laboratory
- Pacific Northwest National Laboratory
- Sandia National Laboratories
- Argonne National Laboratory

ERCOT studies grid resilience

A resilient electric grid can recover quickly, even during the most extreme events. ERCOT in 2016 formed the Grid Resilience Working Group (GRWG) to better understand risks that are not highly likely, but could have significant impact.

The GRWG comprises stakeholders from wires companies, generation owners, consumers and ERCOT staff. One of the topics currently being discussed is the potential impact electromagnetic pulses (EMPs) could have on the ERCOT system. The GRWG will report on ways to help mitigate or prevent the potential negative effects of a localized, regional or high altitude EMP event.

ERCOT also is participating in an EMP study led by the U.S. Department of Energy and the Electric Power Research Institute.

Critical Infrastructure Protection upgrades completed

NERC develops and enforces reliability standards to help protect the bulk electric system. In July 2016, NERC implemented Version 5 of its Critical Infrastructure Cyber Security Standards, which address cyber security threats. By the implementation date, ERCOT had successfully implemented changes to its process and systems in the areas of access, compliance, change management, security and infrastructure.





ERCOT is committed to recruiting, retaining and developing its most critical asset, employees.

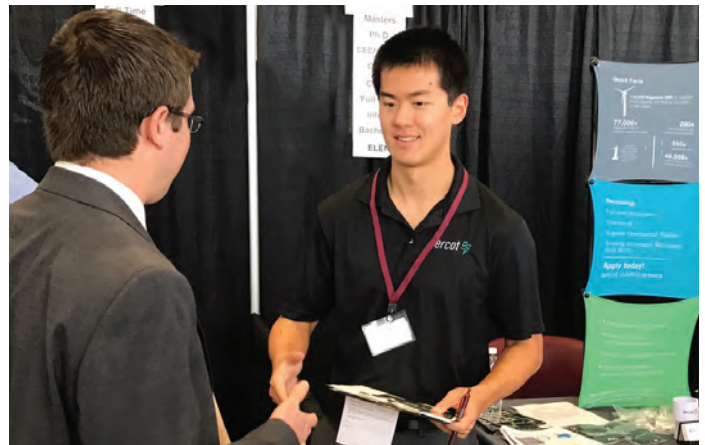
Keeping our promise to lead by example

ERCOT's success begins with people who are committed to fulfill its mission. ERCOT recruits and develops industry leaders, from entry-level college graduates to seasoned experts. The complexities and unique problem-solving opportunities associated with its mission make ERCOT an attractive place for engineers and Information Technology professionals to develop their careers.

ERCOT's reputation as a thought leader in the industry attracts visitors from utilities and other energy companies worldwide to learn about the company's operations. ERCOT subject-matter experts also participate in dozens of speaking engagements annually and publish scholarly papers to share their expertise and help elevate the company's visibility.

Ongoing training plays a key role at ERCOT. Control room operators attend a week's worth of training every

six weeks, and ERCOT hosts Black Start and Operator Training Seminars each year for staff and market participants. ERCOT also offers management training and coaching clinics for staff, as well as monthly training sessions for all employees.



Training employees for a future with ERCOT

ERCOT offers two in-depth training programs for recent college graduates in the fields of power engineering and IT, as well as an internship program for college students.

Engineer Development Program (EDP)

EDP is a 12-month program that exposes entry-level engineers to 15 areas of study, with the goal of developing them to become productive power engineers.

Five ERCOT employees graduated from the program in 2016, bringing the total graduates to 17 since the program began in 2012. Most EDP participants remain employed with ERCOT.

In 2016, the EDP Reach committee — comprising EDP alumni currently employed at ERCOT — presented its first college scholarship as a way to help draw attention to the program and the power engineering profession.



“The EDP has really elevated my career development at ERCOT. I have a better understanding of how the ERCOT grid works and how information flows among the different engineering groups.”

- Megan Miller
Engineer 1

Building Information Technology Staff (BITS)

BITS was established in 2015 to help develop entry-level IT professionals. The program introduces participants to multiple IT tracks, including development, infrastructure and operations. In 2016, a test management module also was added to the program rotation schedule. Four BITS associates have graduated from the program since it began just two years ago.



Internship Program

ERCOT has a robust internship program in multiple areas. Students are given a wide range of opportunities to learn about the electric industry and apply their skills to meaningful projects. In 2016, 29 interns worked in 25 departments. Of those, four interns became full-time employees with ERCOT.

A valued community partner

The ERCOT Community Involvement Committee works with local nonprofits to provide volunteering and fundraising opportunities for employees. In 2016, ERCOT employees assisted 10 entities that provide a variety of services to Central Texans.



United Way

Provided volunteers and funding to help support services for seniors, victims of domestic violence, students and low-income residents

Central Texas SPCA

Donated funds and supplies for the animal shelter



Ghisallo Cycling Initiative

Raised funds for youth and senior bicycle education programs in Travis County

GHISALLO
CYCLING INITIATIVE



Beginners Learning Alternative Designs for Energy (BLADE)

Raised funds for BLADE after-school engineering club and completed pavilion solar light project at Bull Branch Park in Taylor



“ERCOT is very supportive of employees working to improve their community, and I encourage everyone to consider volunteering their talents. As a mentor for an after-school engineering club, I enjoy seeing students tackle big challenges. Who knows? Maybe some of them will work for us in the future!”

- Jonathan Rose
Senior Planning Engineer



Mentoring students at Taylor Independent School District

Provided volunteers and funds for supplies for Mentoring at Lunch (MUNCH) and Mentoring a Pasemann Student (MAPS) programs



Shepherd's Heart Food Pantry

Donated canned goods for food pantry serving residents in Taylor and the surrounding area

Meals on Wheels

Delivered meals to homebound seniors in Taylor



We Are Blood

Hosted on-site blood drives for Central Texas blood bank



Military and Veterans Services

Raised funds for Fisher House Foundation, which houses families of active military and veterans receiving medical care



Court Appointed Special Advocates (CASA)

Provided holiday gifts for children served by this program

Fit for work

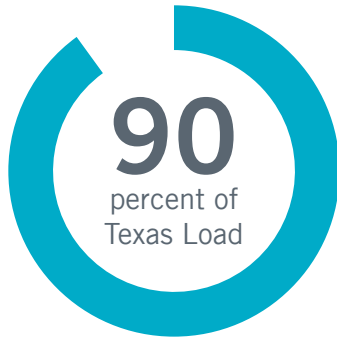
ERCOT continually strives to be one of the best places to work in Central Texas.

In 2016, the Austin Business Journal recognized ERCOT as one of the healthiest employers in Central Texas. In the same year, ERCOT was designated as a Fit-Friendly Worksites by the Austin Heart Association.

ERCOT has on-site fitness centers and offers healthy food options for employees at its Taylor facility. The ERCOT Wellness Committee hosts several ERCOTStrong challenges, classes and other activities to support and encourage employees' healthy lifestyles.



Quick Facts



24
million consumers
in the ERCOT region

In 2016, **\$2.1 billion** in
transmission development added
to the ERCOT region

75%
of load is competitive-
choice customers —
more than 7 million
electric-service IDs
(premises)

1,800+
active market participants
that generate, move, buy, sell
or use wholesale electricity

78,000+
megawatts (MW)
of expected capacity
for peak

1 megawatt of electricity
can power about 200
Texas homes during
periods of peak demand.



7 million advanced meters

98.9%
of ERCOT load settled with
15-minute interval data

1,448
circuit miles of
transmission
improvements
completed by
market participants
in 2016

550+
generating units

46,500+
circuit miles of high-
voltage transmission

Natural Gas
52%

Coal
22%

Wind
20%

Nuclear
6%

Other*
1%

2016 Generation Capacity

as of Dec. 31, 2016

*Includes solar, hydro and biomass

Special Thanks

Page 11 photo courtesy of Cross Texas Transmission • Page 12 photo courtesy of NRG Energy • Page 16 photo courtesy of Larry Jones, AEP Texas • Page 23 photo courtesy of Self Reliant Solar

Dedicated to:

Matt Tozer, who passed away in August 2016, was ERCOT's manager of Settlements and Billing. His kind heart, brilliant mind and fighting spirit will long be remembered by the many friends, colleagues and others whose lives he touched.

Cheryl Moseley, who passed away in September 2016, was a dedicated ERCOT employee who was instrumental in establishing the foundation for ERCOT's market rules and internal control management processes. She was also very active in ERCOT's community outreach efforts.

Connect with us: www.ercot.com



@ERCOT_ISO



Electric Reliability Council of Texas

ERCOT app



Celebrating
75
years as an
interconnected system

20 years as an ISO

15 years as a single
control area

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