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Received - 2021-09-30 08:17:09 AM
Control Number - 52373
ItemNumber - 134

Exhibit A

Energy+Environmental Economics

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To: Chairman Peter M. Lake
Commissioner Will McAdams
Commissioner Lori Cobos
Commissioner Jimmy Glotfelty

Re: Project No. 52373 – Review of Wholesale Electric Market Design

Dear Chairman Lake and Commissioners McAdams, Cobos, and Glotfelty,

Please find attached a whitepaper entitled *The Load Serving Entity Reliability Obligation*. This whitepaper proposes a significant reform to the ERCOT electricity market in response to the provisions put forward by SB 3 to "establish requirements to meet the reliability needs of the power region." The proposal would establish a formal standard for electricity reliability and require load-serving entities (LSEs) to procure sufficient resources to meet this standard if there is a projected supply shortfall across the entire ERCOT market.

This proposal is submitted by Energy and Environmental Economics, Inc. (E3) and Ms. Beth Garza. E3 is an energy economics consulting firm with expertise in electricity planning, market design, distributed energy resources, retail rate design, and asset valuation. Ms. Garza is the former independent market monitor of ERCOT. E3 and Ms. Garza were retained by NRG Energy, Inc. and Exelon Corporation to provide unbiased, independent analysis of ERCOT market design and provide recommendations for practical reforms that can improve reliability while retaining the core aspects of ERCOT's existing competitive electricity market.

We appreciate the opportunity to submit this whitepaper and look forward to collaboratively working with the Commission and other public stakeholders to describe the proposal and provide any additional support that might be helpful.

Sincerely,

Arne Olson
Senior Partner
E3

Zach Ming
Director
E3

Beth Garza
Independent Consultant

Executive Summary

The Load-Serving Entity (LSE) Reliability Obligation

Whitepaper by Energy and Environmental Economics, Inc. (E3) and Ms. Beth Garza

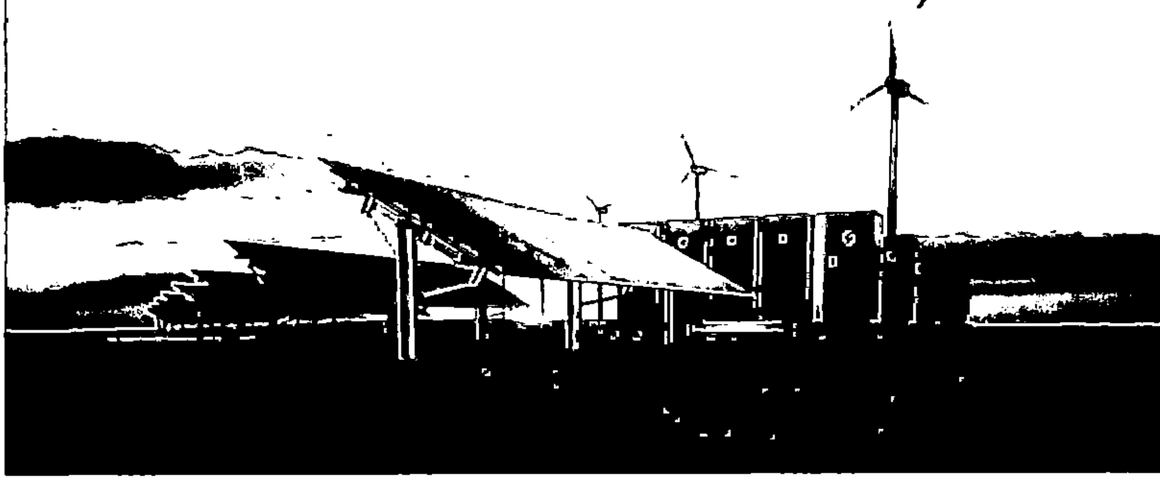
Sponsored by NRG Energy, Inc. and Exelon Corporation

The proposed ***LSE Reliability Obligation*** introduces a formal reliability standard and a mechanism to ensure that there are sufficient resources to meet this standard. The proposal is designed to preserve the competitive and customer choice elements of the existing ERCOT energy market, while ensuring that there are sufficient resources with the right combination of attributes, namely their ability to perform during reliability events. Additionally, the design would encourage LSEs to make investments in demand response, because those would reduce the size of the obligation the LSE must meet. Key elements of the proposal include:

- **Reliability Standard:** the PUCT determines a formal system reliability standard. ERCOT calculates the required seasonal reserve margin to achieve this standard.
- **Resource Accreditation:** ERCOT will accredit the reliability value of each resource for each season. Resources with dispatch limitations – whether due to intermittency, energy output duration limitations, or fuel supply challenges – would be accredited according to their expected performance during reliability events.
- **System Assessment:** ERCOT will project, on a 3-year forward basis, whether there are sufficient accredited resources to satisfy the seasonal reserve margin necessary to meet the reliability standard.
- **Trigger:** The PUCT will trigger the LSE Reliability Obligation on a 3-year forward basis when ERCOT system assessment projects a likelihood of insufficient resources to meet the reliability standard.
- **LSE Requirement:** If triggered, each LSE would be assigned a seasonal reliability requirement based on its projected firm load during critical system hours. LSEs serving interruptible loads or with demand response capabilities would receive a reduction in their reliability requirement.
- **LSE Showing:** If triggered, LSEs would be required to show sufficient resources (based on ERCOT's resource accreditation) to meet their seasonal LSE requirement on a year-ahead forward basis. Any showing deficiency would be assessed a penalty that would be used by ERCOT to procure accredited resources and correct the deficiency.
- **Performance Assessment:** Resources that are accredited with a reliability value and obligated as part of an LSE Showing would be required to offer into the energy market during designated reliability events, with penalties assessed for non-performance.

The Load-Serving Entity Reliability Obligation

A Market Design Reform to Ensure Electric Reliability in Texas



September 2021

Energy+Environmental Economics

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The authors appreciate the contributions and insights of Travis Kavulla, Bill Barnes, and Vafa Mohtashami

This whitepaper is funded by:

NRG Energy, Inc.

Exelon Corporation

About this Whitepaper

This whitepaper proposes the "LSE Reliability Obligation", a reform to the ERCOT electricity market structure. The LSE Reliability Obligation was filed at the Public Utility Commission of Texas on September 30, 2021 under Project No. 52373 in response to the provisions put forward by Senate Bill 3 of the 87th Texas Legislature.

The basis of the proposed LSE Reliability Obligation is derived from a report published by E3 in 2021 titled "Scalable Markets for the Energy Transition" that provides a foundation for understanding the important dynamics at play in electricity markets across North America, including the need for a forward signal to procure reliability resources.[1]

Other important energy system reforms should be considered in conjunction with the LSE Reliability Obligation, including power-plant and gas-system winterization requirements, updated energy efficiency goals and building codes, and better communication between customers, market participants, transmission and distribution utilities, and retail electric providers.

About the Authors

Energy and Environmental Economics, Inc. (E3) is an energy economics consulting firm with offices in San Francisco, New York, Boston and Calgary with expertise in electricity planning, market design, distributed energy resources, retail rate design, and asset valuation.

Ms. Garza is the former independent market monitor of ERCOT, and currently affiliated with the R Street Institute, a nonprofit, nonpartisan, public policy research organization whose mission is to engage in policy research and outreach to promote free markets and limited, effective government.

E3 and Ms. Garza were retained by the project sponsors to provide unbiased, independent analysis of the ERCOT market design and to provide recommendations for practical reforms that can improve reliability while retaining the core aspects of ERCOT's existing competitive electricity market.

[1] https://www.ethree.com/wp-content/uploads/2021/05/E3-Scalable-Clean-Energy-Market-Design-2021.05.25.pdf

Table of Contents

1. Executive Summary

In the aftermath of Winter Storm Uri, the Texas electricity market has been the subject of a series of discussions aimed at improving reliability. These efforts to reform the market operated by the Electric Reliability Council of Texas (ERCOT) have been wide-ranging and have captured the attention of stakeholders and policymakers at the highest levels. The cornerstone of these efforts was Senate Bill 3, a sweeping law passed by the 87th Texas Legislature directing the Public Utility Commission of Texas (PUCT) to "establish requirements to meet the reliability needs of the power region."[2] To inform these market reform discussions, the project sponsors retained the consulting firm Energy and Environmental Economics, Inc. (E3) and Beth Garza, senior fellow at the non-profit R Street Institute.

As an energy-only market, ERCOT has no formal reliability standard nor any explicit mechanism to ensure there are sufficient resources to meet a specified reliability standard. Implied expectations of electricity scarcity in forward energy prices serve as the primary financial incentive for Load Serving Entities (LSEs) to procure supply and support investment. ERCOT does conduct technical studies of resource adequacy for its system, which have determined that a 13.75%[3] reserve margin[4] would be needed to meet the reliability standard most commonly used in other markets—one loss-of-load event in ten years. However, ERCOT's actual reserve levels have fallen below that benchmark recently.

Many stakeholders have put forward proposals to improve the reliability of the system, increase financial protection of consumers, or both. Most proposals continue to substantively rely on the existing energy-only market design, merely modifying the way in which the system operator derives the prices of energy or the quantities of real-time operating reserves in the energy market.[5] These are actions that may improve reliability but do not establish an explicit reliability standard. Minor modifications to the current market design are not only insufficient to ensure reliable electricity supplies in ERCOT, but in some cases might inadvertently increase financial rewards for generators that do not consistently contribute to reliability. Instead, this whitepaper proposes a mechanism for directly addressing resource adequacy.

The LSE Reliability Obligation introduces a formal reliability standard and a mechanism to ensure that there are sufficient resources to meet this standard

The proposed ***LSE Reliability Obligation*** (described more fully in Section 5) introduces a formal reliability standard and a mechanism to ensure that there are sufficient resources to meet this standard. Load-Serving Entities, or LSEs, are responsible for procuring energy on behalf of customers in Texas (both competitive retail providers and municipal/co-operative utilities) and are the natural vehicle to procure

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[2] https://capitol.texas.gov/tlodocs/87R/billtext/pdf/SB00003F.pdf#navpanes=0

[3] ERCOT, *Resource Adequacy*, http://www.ercot.com/gridinfo/resource (last visited Sep. 21, 2021) ("The current minimum target reserve margin established by the ERCOT Board of Directors is 13.75 percent of peak electricity demand to serve electric needs in the case of unexpectedly high demand or levels of generation plant outages.")

[4] Reserve margin is defined as the percentage buffer of resources needed by the system above and beyond expected peak demand to account for 1) abnormally high load 2) resources outages and 3) operating reserve requirements

[5] For example, see https://interchange.puc.texas.gov/Documents/52373_55_1147848.PDF

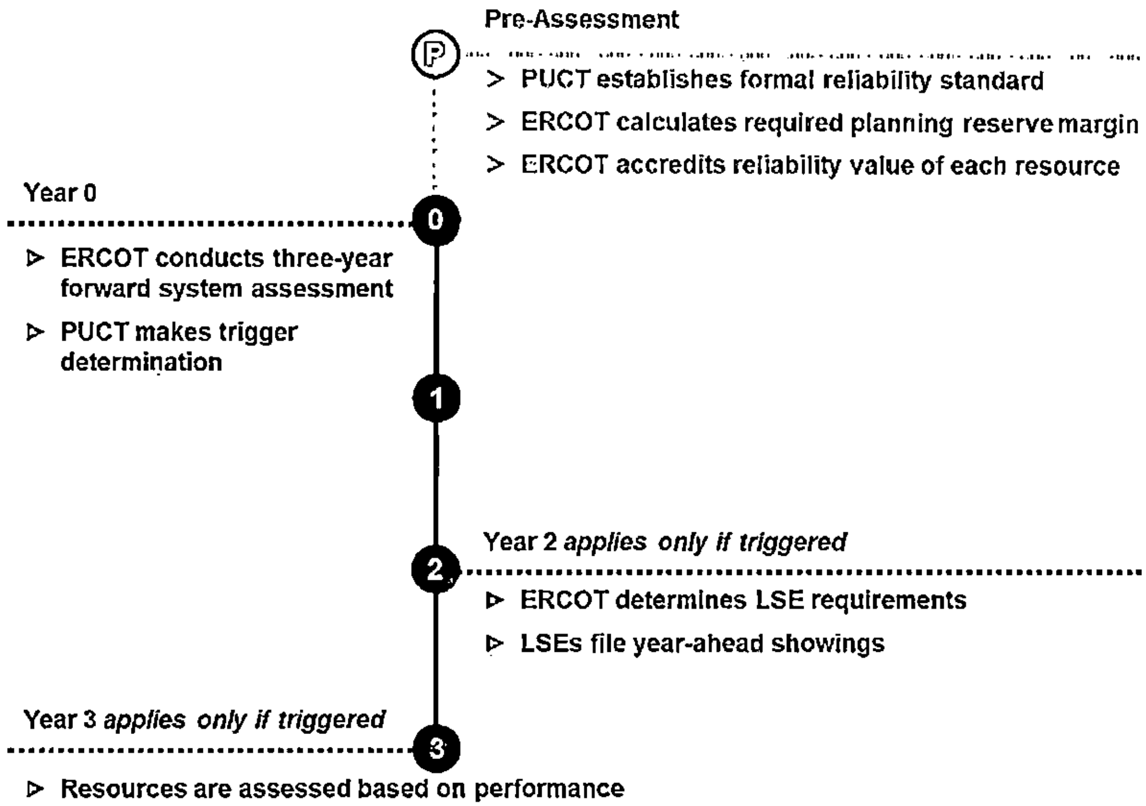
additional resources for reliability, should they be needed. The proposal is designed to preserve the competitive and customer choice elements of the existing ERCOT energy market, while ensuring that there are sufficient resources with the right combination of attributes, namely their ability to perform during reliability events.[6] Key elements of the proposal include:

- **Reliability Standard:** the PUCT determines a formal system reliability standard (e.g., 1-day-in-10-years). ERCOT calculates the required seasonal reserve margin to achieve this standard.
- **Resource Accreditation:** ERCOT will accredit the reliability value of each resource for each season. Resources with dispatch limitations – whether due to intermittency, energy output duration limitations, or fuel supply challenges – would be accredited according to their expected performance during reliability events.
- **System Assessment:** ERCOT will project, on a 3-year forward basis, whether there are sufficient accredited resources to satisfy the seasonal reserve margin necessary to meet the reliability standard.
- **Trigger:** The PUCT will trigger the LSE Reliability Obligation on a 3-year forward basis when ERCOT system assessment projects a likelihood of insufficient resources to meet the reliability standard.
- **LSE Requirement:** If triggered, each LSE would be assigned a seasonal reliability requirement based on its projected firm load during critical system hours. LSEs serving interruptible loads would receive a reduction in their reliability requirement.
- **LSE Showings:** If triggered, LSEs would be required to show sufficient resources (based on ERCOT's resource accreditation) to meet their seasonal LSE requirement on a year-ahead forward basis. Any showing deficiency would be assessed a penalty that would be used by ERCOT to procure accredited resources and correct the deficiency.
- **Performance Assessment:** Resources that are accredited with a reliability value and obligated as part of an LSE Showing would be required to offer into the energy market during designated reliability events, with penalties assessed for non-performance.

A visual overview of the LSE Reliability Obligation process is illustrated in Figure 1.

[6] While resources are often characterized as "dispatchable" or "firm", these distinctions often blurred in a modern electricity system. For example, solar and wind resources can be operated dispatchably. Pairing resources together such as solar and energy storage can create a resource with firm attributes. Ultimately what matters is a resource's ability to generate power when the system needs it the most. No resource is perfect and all resources should be characterized on an apples-to-apples basis based on their ability to generate during these critical hours.

Figure 1: Overview of LSE Reliability Obligation Timing



Many core components of the LSE Reliability Obligation build significantly on experience and policies in other jurisdictions around the world[7] or prior reform proposals to the ERCOT market.[8] The end result is a balanced and comprehensive solution to help ensure electric system reliability for a healthy and prosperous twenty-first century Texas.

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[7] For example, see the Australian Retailer Reliability Obligation (RRO) https://www.aer.gov.au/retail-markets/retailer-reliability-obligation

[8] For example, see comments of Golden Spread, a non-profit electric generation and transmission utility in the ERCOT market http://interchange.puc.texas.gov/Documents/40000_283_735592.PDF

2. Introduction and Background

The restructuring of the Texas electricity system in the late 1990s introduced many reforms, notably generation competition and retail choice. It also redefined the role of the Electric Reliability Council of Texas (ERCOT) as the state's independent system operator (ISO).[9] For more than twenty years, competition and retail choice have served Texas electricity consumers well, allowing for some of the lowest-priced electricity in the nation[10] and a rich selection of retail electricity supply products that fit individual customer needs and preferences.[11]

The cornerstone of Texas' restructuring was the creation of an offer-based "energy-only" market design, wherein the lowest priced generators clear the market and receive a clearing price equal to the marginal generator required to serve customer demand. In this system, there is no explicit mechanism to ensure there are sufficient resources to meet a formal reliability standard. Instead, hourly energy prices are allowed to rise to very high levels (much higher than other electricity markets) with the implied expectation that electricity scarcity assumptions influencing forward energy prices will serve as a financial incentive for Load Serving Entities (LSEs) to procure supply and support investment.

While this market structure has promoted competition within Texas' deregulated environment, concerns that it may not be sufficient to maintain reliability are not new. A study commissioned by the PUCT in 2012 found that "involuntary curtailment in an energy-only market may occur more often than customers, regulators, and policymakers find acceptable" and further that "regulators and policymakers must be committed to tolerating price spikes."[12] Around the world, similar market structures are only seen in Alberta and Australia; however, these markets have also been the subject of market design reform discussions and legislation intended to ensure resource adequacy.

In the current ERCOT system, there is no explicit mechanism to ensure there are sufficient resources to meet a formal reliability standard

In February 2021, Winter Storm Uri crippled the ERCOT electricity system, knocking out power to over a third of the state's customers, resulting in significant damages and loss of life. The event resulted in the resignation of all sitting commissioners on the Public Utility Council of Texas (PUCT),[13] several ERCOT board members, and the ERCOT CEO.[14] While many of the physical causes of those events may be beyond the reach of electricity market design (e.g., challenges with natural gas delivery), Winter Storm Uri nevertheless drew attention to ERCOT's electricity market design as a contributing factor to the persistent shortfall of generation capacity. Efforts to rectify this situation have been wide-ranging and have captured the attention of stakeholders and policymakers

[9] https://energy.utexas.edu/sites/default/files/UTAustin%20%282021%29%20EventsFebruary2021TexasBlackout.pdf
[10] https://www.eia.gov/electricity/state/
[11] https://www.puc.texas.gov/industry/electric/directories/rep/alpha_rep.aspx
[12] https://brattlefiles.blob.core.windows.net/files/8245_ercot_investment_incentives_and_resource_adequacy_newell_spees_pfeifenberger_mudge_ercot_june_2_2012.pdf
[13] https://www.texastribune.org/2021/03/16/texas-public-utilty-commission-resignation/
[14] https://www.businessinsider.com/texas-blackouts-public-utility-commission-chair-resigns-deann-walker-storm-2021-3

at the highest levels. The Governor of Texas has made it clear that "maintaining the reliability of the Texas electric grid... must remain [the PUCT's] top priority",[15] while the Texas legislature passed a sweeping law directing the PUCT to "evaluate whether additional services are needed for reliability."[16]

Against this backdrop, the ERCOT electricity market has recently experienced unprecedented development of renewable resources. Wind capacity has increased threefold over the past ten years, while solar capacity has increased by a factor of five over the past five years.[17] This trend is expected to continue as the falling cost of renewable technologies, the presence of tax subsidies, and customer preferences for clean generation resources together favor low-carbon resources such as wind, solar, and energy storage. The rapid development of renewable resources has prompted some to question the reliability of an electricity grid in which renewable energy plays a significant role.[18]

Holistically evaluating the ERCOT market (both past and future), the authors believe the ERCOT system faces three major challenges, each of which is described in more detail below.

- **Challenge 1: Ensuring Sufficient Reliable Generation**
- **Challenge 2: Ensuring Resource Performance**
- **Challenge 3: Adapting to Higher Penetrations of Renewables**

Challenge 1: Ensuring Sufficient Reliable Generation

The existing ERCOT market sends investment signals purely through the expectation of future energy prices. Ultimately, resources rely on energy prices that are higher than the variable cost of energy generation to cover the fixed cost of maintaining existing resources and investing in new resources. Many of these margins were historically achieved during times of scarcity when supplies were tight. ERCOT's current energy-only market design incentivizes investment through the expectation of energy prices resulting from market forces but does not require that a sufficient quantity of resources will be constructed to meet a specified reliability standard.

A number of reforms have been introduced to the market over the past twenty years to enhance the energy market's ability to provide price signals encouraging sufficient investment in reliable generation resources. The most significant of these was the introduction of the operating reserve demand curve (ORDC) in 2014. The ORDC has the effect of increasing the frequency and level of scarcity prices when market conditions are tight. In response to concerns that the initial ORDC construct was insufficient to incentivize necessary investment in new generation, ERCOT subsequently modified the ORDC in 2018 to further increase frequency and level of scarcity pricing in order to increase investment.[19]

These reforms notwithstanding, a review of ERCOT's actual reserve margins relative to the target reserve margin needed to meet a 1-event-in-10-year loss of load standard shows a consistent shortfall over the

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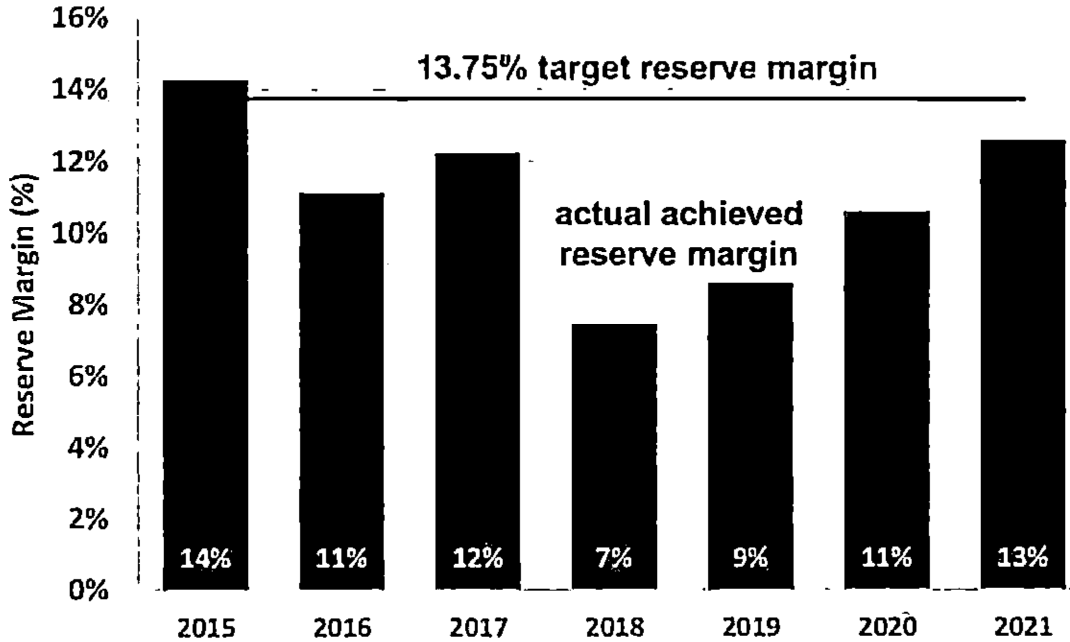
[15] https://gov.texas.gov/news/post/governor-abbott-directs-public-utility-commission-to-take-immediate-action-to-improve-electric-reliability
[16] https://capitol.texas.gov/tlodocs/87R/billtext/pdf/SB00003F.pdf#navpanes=0
[17] ERCOT Fuel Mix Report. http://www.ercot.com/gridinfo/generation
[18] https://www.texastribune.org/2021/02/17/abbott-republicans-green-energy/
[19] https://www.utilitydive.com/news/texas-regulators-direct-higher-plant-payments-amid-capacity-crunch-concerns-1/546540/

past seven years. This means that the ERCOT market can be expected to experience loss-of-load events more frequently than once every ten years.

Figure 2: Historical ERCOT Reserve Margins



Challenge 2: Ensuring Resource Performance

One of the primary issues that led to widespread power outages during Winter Storm Uri was that many existing resources on the system were unavailable to generate electricity due to a variety of factors. Outages of 25 GW of natural gas generating capacity is widely regarded as the single largest contributing supply-side factor in the power outages.[20] The natural gas power plant failures can primarily be attributed to 1) the freezing of critical parts of the plants themselves, and 2) the unavailability of natural gas fuel supplies (an issue that affected both plants with firm pipeline contracts and those without) and 3) grid frequency excursions that caused plants to trip offline, subsequently exacerbating freezing issues.[21] These failures reduced the generating capability of the natural gas fleet by 25 GW (nearly 50% of installed capacity), significantly higher than the 14 GW of outages postulated in ERCOT's "extreme generation outages" planning scenario.[22] In addition, one of the state's four nuclear power plants was offline during the storm, various coal units froze or tripped offline, and production from renewable power plants was below average.

[20] https://ferc.gov/media/february-2021-cold-weather-grid-operations-preliminary-findings-and-recommendations-ppt
[21] https://energy.utexas.edu/sites/default/files/UTAustin%20%282021%29%20EventsFebruary2021TexasBlackout%2020210714.pdf
[22] http://www.ercot.com/content/wcm/lists/197378/SARA-FinalWinter2020-2021.pdf

It is critical that ERCOT consider the potential reliability challenges of each resource type into its reserve margin accounting, including the potential for unavailability of natural gas generation. Many of the challenges faced by natural gas plants had to do with the reduction in gas production due to freeze-offs at natural gas wellheads. While this portion of the energy sector is outside the purview of ERCOT's market design, it is nonetheless critical that ERCOT consider this risk in any efforts to plan for a reliable electricity system. If the reliability and resiliency of natural gas production and the pipeline system improves due to reforms, ERCOT can and should reflect those changes in the expected reliability of natural gas plants. Until that happens, the evidence is plain that power plants that rely on pipeline fuel cannot be relied upon to provide critical generation services during the winter season to the same extent as plants with on-site fuel storage. Meanwhile, power plants of all types saw freeze-ups at their own equipment. The PUCT has a separate, ongoing proceeding to impose mandatory weatherization requirements on all power plants, regardless of fuel source.[23]

Another important aspect of thermal plant performance is consideration of planned outages due to maintenance. All generators need to ensure that they have sufficient time during the year to go offline and perform routine, necessary maintenance, often for weeks at a time. Generators often attempt to schedule maintenance during the spring and fall "shoulder" months when weather is mild and demand for electricity is low. Recently, there have been instances that despite mild weather/demand, so much generation was offline for maintenance that ERCOT had to publicly request load reductions to avoid emergency actions.[24] SB 3 specifically recognizes this by granting ERCOT authority to "approve or deny... planned power outage during any season for any period of time."[25] Power-plant weatherization and outage coordination are standards-based functions that are internal to the power sector and can help improve the availability of power plants. The improvements that can be hardwired into the system through standard-based regulation should be accounted for in expectations of resource performance.

Challenge 3: Adapting to Higher Penetrations of Renewables

Considering the significant changes to ERCOT's generation mix that are expected to occur over the next decade, market reforms should be robust to *any* future grid mix, including penetrations of higher renewables. Wind and solar generation are inherently variable and uncertain, creating challenges for system operators that must be managed through efficient market operations. Two specific challenges arising from higher penetration of these resources are (1) ensuring sufficient operating flexibility to address intraday variability and forecast error, which can be remedied through reforms to ERCOT's ancillary services and unit commitment procedures, and (2) ensuring there is sufficient installed capacity during periods of low renewable generation, i.e., high "net load", which must be addressed through broader market reforms aimed at investment. The latter is the subject of this paper, though the proposal is complementary with reforms to ensure better same-day or day-ahead operating practices and price formation.

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[23] https://interchange.puc.texas.gov/Search/Filings?ControlNumber=51840
[24] https://www.texastribune.org/2021/04/13/ercot-power-conservation-emergency/
[25] https://capitol.texas.gov/tlodocs/87R/billtext/pdf/SB00003F.pdf#navpanes=0

As the presence of variable resources in the electricity system increases, the most challenging periods for reliability will tend to shift away from the traditional gross system peak to the "net system peak" – where net peak is defined as system load minus the output from variable generation resources. This phenomenon is well-documented in jurisdictions that have begun to adapt resource adequacy planning to accommodate high penetrations of renewables. An example is evening hours after the sun has set but when electricity demand is still relatively high. Periods of prolonged low renewable generation that reduce wind and/or solar output for multiple days or during extreme cold weather represent another potential future challenge. Multi-day events of sustained low renewable generation also have implications on the reliability value of energy storage, which is often constructed with a discharge capability of 4-6 hours.

The challenge of financially incentivizing sufficient reliability under an energy-only market framework is also exacerbated under a high-renewable electricity system. Increasing penetrations of variable renewable energy tend to increase volatility in energy markets, which will experience prolonged periods of very low or negative prices (due to excess wind or solar generation) punctuated by infrequent periods of very high prices (due to a dearth of wind or solar generation). While these infrequent periods of high prices can theoretically provide a sufficient economic price signal to firm generation, they create an increasingly uncertain signal for investors regarding whether scarcity pricing will materialize and, if so, for how long. Further, investors must trust that policymakers or regulators will not "roll back" high prices if they do occur either through market repricing or prospective changes in price caps. It also requires acceptance of risk of periods of low electricity reserves. It is important that any future market design provide sufficient, investable, and predictable signals to market participants to procure the appropriate amount of reliability resources.[26]

[26] https://www.sciencedirect.com/science/article/abs/pii/S0301421516306966?via%3Dihub

3. Objectives of Market Design Reform

The market design reforms proposed in this whitepaper are aimed at achieving six key objectives toward the improvement of the ERCOT market design. These are listed below, with a more detailed description of each provided in this section. These objectives were developed based on the industry experience of the authors and their reading of SB 3. The whitepaper evaluates a variety of potential market design reform options based on their ability to help the system achieve each of these design objectives.

Figure 3: Key Objectives of Market Design Reform

1. **Reliability**
   Does the market design result in more steel in the ground that contributes to the reliability needs of the system?
2. **Economic Efficiency**
   Does the market design achieve resource adequacy and operational reliability at minimal cost to society?
3. **Competition**
   Does the market design maintain consumer choice and allow for retail provider differentiation?
4. **S. B. 3 Responsiveness**
   Do the market design reforms provide a solution to the requirements imposed by Senate Bill 3?
5. **Stakeholder Acceptability**
   Is the proposed market design acceptable to the unique set of Texas stakeholders?
6. **Implementation Barriers**
   Can the market design reform be implemented in a timely manner, without additional legislative action?

A more detailed description of each of the objectives of market design reform is provided below.

Reliability

Reliable electricity service is essential for the preservation of life and property and to the functioning of a modern economy. Maintaining and enhancing electricity system reliability is a bedrock principle for any sustainable market design. Maintaining reliability requires both ensuring adequate supplies of energy resources are available to the system operator and ensuring that the system operator can deploy those resources to address operational reliability challenges. Market operators and regulators often set explicit reliability standards for both the forward investment time frame (usually referred to as "Resource Adequacy") and real-time operations. This paper focuses on the Resource Adequacy dimension of reliability.

Resource Adequacy characterizes the sufficiency of resources (i.e., "steel in the ground") to meet a specified reliability standard. Although not mandated/prescribed, ERCOT does have an informal reliability target of "1 loss of load event in 10 years," as described above.[27] However, regulators are free to set an appropriate alternative standard, using regulatory judgement and specific objectives.[28] Determining a specified reliability standard will clearly delineate which events are within and outside of the planning standard. Stated simply, a mandatory ERCOT reserve margin should be established to ensure a bright line of what level of system reliability should minimally be achieved, enforceable through a market design.

Resources contribute to system reliability by generating power during times when the system has highest loss of load probability – for example during periods of high net load, during events with higher than expected generator outages, during periods of low renewable supply, or during periods of constrained fuel supply. The authors believe the market design reform should clearly and directly ensure that there are sufficient resources to meet the specified reliability standard, without reliance on indirect market mechanisms that may not deliver sufficient investment.

Economic Efficiency

Any market design reform should promote economic efficiency, minimizing costs to society. Ensuring that the electricity sector can deliver electricity at a low cost is a core goal of competition and one of the key drivers of restructuring the Texas market over twenty years ago. ERCOT is an industry leader in market designs that maximize efficiency and should continue to prioritize this objective to support economic growth and consumer welfare.

Competition

Another key tenet of the Texas electricity market design is the important role of competition and free market principles. Texas fully embraced this goal over twenty years ago through the restructuring of the generation and retail supply monopolies. Today, the Texas retail market offers a wide range of retail electricity supply options, allowing each customer to choose from over a hundred unique retail electric providers (REPs) that offer products in the competitive-retail market. A key market design principle is to maintain this level of customer choice, allowing customers to contract with retailers that meet their preferences for risk, price, emissions, and other important factors. This entails minimizing the role of "uplift", i.e., costs that are uniformly spread across all customers in a way that reduces the ability of retail providers to differentiate themselves.

SB 3 Responsiveness

In response to the aftermath of Winter Storm Uri, the 87th Texas legislature passed Senate Bill 3, a sweeping and comprehensive set of energy sector reforms.[29] The law addresses many topics, including infrastructure weatherization, load shedding, customer communication, and new ancillary services.

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[27] http://www.ercot.com/content/gridinfo/resource/2015/mktanalysis/Brattle_ERCOT_Resource_Adequacy_Review_2012-06-01.pdf

[28] Alternative reliability metrics include loss of load expectation (LOLE), loss of load hours (LOLH), loss of load events (LOLEV), and expected unserved energy (EUE). For each metric, regulators must decide on the stringency or standard used e.g. 2.4 LOLH. For more information, see: https://www.nerc.com/comm/PC/Probabilistic%20Assessment%20Working%20Group%20PAWG%20%20Relat/Probabilistic%20Adequacy%20and%20Measures%20Report.pdf

[29] https://capitol.texas.gov/tlodocs/87R/billtext/pdf/SB00003F.pdf#navpanes=0

Sections of the law direct the PUCT to "evaluate whether additional services are needed for reliability" and to "procure ancillary or reliability services on a competitive basis" but leave sufficient flexibility to the PUCT in how to implement these directives. The market design proposal put forth in this whitepaper responds directly to the directives of SB 3. Specifically, the portions of the law that this market design proposal addresses are listed below.

Key Provisions from Section 18 of SB 3 – Dispatchable Generation

+ Establish requirements to meet the reliability needs of the power system
+ Periodically, but at least annually, determine the quantity and characteristics of ancillary or reliability services necessary to ensure appropriate reliability during extreme heat and extreme cold weather conditions and during times of low non-dispatchable power production
+ Procure ancillary or reliability services on a competitive basis to ensure appropriate reliability
+ Develop appropriate qualification performance requirements for providing services... including appropriate penalties for failure to provide services
+ Ensure resources that provide services are dispatchable and able to meet continuous operating requirements for the season in which they are procured
+ Winter resource capability qualifications... Include on-site fuel storage, dual fuel capability, or fuel supply arrangements
+ Summer resource capability qualifications... include procedures to ensure operation under drought conditions

Key Provisions from Section 14 of SB 3

+ Review the type, volume, and cost of ancillary services to determine whether those services will continue to meet the needs of the electricity market in the ERCOT power region
+ Evaluate whether additional services are needed for reliability in the ERCOT power region while providing adequate incentives for dispatchable generation
+ Modify the design, procurement, and cost allocation of ancillary services for the region in a manner consistent with cost-causation principles and on a nondiscriminatory basis

Other topics in SB 3 related to reliability include, but are not limited to, weatherization standards, customer communication protocols, and critical infrastructure mapping are important for the PUCT to address and should be pursued in tandem. Market design reform does not limit or affect the manner in which these items should be addressed. However, they are not discussed extensively here as they are outside the scope of this whitepaper.

Stakeholder Acceptability

In order for any market design reform proposal to be successful, it must be acceptable to the broad group of stakeholders that it would impact. Groups of important stakeholders include, but are not limited to, residential, commercial, and industrial customers; generators; developers; retail providers; public power utilities; environmental advocates; ERCOT; the PUCT; the Legislature; and the Governor.

Implementation Barriers

All meaningful market design reforms will require approval from the relevant Texas regulatory agencies (the Public Utility Commission of Texas (PUCT) or the Railroad Commission (RRC)). Market reforms that are able to leverage existing regulatory authority have the highest likelihood of swift implementation.

4. Market Design Reform Options

In developing the proposed LSE Reliability Obligation, the authors carefully reviewed many different market designs in use around the world as well as proposed market design reforms offered by a variety of stakeholders. Emerging from that review were a series of "candidate" market design reform options that are described in this section. These candidate options were then evaluated based on the market design reform objectives described in Section 3.

Centralized Capacity Market

A centralized capacity market ensures there is sufficient capacity through centralized capacity procurement, generally carried out by the system operator. In this structure, the system operator determines the total quantity of capacity needed to achieve a specified reliability target and then procures that quantity of capacity via an auction process where individual resources offer bids for capacity and the lowest bids clear the auction. In this sense, the target reliability of the system is an input and the price of capacity needed to achieve that standard is an output. Each load serving entity is required to purchase capacity equal to their pro-rata share of total system capacity requirements, at a single clearing price as determined through the capacity auction. These markets have the benefit of transparency and reduced transaction costs, however, the uniform clearing price has the potential to crowd out the bilateral dealmaking that is core to a more decentralized, competitive-retail market like ERCOT. The centralized framework is most notably used in the Northeast U.S. by PJM, Independent System Operator of New England (ISO-NE), and the New York Independent System Operator (NYISO) electricity markets.

Individual Load Serving Entity Obligation

An individual load serving entity obligation requires each LSE within the electricity system to procure a sufficient quantity of resources to meet their share of total system-wide reliability requirements. LSEs can satisfy this obligation through ownership or contractual relationships with independently-owned resources and can bilaterally trade the reliability attribute of resources with other LSEs. This format is most notably used in the Southwest Power Pool (SPP) electricity market,[30] the California electricity market,[31] and has been recently introduced in Australia National Energy Market[32] due to the challenges imposed by renewable energy. The Mid-Continent Independent System Operator (MISO) has a hybrid model where LSEs procure capacity individually, subject to a systemwide obligation determined by MISO, and MISO holds an auction to clear any residual capacity needs. Under this framework, the reliability standard is an input, determined by the regulator and/or system operator, while cost is an output unique to each LSE based on their contracted capacity. This framework, adapted to ERCOT, is at the core of the LSE Reliability Obligation proposal that this paper makes in Section 5.

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[30] https://www.spp.org/engineering/resource-adequacy/

[31] https://www.cpuc.ca.gov/RA/

[32] https://www.aer.gov.au/retail-markets/retailer-reliability-obligation#:~:text=The%20Retailer%20Reliability%20Obligation%20(RRO,in%20the%20National%20Electricity%20Market.

Targeted Capacity Payments

Targeted capacity payments compensate specific resources with an administratively-determined price for their contributions to the reliability of the system. In effect, this policy creates a subsidy for capacity that results in more of this product than would have occurred in its absence. In this sense, the price of capacity is an input while the output is the ultimate achieved quantity of reliability resources. While targeted payments for capacity are relatively rare in the electricity sector, targeted payments for other electricity products, namely clean energy, are relatively common. In the American experience, such payments typically are expressed in the form of federal or state tax subsidies. Examples of targeted clean energy payments include the U.S. federal investment tax credit (ITC), the U.S. federal production tax credit (PTC), and feed-in-tariffs (FITs) that are common across the globe. To the extent that targeted capacity payments are used, they are often limited to specific technologies on resources in special circumstances – for example, zero emission credits (ZECs) targeted toward nuclear resources at risk of retirement in New York[33] and targeted payments to fuel-secure resources at risk of retirements in ISO-NE.[34]

Strategic Reserve

A strategic reserve product is a centrally procured quantity of capacity that is held outside of the market for use during scarcity or other time periods. The most notable use of this is the U.S. strategic petroleum reserve, which is held by the federal government in the event of sudden and unexpected supply contraction and/or price increases of petroleum products in order to limit shock to the U.S. economy.[35] The strategic reserve is procured by a centralized entity, with costs allocated to all market participants (or taxpayers). The appropriate quantity of strategic reserve to procure is often arbitrary as the product will exist alongside products procured by the competitive market where the sufficiency or deficiency quantity is often unknown to some degree.

Use of this design has been proposed for use within the electricity sector but to-date has been rarely used, with the most prominent examples being used to a small degree in the socialist countries of Sweden and Belgium.[36]

A strategic reserve resource can be used in two ways: 1) fully optimized with the market, bidding and participating identically to all other plants in the market, or 2) held back for use only during times of scarcity, which is practically implemented by only allowing these plants to bid into the market at the price cap. In the first case, the strategic reserve functions as a near-complete substitute for private procurement of reserve capacity. In the second case, the strategic reserve does not distort the functioning of the electricity market, but instead serves as an emergency insurance policy against an extraordinary event that is outside the realm of standard system planning. However, because the resources are dispatched very infrequently and only at the price cap, captive ratepayers are required to bear the entire cost of the

[33] https://www.nyserda.ny.gov/all-programs/programs/clean-energy-standard
[34] https://www.iso-ne.com/committees/key-projects/forward-capacity-market--retain-resources-for-fuel
[35] https://www.energy.gov/fe/services/petroleum-reserves/strategic-petroleum-reserve
[36] https://reader.elsevier.com/reader/sd/pii/S0140988319300453?token=1DD8B026D32FD594E4E92AC0960C871752336E1A7E6B992DA9865026DBA28B3CBD5EC166962EF14D72F2913659AAE8C6&originRegion=us-east-1&originCreation=20210906010817

fleet of reserve capacity in the form of a non-bypassable uplift charge. A strategic reserve is likely the most economically inefficient policy that might be pursued among those reviewed.

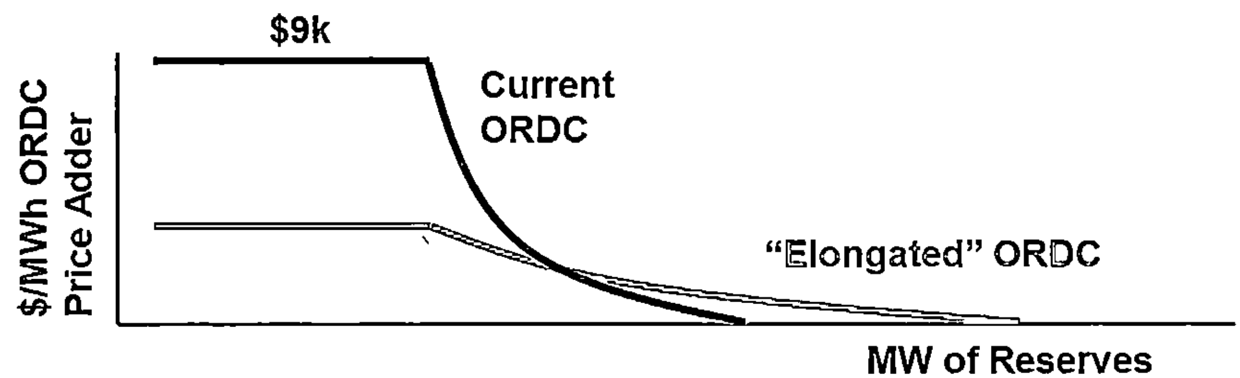
Energy Price Formation / ORDC Modification

Even Texas's energy-only electricity market features a number of administrative factors that impact the clearing price of energy, the costs to consumers, the margins to producers, and the operations and investments in the electricity system. The most common intervention in the market is a price offer cap, which today is set at $9,000/MWh.[37] During the early years of restructuring in Texas, scarcity price formation was solely dependent on the submission of high energy offers, but it eventually became clear that this energy price signal raised competitive concerns and did not incentivize sufficient capacity. To compensate, ERCOT introduced the operating reserve demand curve (ORDC) in 2014 that effectively added a price adder during "tight" hours when supplies were scarce but there was not yet firm load shed. The introduction of the ORDC has increased the energy price signal and resulted in more capacity than would have otherwise been procured in its absence.

ORDC Elongation

The current framework and administrative control of the ORDC has become a subject for energy market reform, with proposals to modify its application in the hope that a reformulation will better support investment incentives for firm generation. One proposal for ORDC reform that has been put forward by a number of stakeholders is an ORDC "elongation", with the scarcity price reduced in the hours with lowest reserves (most scarce) and increased in hours with more reserves (semi-scarce). This potential elongation reform is illustrated in Figure 4.

Figure 4: Illustration of ORDC Elongation



The genesis of this reform is based on the observation that the current ORDC formulation leads to "feast-or-famine" pricing, with the vast majority of energy-market margins occurring in the relatively infrequent hours of severe scarcity. This has resulted in an inconsistent price signal that is seen as a barrier to

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[37] https://www.puc.texas.gov/agency/rulesnlaws/subrules/electric/25.505/25.505.pdf

financing new capacity projects. Elongation would lead to more consistent payments for resources by targeting many more hours.

However, an elongation of the ORDC inherently results in a reduction of price during hours when energy is *most* needed and an increase in price when energy is *less* needed. This framework may result in unintended consequences such as increased payments to resources that do not materially improve system reliability. While this market reform may increase the incentive for reliability resources, it suffers from the same challenges as ERCOT's existing energy-only market design in that it is not designed to ensure sufficient resources necessary to meet a specified reliability standard. If the system-wide offer cap in ERCOT is lowered, while incidences of the ORDC adder are increased, even while energy-market revenues are held constant, it would likely *increase* the need for a reliability backstop like the one proposed here.

ORDC Application to Select Resources

Another potential energy market price reform that has been discussed is the application of the ORDC to only select resources, e.g., thermal generators. While these resources may provide more reliability value than variable or dispatch-limited resources such as wind, solar and battery storage, it does not follow that variable or dispatch-limited resources have *no* reliability value. Differentiating payments to resources that are simultaneously providing identical amounts of energy to the system simply based on the technology would create significant market inefficiencies, friction, and distortions. Implementing such a reform would necessarily deviate from a core tenet of non-discrimination shared by all electricity markets across North America, i.e., that resources are paid uniformly for uniform services. The end result would inevitably lead to higher prices for consumers, lower reliability, or both.

Operating Reserve Requirements

Closely tied to energy price formation is the idea of procuring more "operating" reserves – resources on standby on a real-time basis to ramp up in the event of a potential sudden drop-off in renewable generation i.e. "net load variability." This market design modification can also incentivize resources to be more fuel secure, as is being pursued in New England.[38] However, a solution to procure higher operating reserves only works if there is sufficient "steel in the ground" to actually provide the additional reserves. Historical and potential future reliability challenges are primarily driven by insufficient resources overall, not the inability to utilize or commit existing resources on a real-time basis. To the extent that reliability issues are driven by wintertime fuel supply shortages, these are generally physical constraints, caused by either a sudden drop-off in supply (Texas) or maxed out natural gas pipelines (New England). In either case, the solution to the problem is physical investment in new pipelines or fuel storage as opposed to operational changes.

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[38] https://www.iso-ne.com/static-assets/documents/2020/04/esi-white-paper-final-with-cover-page-04152020.pdf

5. LSE Reliability Obligation

This whitepaper evaluated all potential market design reform options in Section 4 against the objectives of market design reform described in Section 3. The **LSE Reliability Obligation** proposed in this paper scores highly on a qualitative basis relative to many of the reform objectives, striking an appropriate balance between ensuring reliability and preserving Texas's competitive market structure. This section provides a detailed overview of the LSE Reliability Obligation, while the following section provides a comparison of the LSE Reliability Obligation to other potential alternatives. The whitepaper seeks to provide sufficient detail to make the proposal understandable without being overly prescriptive in the numerous implementation details that must necessarily follow. In each case, it describes the issue at stake, discusses the pros and cons and various design choices, and provides a sense as to the reasonable range of implementation options for each component.

Because LSEs are the primary entities that manage power procurement today, it is a natural extension that LSE should procure reliability services if needed

Load serving entities (LSEs) are the entities responsible for energy procurement on behalf of customers in Texas. They manage price, risk, environmental performance, and other important attributes of an integrated portfolio of supply resources, as well as forecasting and offering incentives to their customers to shape or reduce demand. LSEs include competitive retail electric providers (REPs) in areas of ERCOT open to retail choice, municipal and cooperatively owned utilities, and large industrial customers that procure energy for themselves directly from the ERCOT market. Because LSEs are the primary entities that manage power procurement today, it is a natural extension that LSEs should procure reliability services for their customers if needed.

Overview

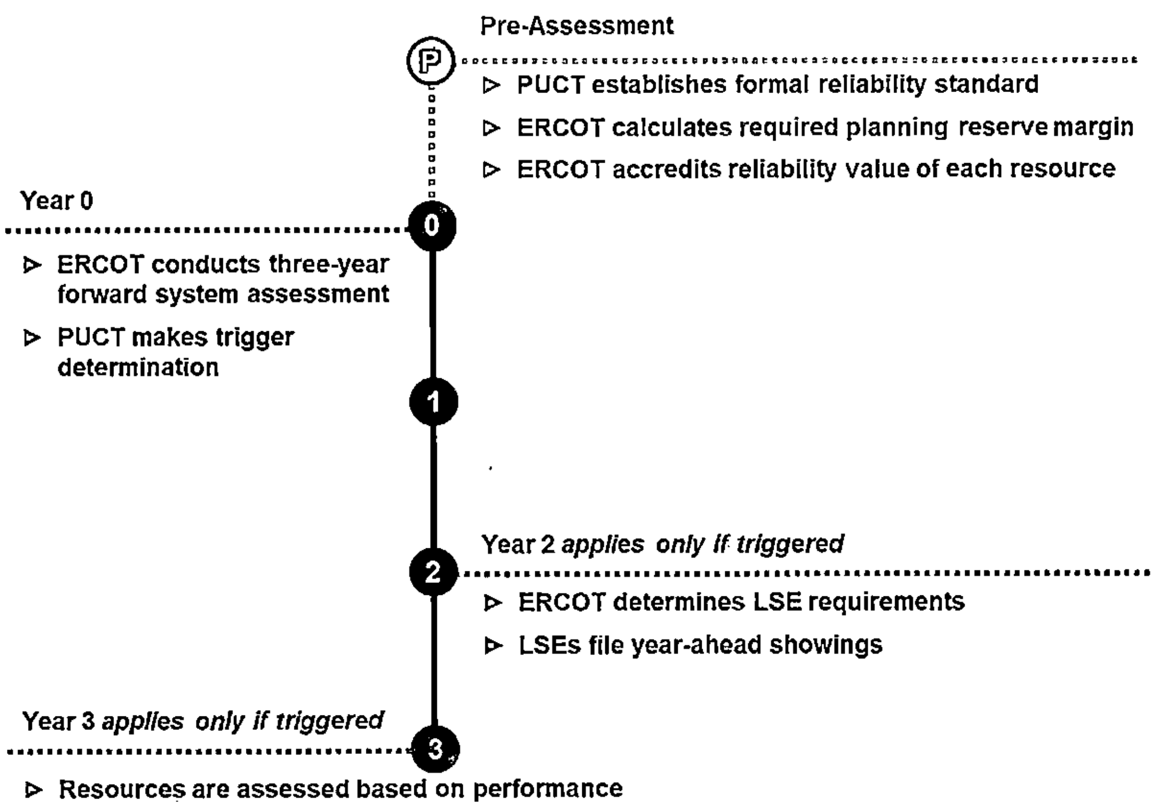
The premise of the LSE Reliability Obligation is the idea that ERCOT and the PUCT should specify a desired reliability standard and develop a market mechanism that intervenes to ensure that sufficient resources are procured to meet the specified standard in the event that the investment signals provided by the energy-only market alone prove inadequate. The key elements of the LSE Reliability Obligation are listed below, with more detail provided throughout the rest of this section.

- **Reliability Standard:** the PUCT determines a formal system reliability standard (e.g., 1-day-in-10-years). ERCOT calculates the required seasonal reserve margin to achieve this standard.
- **Resource Accreditation:** ERCOT will accredit the reliability value of each resource for each season. Resources with dispatch limitations – whether due to intermittency, energy output duration limitations, or fuel supply challenges – would be accredited according to their expected performance during reliability events.
- **System Assessment:** ERCOT will project, on a 3-year forward basis, whether there are sufficient accredited resources to satisfy the seasonal reserve margin necessary to meet the reliability standard.

- **Trigger:** The PUCT will trigger the LSE Reliability Obligation on a 3-year forward basis when ERCOT system assessment projects a likelihood of insufficient resources to meet the reliability standard.
- **LSE Requirement:** If triggered, each LSE would be assigned a seasonal reliability requirement based on its projected firm load during critical system hours. LSEs serving interruptible loads would receive a reduction in their reliability requirement.
- **LSE Showings:** If triggered, LSEs would be required to show sufficient resources (based on ERCOT's resource accreditation) to meet their seasonal LSE requirement on a year-ahead forward basis. Any showing deficiency would be assessed a penalty that would be used by ERCOT to procure accredited resources and correct the deficiency.
- **Performance Assessment:** Resources that are accredited with a reliability value and obligated as part of an LSE Showing would be required to offer into the energy market during designated reliability events, with penalties assessed for non-performance.

A visual overview of the LSE Reliability Obligation process is illustrated in Figure 5.

Figure 5: Overview of LSE Reliability Obligation Timing



Reliability Standard

The PUCT will need to determine an appropriate reliability standard for Texas and in doing so will implicitly decide what events should be included in the system planning standard and what events fall outside the standard. It is important to note that no electricity system plans for perfect reliability, so some firm load shedding should be expected. While the "1 loss of load event in 10 years" standard is common throughout North America, policymakers have begun to explore alternative metrics as shown in Table 1. A standard based on expected unserved energy may have helped to mitigate some of the worst impacts of Winter Storm Uri due to the sheer magnitude of the power outage.

The two components of a reliability standard are 1) the selected reliability metric, and 2) the stringency of this metric. Example reliability metrics are provided below.

Table 1: Overview of Reliability Metrics

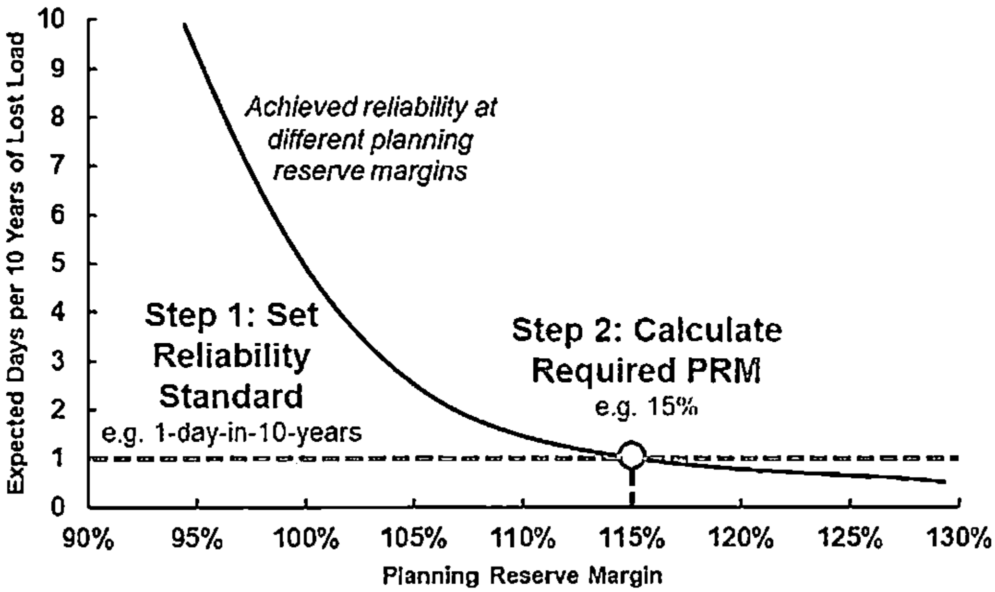
Acronym	Name	Unit	Definition
LOLE	Loss of Load Expectation	days/yr	The expected number of days per year where load + reserves exceed available generating capacity at least once during the day
EUE	Expected Unserved Energy	MWh/yr	Average total quantity of unserved energy (MWh) over a year due to load + reserves exceeding available generating capacity
LOLH	Loss of Load Hours	hrs/yr	Expected average number of hours per year where load + reserves exceed available generating capacity
LOLEV	Loss of Load Events	events/yr	Average number of loss of load events per year, of any duration or magnitude, due to load + reserves exceeding available generating capacity

The stringency of the standard assigns a numerical target to the chosen metric: For example, 0.05 LOLE (1-day-in-20-years), 0.1 LOLE (1-day-in-10-years), or 0.2 LOLE (1-day-in-5-years).

Once a reliability standard has been determined, ERCOT should calculate the required planning reserve margin (PRM) to achieve that standard, using industry best practices.[39] An illustration of this process is provided below.

[39] Conversion of reliability standard to required reserve margin described on page 3: https://www.ethree.com/wp-content/uploads/2020/08/E3-Practical-Application-of-ELCC.pdf

Figure 6: Translation of Reliability Standard to Planning Reserve Margin (PRM)



Resource Accreditation

Going hand-in-hand with the reliability standard and required planning reserve margin is the determination of a resource's ability to contribute to meeting that standard. Individual resource accreditation would be measured as a percentage (%) value, potentially reducing a maximum nameplate capacity (MW) to reflect a reliability value.

Characterizing a resource's reliability value has historically been a relatively straightforward exercise when most resources were "firm" i.e., always available for continuous periods of time except during forced outages. Resources such as nuclear, coal, and natural gas (with reliable fuel supply) fit this description. However, the determination of effective capacity is more complex and challenging for variable and dispatch-limited resources such as wind, solar, energy storage, or thermal resources with significant limitations such as air permits that constrain runtime, lack of firm fuel supplies, or risks of correlated outages. At its core, the exercise to quantify reliability value should determine if resources are available *when the system needs them the most* during critical scarcity hours.

ERCOT currently quantifies the reliability value of wind and solar toward its planning reserve margin via a *Seasonal Peak Average Solar/Wind Capacity as a Percent of Installed Capacity* metric that is calculated as the average output of solar/wind during the 20 highest system load hours during prior summer and winter seasons.[40] However, this approach does not account for the fact that the most important hours for

[40] ERCOT Protocol Section 3.2.6 http://www.ercot.com/content/wcm/curent_guides/53528/03-110119_Nodal.docx

reliability are increasingly not peak *gross load* hours, but peak *net load* hours.[41] This has been the subject of significant stakeholder comment.[42] When the quantity of renewable energy was small, simple heuristics such as the top 20 hours approach were not materially impactful on the aggregate assessment of system reliability. However, as renewable penetrations have grown, the need for more robust and sophisticated metrics has become increasingly clear to electricity market operators and participants across the country.

ERCOT also quantifies the reliability contribution of thermal resources such as natural gas, coal, and nuclear using seasonal maximum sustainable limits.[43] These values, which are close to the maximum nameplate capacity of the units, do not account for fuel-supply disruptions or correlated winter outages, which can occur in extreme weather circumstances that can affect many plants simultaneously. ERCOT should incorporate this factor into the reliability contribution of thermal resources. In light of Winter Storm Uri, ERCOT should also consider that the security of fuel supply does not affect all plants equally. Geographic location, connectivity to intra-versus inter-state pipelines, connectivity to natural gas storage, and the presence of on-site fuel (or backup fuel) are all relevant considerations that can impact the reliability contribution of thermal resources.

A resource's accredited reliability value should reflect its limitations – from uncertain wind or solar output, energy dispatch limitations or undependable fuel supplies – on a apples-to-apples basis across *all* resources

A resource's accredited reliability value should reflect its limitations – from uncertain wind or solar output, energy dispatch limitations, or undependable fuel supplies – on an apples-to-apples basis between *all* resources. Over the past decade, there has been a growing movement toward the use of the effective load carrying capability (ELCC) metric to quantify the reliability contribution of diverse resources on an equivalent basis. ELCC is a technology-neutral measurement of the equivalent "perfect" capacity from intermittent, energy-limited, or fuel-insecure resources. For example, if the marginal ELCC of wind is 15%, an additional 100 megawatts of wind would provide the same reliability benefit to the system as an additional 15 megawatts of perfectly firm capacity. The ELCC metric stands in contrast to other alternative "rule of thumb" approaches (such as ERCOT's) based on its ability to assess each resource's expected performance during the specific and infrequent hours that are most important for system reliability.

Four of the six U.S. electricity markets with a resource adequacy program or an organized capacity market (MISO,[44] CAISO,[45] SPP,[46] PJM[47]) currently use ELCC or will use ELCC by 2023. The other two electricity

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[41] Net load is calculated as gross load minus the contribution of solar, wind, and energy-limited resources such as storage and hydro

[42] http://www.ercot.com/content/wcm/lists/219841/CapacityDemandandReservesReport_May2021.pdf

[43] http://www.ercot.com/content/wcm/lists/197378/SARA-FinalWinter2020-2021.pdf

[44] https://cdn.misoenergy.org/2019%20Wind%20and%20Solar%20Capacity%20Credit%20Report303063.pdf

[45] CAISO Resource Adequacy is administered through the California Public Utilities Commission (CPUC) https://www.cpuc.ca.gov/uploadedFiles/CPUCWebsite/Content/UtilitiesIndustries/Energy/EnergyPrograms/ElectPowerProcurementGeneration/DemandModeling/ELCC_2_13_19.PDF

[46] https://www.spp.org/documents/61025/elcc%20solar%20and%20wind%20accreditation.pdf

[47] https://www.pjm.com/planning/resource-adequacy-planning/effective-load-carrying-capability