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REVIEW OF WHOLESALE ELECTRIC MARKET DESIGN	**§** **§**	**PUBLIC UTILITY COMMISSION OF TEXAS**

COMMENTS OF FORM ENERGY

Form Energy ("Form") files these comments in response to the request of the Public Utility Commission ("PUC") of Texas on September 20, 2021.

EXECUTIVE SUMMARY

- Form proposes a technology-agnostic stored energy reserve product to compensate resources physically capable of and guaranteed to deliver their contracted capacity for sequential days as determined by the Commission and ERCOT to address long duration reliability risks.
- Research spurred by Winter Storm Uri and Form's internal analysis indicates that there is a basis for a product that requires performance for at least 90 continuous hours that could be called upon any time of the year.
- Correspondingly, Form recommends that the PUC and ERCOT conduct a set of studies to characterize multi-day reliability risks, assess the appropriate duration and magnitude of a stored energy reserve product, and identify an economic pathway to meeting identified needs.
- Texas faces three multi-day risks to grid reliability: extreme weather events, fossil fuel generator outages, and low renewable energy events. Risks associated with the extreme weather and fossil outages from Winter Storm Uri are documented, but the historic and future incidence of these events warrants additional study. The potential for and duration of low renewable energy events have not yet been well characterized and also warrant additional study.
- To develop an initial estimate of the multi-day risk associated with renewable generation, Form assessed historical low renewable energy events over the past two decades. For the current Texas resource mix, initial analysis indicates that 40 percent reductions from historic output lasting over 100 hours occur about once every four years. However, the frequency of these low renewable energy events is expected to decline as more renewables are built and the renewable resource mix diversifies. By 2030, 90-hour periods of low renewable generation are expected to occur once in every ten years.

COMMENTS

1. Introduction

a. About Form Energy

Form Energy ("Form") is developing a new class of multi-day energy storage systems to enable a clean electric grid that's reliable and cost-effective year-round. Our first commercial product is a rechargeable iron-air battery capable of continuously discharging electricity for 100 hours at system costs competitive with conventional power plants and at less than 1/10th the cost of lithium-ion battery storage. Form is headquartered in Somerville, MA, with offices in the San Francisco Bay Area and the Greater Pittsburgh area. We have secured over $300M in funding from impact-oriented investors with deep expertise in global infrastructure development, electric grid operations, and manufacturing.

b. ERCOT must establish a path to address multi-day reliability issues.

Winter Storm Uri sparked a search for a market mechanism to address emerging concerns around grid reliability over multi-day periods. ERCOT has long balanced its grid to meet daily variations of load and supply and manage routine outages. Like most independent system operators until recent years, ERCOT's reliability discussions have typically centered around meeting peak hour demand and hourly and sub-hourly load balancing needs. This year, Winter Storm Uri focused attention on multi-day events that can also have consequential impacts and highlighted the failure of existing ERCOT mechanisms to address these risks.

ERCOT is not alone in facing emerging multi-day reliability risks; they are surfacing in various forms across the United States. ISO New England has expressed concerns around fossil fuel shortages during extended winter cold snaps, as well as the potential for semi-frequent

offshore wind lulls that can coincide with seasonal peaks.[1] The Midcontinent Independent System Operator ("MISO") has also highlighted the growing incidence of grid emergency events related to multi-day fossil outages and periods of low wind output, as well as coincident periods in the spring and fall shoulder seasons when planned thermal plant outages can coincide with low wind output.[2] California faces a different set of reliability challenges associated with multi-day heat waves and wildfires in the near-term,[3] and its long-term plans highlight that reliability risks are likely to shift to multi-day periods of weather-driven low solar output in the winter.[4] The causes of these reliability risks are similar to those in Texas: extreme weather, thermal power plant outages, and renewable energy lulls and outages.

The Texas Legislature has required the PUC to review, establish and procure new ancillary or reliability services to ensure reliability during extreme hot and cold weather conditions, as well as during periods of low non-dispatchable power production.[5] By necessity, these provisions require the PUC to address multi-day reliability risks: to characterize their causes, to evaluate the magnitude of the potential impacts, and to define appropriate market products or services.

Form proposes that the PUC can address these reliability risks through a technology-neutral stored energy reserve product designed to compensate resources for being physically capable of and guaranteed to deliver their contracted capacity to address multi-day events. Research spurred by Winter Storm Uri and Form's internal analysis indicates that a duration of at least 90 continuous hours would address reliability issues that Texas can reasonably expect to

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[1] *See* ISO-New England Operational Fuel-Security Analysis (January 17, 2018) and Energy Security Improvements: Creating Energy Options for New England (April 30, 2020)
[2] *See* MISO Aligning Resource Availability and Need (December 2019)
[3] *See* Joint Agency Final Root Cause Analysis: Mid-August 2020 Extreme Heat Wave (January 13, 2021)
[4] *See* E3, Long-Run Resource Adequacy Under Deep Decarbonization Pathways for California (June 2019) at 30-32
[5] Utilities Code Sections 39.159 and 39.160.

occur at least as frequently as once in ten years. Such a product could ensure that resources are guaranteed to be available during major multi-day energy events spurred by extreme weather, renewable lulls, or fossil plant outages. Various stakeholders have suggested that the PUC establish a new reserve product to compensate resources for providing grid services that will ensure long-term reliability.[6] Our comments offer a methodology to quantify the duration of such a reserve product to ensure reasonable grid reliability.

c. Resources that address multi-day reliability issues can also meet daily flexible ramping and grid operational needs.

Multi-day weather events are not the only challenge that the Texas grid faces. ERCOT must also be able to balance hourly load and resource variation. Multi-day and daily reliability needs should not be assessed separately from each other; the grid must be able to meet net load during both typical days and atypical multi-day periods. Indeed, many of the energy resources available to confront multi-day needs, such as multi-day energy storage technologies like Form's, can also help balance the hourly variability of electricity generation and demand. We therefore recommend that as the PUC and ERCOT seek solutions to ensure reliability during multi-day events, they allow and encourage resources like energy storage to provide both daily and multi-day reliability needs.

[6] *See, e.g.*, Comments of Vistra Corp. on Commission Staff's Request for Comment (Aug. 16, 2021) at 5 and testimony of various stakeholders before the Senate Business and Commerce Committee on September 28, 2021.

2. Multi-Day Reliability Events in Texas

a. Texas faces three causes of multi-day risks to grid reliability: extreme weather events, fossil outages, and low renewable energy events.

The ERCOT grid was designed to meet single-day demand peaks with thermal generation resources that were presumed to be available under any grid condition. The increased diversity of generation resources and the increasing intensity of extreme weather events have elevated multi-day reliability risks to the forefront of ERCOT's slate of issues, largely in response to the Legislature's mandates in Senate Bill 3 ("SB 3"). To address these multi-day reliability risks, we recommend that the PUC and ERCOT take stock of three major causes: extreme weather events, fossil outages, and renewable energy lulls. Risks to grid reliability multiply when all three events overlap like they did in Winter Storm Uri, so it is also essential to study periods when these events coincide.

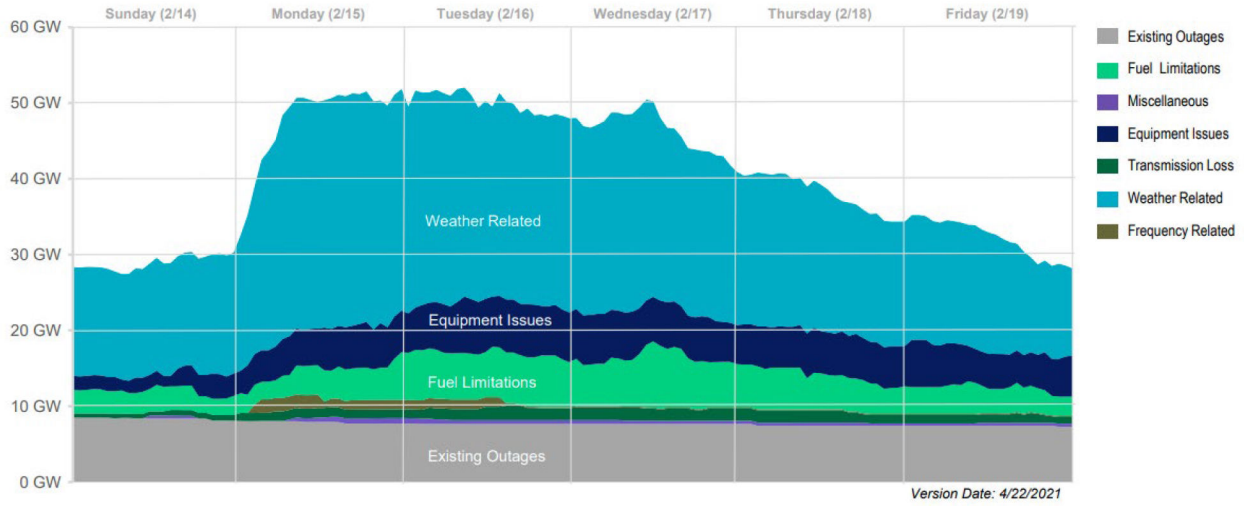
In our September 26, 2021, comments,[7] Form recommended that the PUC and ERCOT first assess the frequency and magnitude of these events as the basis for defining the degree of resource firmness ERCOT should seek from grid resources. The discussion below summarizes recent ERCOT and NERC findings about extreme weather events and fossil resource outages and introduces new analysis that Form has conducted about the incidence of low renewable energy events.

- **Extreme Weather Events:** Winter Storm Uri highlighted the substantial toll that bad weather can take on consistent grid operations: five sequential days of weather-related resource outages and derates. Notably, this February's storm was just the most recent in a string of major weather events over the past decade. This past week, FERC and NERC

[7] Comments of Form Energy on Commission Staff's Request for Comment (Sep. 26, 2021).

released preliminary results from their joint investigation into the causes of the Texas storm.[8] In that report, they find that Winter Storm Uri was the fourth extreme cold weather event in the past decade to threaten bulk system reliability. They identify several key issues that led to major shortfall during Uri: primarily generation freezing, natural gas fuel supply shortages, and natural gas and electric reliability interdependency. **Figure 1** is ERCOT's illustration of the cause of outages throughout the storm. These reports imply that a new reliability product should ensure that resources are guaranteed to be available over at least three to five day continuous periods (72-120 hours) to confront major weather events.

Figure 1. Net Generator Outages and Derates by Cause (MW) | February 14-19, 2021[9]



Net generator outages at the beginning of each hour on February 14-19, 2021, by cause category.

- **Fossil Outages:** The NERC report points to unplanned fossil outages as a key driver of the Uri outages (primarily due to temperature issues or fuel shortages). However, multi-day fossil outages lead to known reliability risks beyond extreme weather events. Short-

[8] The Offices of Electric Reliability and Enforcement and North American Electric Reliability Corporation (NERC), 2021. February 2021 Cold Weather Grid Operations: Preliminary Findings and Recommendations.
[9] ERCOT Public, 2021. Update to April 6, 2021 Preliminary Report on Causes of Generator Outages and Derates During the February 2021 Extreme Cold Weather Event.

term planned outages occur seasonally, typically in spring and fall, as operators take fossil plants offline for maintenance and repair. Short-term forced outages, on the other hand, occur all year, as Potomac Economics described in its 2020 State of the Market Report.[10] Although the report found that the grid operator appropriately adjusts for these outages throughout the year and that generators operate economically, when these multi-day outages align with other reliability events, they pose a risk to grid stability. Further, fossil outages can present a reliability risk on their own. The American Clean Power Association pointed to this year's mid-June heat wave as a multi-day event where renewable resources in Texas outperformed their expected output while thermal generator outages significantly exceeded ERCOT's High Forced Outage Risk Scenario.[11]

- **Low Renewable Energy Events:** Finally, periods of low renewable energy output present a multi-day challenge to the grid that is often discussed but difficult to assess in systems where renewable assets are relatively new. To provide further context, Form performed a preliminary assessment of the frequency and duration of renewable energy lulls in ERCOT given the current and future renewable resource mixes, described in detail below.

[10] Potomac Economics, 2021. 2020 State Of The Market Report For The Ercot Electricity Markets.

[11] American Clean Power Association, Letter to Commissioners, (*Review of Wholesale Electric Market Design,* Project No. 52373 (Aug. 24, 2021) at 3.

3. Assessment of the historic and expected low renewable energy events occurring from 2000 to 2019.

a. Methodology

Senate Bill 3 requires that ERCOT assess which services are necessary to "ensure appropriate reliability during extreme heat and extreme cold weather conditions and during times of low non-dispatchable power production in the power region."[12] With that requirement in mind, Form analyzed twenty years (2000-2019) of publicly-available hourly meteorological data from NASA across seven Texas locations (see **Figure 2**) to assess the frequency and duration of low renewable energy ("non-dispatchable power production") events. We applied that hourly meteorological data to the current and future renewable energy portfolios in ERCOT's Long-Term System Assessment (LTSA)[13] and identified potential periods when hourly renewable output fell below 40 percent historic average output.[14] This 40 percent threshold is roughly equivalent to the scale of renewable reduction during the February 2021 storm and, while purely representative, it provides insight into the kinds of regularly occurring multi-day events that can cause reliability risks today and in the future. We recommend that ERCOT conduct a fuller assessment that includes analysis across a range of thresholds.[15]

[12] Utilities Code Section 39.159(b)(3).

[13] Electric Reliability Council of Texas, 2020. Long-Term System Assessment for the ERCOT Region.

[14] We modeled how the current and future anticipated renewable energy portfolios would operate if future weather patterns mimic the most recent 20 years of weather patterns.

[15] This assessment also relies on the 2019 LTSA scenario, which does not include substantial renewable buildout in the subsequent two years. Most notably, installed solar is over 400% greater today, which provides a diversifying benefit to the renewable portfolio.

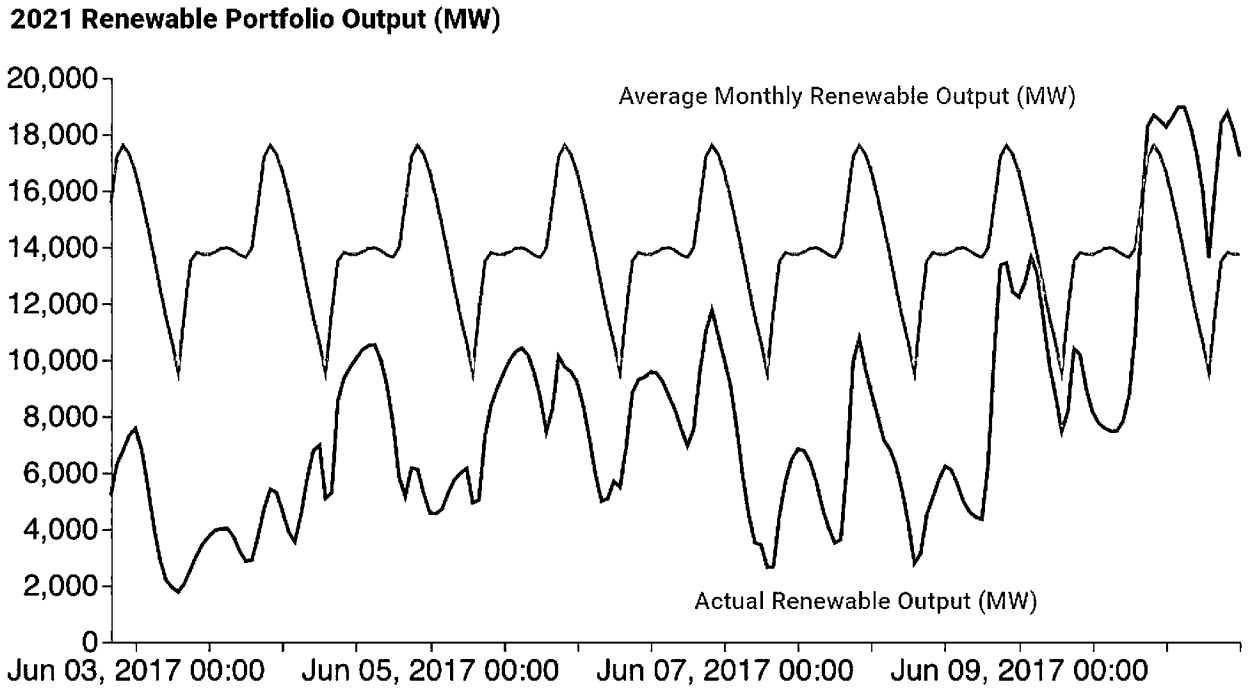
Figure 2. Texas Locations Assessed

b. Findings

i. Under the current Texas energy resource mix, 40 percent renewable energy lulls lasting over 100 hours occur about once every four years.

Form Energy's analysis found that 40 percent reductions in renewable energy output lasting 100 continuous hours happen approximately once every four years given the existing resource mix, which relies heavily on legacy fossil units and new wind assets. **Figure 3** illustrates the effect of a potential 1-in-4 weather event (June 2017) on the 2021 renewable energy mix compared to the average expected output of Texas' renewable portfolio. This illustrative event results in renewables operating at 40 percent below average output for a period of approximately six days.

Figure 3. Average Renewable Portfolio Output Compared to a Multi-Day Renewable Lull (2021 Resource Mix)

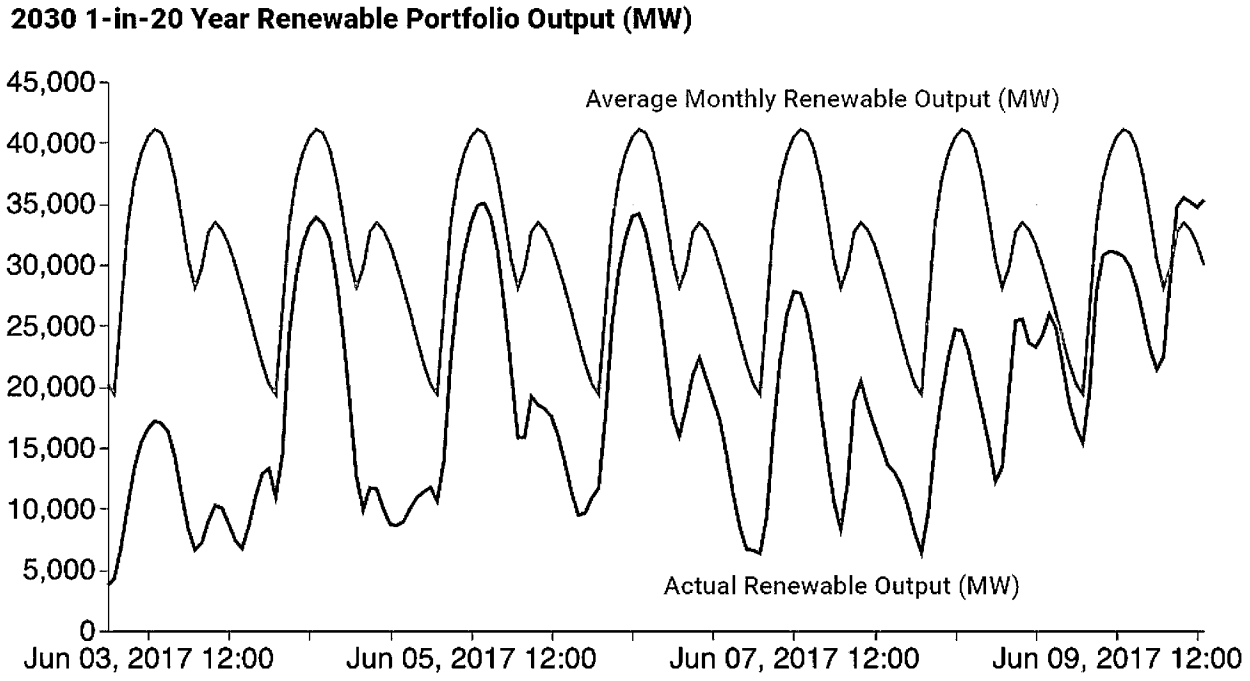


c. The frequency of low renewable energy events declines as the renewable resource mix diversifies. By 2030, 90-hour low renewable energy events occur once in every ten years.

We found that the frequency and duration of renewable energy lulls is likely to decline by 2030. Under ERCOT's Current Trends scenarios, where the renewable energy mix diversifies to include more solar resources, 90-hour lulls occur about once every ten years. Under ERCOT's Renewable Mandate scenario, which reflects faster renewable energy development and more resource diversity, the frequency of 100-hour renewable energy lulls drops to once in every twenty years.

This evolution is both promising and expected: it highlights the reliability benefits that diverse renewables can provide to the grid, and it indicates that increased renewable energy growth and geographical diversity will contribute to higher levels of grid reliability overall.

Figure 4. Average Renewable Portfolio Output Compared to a Multi-Day Renewable Lull (2030 Current Trends Resource Mix)



4. New Reliability Product to Address Multi-Day Risks

a. Form proposes a stored energy reserve product to compensate resources capable of generating for sequential days to meet multi-day reliability needs.

In line with other recommendations to implement a new reliability-centered product, Form's recommended product would compensate resources physically capable of and guaranteed to deliver their contracted capacity for at least 90 continuous hours when called upon in any hour of the year. As demonstrated in our analysis above, a 90 hour requirement could cover events that currently occur once every four years, but decline in frequency as additional renewable

energy resources are installed. It is critical that any reliability product is technology agnostic and enables non-fossil emerging resources to participate. Allowing a broad band of technologies will enable developers to provide crucial reliability services with both traditional and novel solutions.

b. Texas should not restrict the array of technologies capable of meeting system needs during major multi-day events.

Emerging multi-day energy storage (MDS) resources are firm, dispatchable, and clean. Multi-day energy storage is a diverse resource class that includes iron-air batteries like Form Energy's, as well as other novel battery technologies, thermal storage, hydrogen energy storage, compressed air energy storage, and other technologies. All are capable of firming renewable energy resources, providing reliability when thermal resources are off-line for maintenance, acting as clean dispatchable resources capable of replacing legacy resources, and improving grid resilience at the regional and local level.

5. Additional Analytic Work to Support a Reliability Product

a. ERCOT should conduct a study to characterize multi-day operational risks to the grid and assess the appropriate duration of a stored energy reserve product.

In order for the Commission and ERCOT to adopt meaningful reforms that will increase the ability to provide reliable electric service to Texans, ERCOT should conduct a study to characterize multiple operational risks the grid will need to address and to evaluate how these risks may change over seasons and years. These risks include at minimum: 1) multi-day renewable energy lulls; 2) multi-day periods of high demand and extreme temperature; and 3) planned fossil outages in spring and fall.

We recommend that the Commission and ERCOT examine multiple years of weather data, not only typical or average years. This study should be designed to help the Commission understand the magnitude and duration of reliability risks that will occur as frequently as once in at least ten years. To account for increasingly uncertain weather patterns, we think it is prudent to study weather events and reliability risks that are likely to occur at least once in twenty years. Form's preliminary analysis above provides a preliminary template for that work.

b. ERCOT should undertake a long-term planning study related to anticipated reliability needs to inform product implementation.

ERCOT should bolster any study of reliability needs with a comprehensive long-term planning exercise. In addition to starting from the latest information regarding the location and magnitude of current and planned wind and solar investments, a broader set of modeled future scenarios related to renewable build-out, fossil retirement, and weather events is paramount to properly estimate the magnitude of the reliability need. Further, such a comprehensive analysis would provide much-needed context around the least-cost solution to Texas' evolving reliability needs.

CONCLUSION

Form Energy appreciates the opportunity to provide these comments and looks forward to working with the Commission and other interested parties on these issues.

Respectfully submitted,

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Dated: September 30, 2021

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