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PROJECT NO. 54584

RELIABILITY STANDARD FOR THE ERCOT MARKET	**§ § §**	**PUBLIC UTILITY COMMISSION OF TEXAS**

COMMENTS OF FORM ENERGY

Form Energy files these comments in response to Commission Staff's Request for Comment filed on March 7, 2023, in the above-referenced Project. Form Energy ("Form") is manufacturing and commercializing a new class of multi-day energy storage systems to enable a clean electric grid that is 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 a total installed cost per unit of energy that is less than 1/10th the cost of lithium-ion battery storage. Form's battery can achieve these low costs by using iron, one of the most abundant and cheapest minerals. Our iron-air battery is modular, safe, and can be sited anywhere on the grid. Form has over 3 GWh of projects under contract and development, with our first project expected to come online in 2024 with utility Great River Energy in Minnesota. This first project will demonstrate the repeatable, scalable building block of our system, and the ways in which it can provide firm energy delivery to address grid reliability needs. Two of our other announced projects with Xcel Energy, one a 10 MW / 1,000 MWh system at Sherburne County Generating Station in Becker, Minnesota, and the other a 10 MW / 1,000 MW system at the Comanche Generating Station in Pueblo, Colorado, are both expected to come online as early as 2025. We plan to broaden deployments to 100 MW

scale projects in 2026 and beyond, with multiple gigawatts (GW) deployed before 2030. With over 450 employees, Form is headquartered in Somerville, MA, with offices in the San Francisco Bay Area and the Greater Pittsburgh area, and we will soon break ground on our first commercial manufacturing facility in Weirton, WV. We have secured over $820M in funding from impact-oriented investors with deep expertise in global infrastructure development, electric grid operations, and manufacturing.

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. In addition to improving the utilization and efficiency of Texas' abundant wind and solar resources, all are capable of providing reliability when thermal resources are off-line for maintenance or lack access to fuel, acting as clean dispatchable resources capable of replacing legacy resources, providing reliable energy when renewable energy resources have decreased output, and improving grid resilience at the regional and local level. These technologies have a critical role to play in delivering reliability to Texans as demand continues to grow and the grid evolves, regardless of the reliability standard that may be set in this proceeding.

ERCOT is not alone in facing emerging multi-day reliability risks such as those experienced in Winter Storm Uri; these risks are surfacing in various forms across the U.S., with the causes including extreme weather, thermal power plant outages, and renewable energy lulls and outages. The changing grid, aging infrastructure, and more

extreme weather call for planning processes and reliability standards to evolve alongside those changes to properly recognize and account for changing reliability risks. A 2021 report by Energy Systems Integration Group (ESIG), *Redefining Resource Adequacy for Modern Power Systems*,[1] addresses these topics, identifying several important principles that the Commission should consider in this project. Form Energy recommends incorporating the principles in that report throughout this process. We also offer responses to select questions below.

Comments on Specific Questions Posed by Commission Staff

(1) The Commission has previously considered various reliability metrics, such as Loss of Load Expectation (LOLE), Loss of Load Hours (LOLH), and Expected Unserved Energy (EUE). Which reliability metrics, including those not previously studied, should the Commission consider in establishing a reliability standard for the ERCOT power region? Which reliability metric, or combination of reliability metrics, should the Commission adopt for the reliability standard in ERCOT? What are the advantages of your chosen reliability metrics, and what are the disadvantages of alternative approaches?

As the ESIG report notes in its Principle 1, "Quantifying size, frequency, duration, and timing of capacity shortfalls is critical to finding the right resource solutions."[2] The typically-used metrics of the past, such LOLE, LOLH, and EUE — taken in isolation — do not adequately capture variation among events. Based on Form Energy's initial review of the concept document that ERCOT Staff presented at a recent stakeholder workshop,[3] it appears that ERCOT Staff is embracing this principle to a certain extent and intends to

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[1] Energy Systems Integration Group. 2021. *Redefining Resource Adequacy for Modern Power Systems. A Report of the Redefining Resource Adequacy Task Force.* Reston, VA. https://www.esig.energy/reports-briefs.

[2] ESIG at 10-13.

[3] Rickerson, Woody, and Pete Warnken, "Workshop on ERCOT's Proposed Reliability Standard Study Framework," (Mar. 15, 2023). Download at https://www.ercot.com/files/docs/2023/03/09/Workshop_ReliabilityStandardStudy_3-15-2023.pptx

evaluate multiple variables including magnitude, duration, and frequency of outages in its proposed analysis. It will be important to also include timing (seasonality) as a variable as well. When giving preference among these multiple variables, we recommend that the Commission and ERCOT emphasize EUE, which among these three variables gives the best indication of the magnitude and cost of energy shortfall events.

(2) What is the most effective way that the Commission can include deliverability in the reliability standard?

Form Energy does not have a response to this question at this time.

(3) Additional considerations in establishing the reliability standard in the ERCOT power region. Should the reliability standard include a locational requirement? Should the reliability standard include a seasonal component? How can extreme events be captured in a reliability standard? How can the value of distributed energy and load resources be captured in a reliability standard?

Form Energy recommends that analysis be performed to characterize the 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 and outages; 2) multi-day periods of high demand and extreme temperatures; 3) planned thermal generation outages in spring and fall; and 4) unplanned thermal generation outages or fuel shortages in response to extreme weather. We recommend that the Commission and ERCOT examine multiple years of weather data, not only typical or average years, and that the Commission and ERCOT consider correlations between weather and both hourly generation and demand profiles. This recommendation is consistent with ESIG's second principle outlined in their 2021 report:

"Chronological operations must be modeled across many weather years."[4] The analysis 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, at minimum. To account for increasingly uncertain weather patterns, we think it is prudent to study and plan for weather events and reliability risks that are likely to occur at least once in twenty years. See Form Energy's Comments filed in Project No. 52373 for additional detail on recommended analysis.[5] The Northwest Power and Conservation Council has recently proposed to plan for more infrequent 97.5th percentile energy and capacity shortfall events (1-in-40 year events). [6]

One method for actualizing the above recommendation is to examine and set standards for both average reliability metrics – such as EUE, LOLH, and LOLE – and tail-risk versions of EUE, LOLH, and LOLE. These metrics are typically reported as average metrics. That is, planners run tens to thousands of simulated weather, outage, and other conditions to assess system reliability (often referred to as "Monte Carlo" simulations). EUE, LOLH, and/or LOLE are measured in each simulation. Reported EUE, LOLH, and/or LOLE values are generally the average of the results across each of the simulations. Systems can have identical average metrics, but very different tail (e.g. 95th percentile) metrics.[7] As a result, by taking an average, system planners may miss very

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[4] ESIG Report at 13-18.
[5] Project No. 52373, Review of Wholesale Market Design, Comments of Form Energy (Sept. 30, 2021).
[6] See Northwest Power and Conservation Council Resource Adequacy Advisory Committee, *Preliminary Pacific Northwest Resource Adequacy Assessment for 2027*, December 5, 2022, available at https://nwcouncil.app.box.com/s/yivjno3orq69ephgul4hoiffteloilpj
[7] See Telos Energy for NARUC, 2021 at slide 37. https://pubs.naruc.org/pub/3D827A62-1866-DAAC-99FB-47C1762CAC55

costly "tail" events like Winter Storm Uri. ERCOT could examine and set a standard for EUE95, the expected unserved energy during the 95th percentile of simulated EUE events. Some system operators, such as the Belgian system operator, Elia, are already doing this, setting standards for LOLE95 and EUE95 in addition to average LOLE and EUE.[8] In line with this recommendation, ESIG notes "resource adequacy analysis should pay attention not just to the expected values, but to potential tail events."[9]

ESIG also points out in their Principle 3 that "There is no such thing as perfect capacity."[10] This principle emphasizes that designing resource adequacy around "firm capacity" such as a dispatchable, gas turbine is flawed, because, like any resources, these resources are not available 100 percent of the time. Further, gas generation is subject to the problem of correlated outages, as Texas experienced with Winter Storm Uri. No resource is perfect, and all resources are weather-dependent to varying degrees. Indeed, the system should be planned with an eye toward promoting diversity, including demand-side resources as identified in Principle 4: "Load participation fundamentally changes the resource adequacy construct." We again refer the Commission Staff to the ESIG paper for further information.

(4) How frequently should the Commission update the calculation of the requirement necessary to meet the reliability standard? What criteria should help determine the frequency of the update?

Form Energy does not have a response to this question at this time.

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[8] Elia, 2019. Adequacy and flexibility study for Belgium 2020 - 2030. Available at https://www.elia.be/-/media/project/elia/elia-site/company/publication/studies-and-reports/studies/13082019adequacy-and-flexibility-study_en.pdf. See page 178. Note that Elia refers to EUE as EENS, or Expected Energy Not Served. The two concepts are identical.

[9] ESIG Report at 12.

[10] ESIG Report at 18-21.

(5) If you have any industry or academic papers on the topic and best practices that you believe the Commission should review while establishing the reliability standard for the ERCOT power region, please provide them.

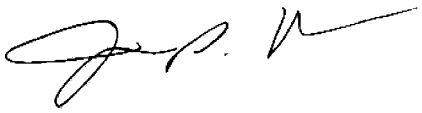
Energy Systems Integration Group. 2021. *Redefining Resource Adequacy for Modern Power Systems. A Report of the Redefining Resource Adequacy Task Force.* Reston, VA. https://www.esig.energy/reports-briefs.

Murphy et al., 2019: *A time-dependent model of generator failures and recoveries captures correlated events and quantifies temperature dependence.* DOI: https://doi.org/10.1016/j.apenergy.2019.113513

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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COMMENTS OF FORM ENERGY
EXECUTIVE SUMMARY

Form Energy ("Form") is manufacturing and commercializing a new class of multi-day, iron/air energy storage systems to enable a clean electric grid that is reliable and cost-effective year-round. Multi-day energy storage systems have a critical role to play in delivering reliability to Texans regardless of the reliability standard that may be set in this proceeding.

The following is a summary of Form Energy's responses to the five questions:

1. No single variable such as LOLE, LOLH, or EUE taken in isolation is adequate. However, when giving preference among multiple variables, we recommend that the Commission and ERCOT emphasize EUE, which among these three variables gives the best indication of the magnitude and cost of energy shortfall events.
2. No response at this time.
3. Form Energy recommends that the Commission and ERCOT:
    - analyze the multiple operational risks the grid will need to address and to evaluate how these risks may change over seasons and years. Risks include at minimum: 1) multi-day renewable energy lulls and outages; 2) multi-day periods of high demand and extreme temperatures; 3) planned thermal generation outages in spring and fall; and 4) unplanned thermal generation outages or fuel shortages in response to extreme weather;
    - examine multiple years of weather data, not only typical or average years, and consider correlations between weather and both hourly generation and demand profiles;
    - examine and set standards for both average reliability metrics – such as EUE, LOLH, and LOLE – and tail-risk versions of EUE, LOLH, and LOLE, such as 95th percentile.
4. No response at this time.
5. See the following:
    - Energy Systems Integration Group. 2021. *Redefining Resource Adequacy for Modern Power Systems. A Report of the Redefining Resource Adequacy Task Force.* Reston, VA. https://www.esig.energy/reports-briefs.
    - Murphy et al., 2019: *A time-dependent model of generator failures and recoveries captures correlated events and quantifies temperature dependence.* DOI: https://doi.org/10.1016/j.apenergy.2019.113513