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| **NOGRR Number** | [**245**](https://www.ercot.com/mktrules/issues/NOGRR245) | **NOGRR Title** | **Inverter-Based Resource (IBR) Ride-Through Requirements** |

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| **Date** | July 31, 2023 |

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| **Market Segment** | Independent Generators |

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| **Comments** |

**Introduction**

Invenergy submits these comments in response to the alternative framework proposed in the June 22, 2023, ERCOT comments in NOGRR 245, Inverter-Based Resource (IBR) Ride-Through Requirements. While Invenergy appreciates ERCOT’s attempt to address some market participant concerns, the revised proposal suffers from several of the same core problems that plagued the initial proposal. Specifically, the proposed rule[[1]](#footnote-2) purports to enact new standards retroactively to older generation models without a full understanding of the impact of such standards on market participants and the overall system. Consider:

* the technology necessary for some older generation models to meet the new standards does not currently exist and is not likely to exist in time to meet the proposed deadline;
* the proposed rule does not take into account the potentially significant costs required for older generation assets to meet the new standards, and whether such costs would render existing generation assets uneconomic; and
* the proposed rule does not take into account the impact on overall system reliability should the new standard cause existing assets to be taken offline.

Over 53 GW of operating wind and solar capacity in the ERCOT region (37.7 GW of wind and 15.7 GW of solar) will be put at risk of disconnection or early retirement by NOGRR245.[[2]](#footnote-3) How many GW depends on whether compliance will be technically feasible, when, and at what cost, all of which will vary by technology, make, and model. “Original Equipment Manufacturers” (OEMs) for both technology types have repeatedly indicated that compliance with the full range of proposed requirements may not be possible by ERCOT’s proposed deadline, if ever. Wind OEMs have indicated that compliance is particularly problematic for wind turbine generators, with expected technical feasibility, compliance timelines, and cost all worsening based on the age of the generators.

Before moving forward, ERCOT should perform detailed studies to assess these risks and better understand the proposed rule’s effect on system reliability. It would surely be a perverse result that a rule intended to enhance the reliability of the ERCOT System would instead serve to undermine system reliability by disconnecting the very same assets that have been the heroes of ERCOT’s grid during periods of high demand this summer.

Further, ERCOT needs to consider the potential chilling effect of this rule on future investment in generation assets for the ERCOT market and potential litigation and financial exposure from takings claims asserted against the state for prior investment stranded due to retroactive application of this new rule. For example, the 37.7 GW of installed wind capacity in ERCOT represents approximately $57B in investment made by market participants that ERCOT is putting at risk.[[3]](#footnote-4) Should careless implementation of ERCOT’s proposal shorten the 30-year (or longer) life over which market participants expect to earn a return on their investment, this would result in potentially billions of dollars in lost value.

Below we provide more detail regarding these continuing concerns and propose an alternative path that mitigates these concerns while still addressing ERCOT’s desire to reduce the reliability risk from Inverter-Based Resources (IBRs).

**NOGRR245 should not retroactively apply to existing IBRs**

Invenergy’s primary concern is that ERCOT proposes a retroactive application of a set of new requirements to all existing Intermittent Renewable Resources (IRRs) with inverters (herein after referred to as IBRs) on a specific timeline, without regard to whether, when, and at what cost these requirements can be met before the deadline, if at all, and without demonstrating a need for these generally applicable requirements rather than more targeted ones. As described below, this is particularly concerning because the OEMs have indicated that existing generators were not originally engineered to meet and cannot meet the full set of requirements proposed by ERCOT on the effective date, if ever. Consequently, ERCOT’s proposal immediately exposes existing generators to the risk of operating restrictions *up to and including disconnection* by ERCOT under certain conditions, with further and additional risk of disconnection after 12/31/2025.

Significant portions of NOGRR245 are based on a similar voluntary standard created by the Institute of Electrical and Electronic Engineers (“IEEE”). As Invenergy noted in previously filed comments, in approving these voluntary standards, the IEEE contemplated grandfathering plants already in existence due to the technical difficulty and cost of retrofitting older turbine or inverter models. Section 1.4 of the IEEE 2800-2022 standard states that:

The application of this standard may be limited to IBR plants for which an interconnection request is submitted after the date by which this standard is enforced by the responsible authority governing interconnection requirements (AGIR); this standard may not apply to IBR plants that are either already interconnected or for which an interconnection request had been submitted prior to the standard’s enforcement date (grandfathering). Any substantial changes in an existing IBR plant, e.g., the “repowering” of a wind power plant, may require retrofitting that IBR plant to meet all of the requirements of this standard.[[4]](#footnote-5)

Consistent with this guidance, other grid operators who are working on an adoption plan of the IEEE 2800-2022 standard are focused on prospective implementation, given the various issues outlined by the IEEE. Both NY State Reliability Council’s PRR 151[[5]](#footnote-6) and MISO’s proposed language modifying Appendix G of pro forma Large Generator Interconnection Agreement (LGIA)[[6]](#footnote-7) have taken IEEE’s advice to exempt existing IBR plants and demonstrate that ERCOT is an outlier in this regard.

Where a reliability need exists for which enhanced ride-through is necessary, Invenergy does not oppose retroactive increases in ride-through performance that can be accomplished in a commercially reasonable manner, such as modest firmware and software changes made over a reasonable timeframe and subject to the OEMs’ technical capability. But it is unreasonable for ERCOT to require compliance with a standard for which the necessary equipment and/or software required to comply does not exist, is not likely to exist by ERCOT’s proposed deadlines if ever, and will likely require market participants to incur significant costs.

Before imposing broad, sweeping retroactive requirements on existing IBR generation assets, ERCOT, in conjunction with generators, OEMs and other market participants, should undertake a systematic analysis to determine the most efficient, realistic, and cost-effective approach to achieve the targeted level of reliability.

Applying NOGRR245 retroactively to existing IBR generation assets puts the cart before the horse. ERCOT has not demonstrated what specific reliability problem they are trying to solve or what range of technical options they have considered, including more targeted requirements for generators based on technology, age, location, or other relevant factors and other grid-based alternatives. Further, ERCOT has provided no studies or cost-benefit analyses, including the impact of large-scale generator retirements or disconnections that may result from the retroactive application of this proposed revision. ERCOT’s failure to take into account the foreseeable consequences of its proposed decision is demonstrated in its Impact Analysis of NOGRR245, wherein ERCOT makes the unsupportable statement that there will be “no impacts to ERCOT grid operations and practices” as a result of NOGRR245. As evidenced by the many written comments and verbal feedback ERCOT has received since first advancing the proposed NOGRR, this is highly inaccurate. In fact, retroactive implementation of this NOGRR on ERCOT’s unrealistic proposed timeframe will result in imposing significant costs on existing Generation Resources and have a potentially crippling effect on resource adequacy given the likely forced retirement of existing IBR models that cannot meet the standards. At the very least, ERCOT should perform the necessary studies before “finding” that there will be no impact to ERCOT grid operations and practices.

When resource adequacy concerns were raised with ERCOT by market participants during meetings of the Operations Working Group (OWG) and the Inverter-Based Resource Task Force (IBRTF), ERCOT said they expect there will be generators that will be disconnected, retired early, or repowered as a result of the rule. ERCOT has acknowledged that the scale of lost capacity could be in the GWs but has not sought to quantify the effect. Instead, ERCOT downplayed the likely effect by incorrectly assuming only the oldest wind generators will be retired or disconnected by ERCOT and assuming that those generators would contribute only a small fraction of capacity during times of peak Load. This is a gross oversimplification that falls far short of the analysis required of potentially catastrophic capacity losses that may be concentrated in certain areas of the grid.

**The technology to retrofit older IBRs to meet the new NOGRR245 standards does not exist**

As the OEMs and various commenters have previously noted, the feasibility of retroactively meeting each requirement proposed by ERCOT will vary by IBR technology, make, and model of equipment, along with other project design factors.

Some newer models may be able to comply with relatively modest changes to software or firmware. But older models that were not engineered with this standard in mind will require more time and more extensive changes, including modification to, or replacements of, major mechanical and electrical components. And some models will simply be unable to comply with the full set of requirements. Wind OEMs have indicated the problem is particularly acute for wind turbine generators and worsens the older the generator is. As but one example, GE has 1,800 1.x non-ESS turbines in ERCOT, representing approximately 2.7 GW of generation capacity. These turbines cannot meet the full set of proposed requirements today and have no path to do so inthe time proposed by ERCOT, if ever.  Repowering these units may ultimately prove technically feasible (we do not know today), but that would not be a “retrofit,” rather it would require a complete overhaul akin in scope and cost to installing new turbines.

Despite ongoing discussions and preliminary feedback from its OEMs, Invenergy cannot definitively say today which of its existing IBR makes and models can meet which proposed ERCOT requirement, on what date, and at what cost. Similarly, today it cannot offer precise alternatives to each of ERCOT’s proposed parameters (*e.g.*, a 15-degree phase angle jump rather than ERCOT’s proposed 25 degrees) because the OEMs need time to evaluate and propose alternatives, time that in many cases will extend beyond ERCOT’s proposed March 1, 2024 deadline to report such information to ERCOT. Invenergy and other stakeholders need time to develop these alternatives with their OEMs. As noted in the alternative approach laid out below, ERCOT should allow this investigative process to play out before mandating compliance without a full understanding of the consequences.

In publicly posted comments,[[7]](#footnote-8) the OEMs have voiced their concerns to ERCOT that development of the equipment and software needed for this revision will take years to develop, and that is a best-case scenario:

* GE comments of May 3, 2023, describe the lengthy process required to develop the equipment required by this revision request.  While there are challenges in developing equipment for new projects, GE states that evaluating out of production turbine designs against standards that were not in place at the time of manufacture is a lengthy process, requiring lab and field testing that relies on test equipment in short supply. ERCOT had 19 GW of installed GE wind capacity as of year-end 2022 according to the U.S. Energy Information Administration (EIA), 48% of the total installed wind capacity in ERCOT at the time.

* Siemens Gamesa comments of June 6, 2023, strongly recommend that ERCOT consider providing prioritization based on historical performance (critical areas, etc.) as well as a staged process to help OEMs better manage their resources to make currently feasible improvements first, and leave items with more uncertainty and complexity for deeper analysis.  Their comments demonstrate that existing projects, retrofits, and new projects may be unable to comply with current technical requirements and deadlines based on the lengthy timeline necessary to develop and market such equipment.  ERCOT had 6.3 GW of installed Siemens Gamesa wind capacity as of year-end 2022 according to EIA, 16% of total installed wind capacity in ERCOT at the time.

* Vestas comments of June 22, 2023, reiterate the inability of legacy projects to comply with the proposed standards, including items in the specificity requirements.  Vestas urges a good cause exception process to exempt these older projects.  ERCOT had 8.1 GW of installed Vestas wind capacity as of year-end 2022 according to EIA, 20% of total installed wind capacity in ERCOT at the time.
* Together, GE, Siemens Gamesa, and Vestas models accounted for 33.3 GW of operating wind capacity in ERCOT as of year-end 2022.

While the risk of generators facing disconnection or forced retirement increases with the age of the generator, it is not limited to the oldest generators. All existing generators are at varying levels of risk of being unable to meet the proposed requirements on the timeline proposed by ERCOT, if at all. However, even if one were to consider only the wind generators installed over 10 years ago, that is still 9.7 GW of capacity, or over 25% of the wind fleet.

**Table 1. Wind IBR Capacity by In-Service Year[[8]](#footnote-9)**

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| **In-service year** | **MW** |
| 2010 and older | 7,970 |
| 2011-2013 | 1,737 |
| 2014-2019 | 13,067 |
| 2020-2023\* | 14,973 |
| **Total** | **37,747** |
| \*Includes synchronized but not approved for commercial operations. |  |

**Where retrofits prove to be technically feasible, the costs imposed on existing IBR generation assets to retrofit are likely to be significant**

It is difficult to estimate the cost of technical solutions that have not yet been developed. Nonetheless, wind OEMs operating in ERCOT have indicated that where retrofits prove to be technically feasible, component changes and replacements, including the converter will likely be required to meet certain requirements depending on the turbine make and model. For those turbines, the estimated costs of compliance imposed by this proposal range from tens of thousands of dollars per turbine to hundreds of thousands of dollars per turbine. That estimate does not include repowers, which goes well beyond a retrofit and involves far more extensive equipment replacement and a much higher cost. Even firmware and software updates will impose additional cost, particularly as market participants are wholly reliant on the OEM to deliver them. Total costs of compliance from retrofits (not repowers) across the ERCOT market could range from hundreds of millions, into the billions of dollars.

Moreover, if for example, wind generators upgrade or replace a converter to increase the ride-through capability to meet the retroactive standards, ERCOT’s proposal would likely force that generator to meet an even *higher* ride-through standard applicable to new generators and those for which a Generator Interconnection or Modification (GIM) is required.[[9]](#footnote-10) This presents a moving target and further increases risk: the higher standard applicable to new generators may not be technically feasible for older generation assets on the timeline required, or may impose even higher costs as additional upgrades and replacements are required.

**ERCOT’s new “specificity” requirements make compliance even harder**

ERCOT’s proposed ride-through requirements for existing generators include three elements, the last of which ERCOT refers to as “specificity”:

1. “Voltage Ride-Through” (VRT) table - Under the current protocols, more stringent requirements apply to newer generators than to older ones. ERCOT’s proposal is to retroactively apply these more stringent requirements to all existing IBRs, irrespective of age.
2. “Frequency Ride-Through” (FRT) table - Effective 1/1/2026, ERCOT’s proposal implements more stringent ride-through tables from the forward-looking IEEE 2800-2200 standard to all existing IBRs.
3. “Specificity”- All other elements of the ride-through requirements, including but not limited to items relating to VRT like multi-fault ride-through (how many successive events a generator must ride-through in a given time interval) and maximum phase-angle jumps. The current protocols are silent on these items. ERCOT’s proposal imposes recommendations from the forward-looking IEEE 2800-2200 standard retroactively to all existing IBRs.

ERCOT states that its new “specificity” requirements are merely a clarification of existing requirements. Invenergy disagrees. In fact, the “specificity” requirements create new, more stringent standards which even newer existing projects cannot meet.[[10]](#footnote-11)

This is a critical point. Based on preliminary feedback from its OEMs, Invenergy has identified the new “specificity” standards as a separate problematic requirement for existing IBRs, including newer models. The ability to comply appears to be more technically challenging for wind than solar, but solar inverter OEMs will need time to develop and test solutions. For wind, Vestas explains in their comments that these new standards, specifically with regard to the phase angle jump and the multiple-event ride-through requirements, need more evaluation in order to even determine the level of compliance challenges faced by the existing machines.[[11]](#footnote-12)  Similarly, GE noted the following in their filed comments: “Meeting new requirements with significant electromechanical complexity, such as multiple fault ride through, cannot be accomplished by analysis alone and may require months of lab and field testing for each variant.”[[12]](#footnote-13) Moreover, the testing procedure of such phase angle jump requirements for new units is not straightforward and is being discussed actively in IEEE P2800.2 Working Group (“WG”) SG2. One of Invenergy’s employees who sits on the IEEE P2800.2 WG has indicated that the group is not considering developing testing procedures for existing operational resources as the base IEEE 2800-2200 standard clearly recommended the applicability of its standard to be prospective, not retroactive.

If ERCOT removed the new “specificity requirements,” Invenergy expects that a subset of existing IBRs could meet ERCOT’s other VRT and preferred FRT requirements in a commercially reasonable manner by 12/31/2025, though these IBRs may not have the preferred FRT capability today. This is an example of the potential to apply a more targeted subset of retroactive requirements to a subset of existing projects on a timeline similar to what ERCOT is proposing now.

Furthermore, with more time and subject to evaluations by the OEMs, some parameters for the new “specificity” requirements if not the ones currently proposed by ERCOT, might be possible to implement depending on IBR technology, make, and model. But that determination will require ERCOT to allow for the necessary studies to be made.

**Retroactive application of NOGRR245 as currently drafted will negatively impact resource adequacy in ERCOT**

As currently drafted, NOGRR245 will have a negative impact on resource adequacy and reliability because the proposed rule requires existing generators to meet an impossible compliance deadline or face disconnection from the grid imposed by ERCOT for non-compliance. Such an outcome is the opposite of the intent and purpose of the proposed rule to enhance reliability. Invenergy strongly urges ERCOT to consider resource adequacy *in advance* of adoption of any proposed revision, and tailor its proposed rule accordingly, as discussed further below. Invenergy views anything less to be irresponsible.

ERCOT’s proposal imposes a uniform set of enhanced ride-through requirements to all existing IBRs, abandoning the current structure that imposes less stringent requirements on older IBRs and effectively ignoring the fact that several of the largest OEMs do not have an existing solution for legacy projects to comply with the proposal today.

ERCOT has not identified how many GW of IBRs are at risk of disconnection for non-compliance and has indicated it will not know until market participants have provided that information by the proposed March 1, 2024 deadline for reporting resource capability.[[13]](#footnote-14)  This is a problem, as the scale is on the order of GW of potential disconnections, as illustrated by considering that we already know there are 9.7 GW of wind turbine generators at least 10 years old. This does not take into account either the difficulties faced by other wind turbines or the impact on solar facilities. Thus, adoption of the proposed language without knowing and understanding what its impact will be on existing Generation Resources seems reckless.  Without the IBRs that cannot meet the currently unattainable compliance date that ERCOT has indicated it will disconnect, ERCOT risks a serious resource adequacy crisis at a time when reliability is of the utmost importance. One need only look at the past summer to see the critical role IBRs are playing in ERCOT.

This summer these Resources have been the heroes of the grid providing a significant amount of affordable power throughout ERCOT.

* *June 25-30*: ERCOT issued a Weather Watch due to forecasted higher temperatures and higher electric demand. When temperatures and demand were at some of their highest in ERCOT, renewables played a vital role in keeping the lights on.
  + On June 27, ERCOT had a (at the time) record load of 81,017 MWs between 5 – 6 pm and during that time IBRs provided approximately 35.2% of production, or 28,471 MWs, while 8 GW of coal & gas were offline.
  + On June 28, the maximum IBR production was 31,468 MW, which at the time was a record, while 9.6 GW of coal and gas were offline.
  + On June 29, the maximum IBR production was 31,375 MWs, which ranked as the 4th highest renewable production in ERCOT.
* *July 16-18*: ERCOT issued a Weather Watch due to forecasted higher temperatures, higher electrical demand, and the potential for lower reserves.
  + On July 17, solar hit a record production of 13,300 MWs (at that time).[[14]](#footnote-15)
  + On July 18, ERCOT set a new load record at 82,781 MW,[[15]](#footnote-16) and renewables set a new output record, delivering 31.5 GW in the middle of the day. At peak load, wind and solar delivered 35% of ERCOT’s power needs. Renewables also provided approximately 45% of production for approximately 3 hours and approximately 40% of production for >10 hours during a day where ERCOT had its highest load. Real-time prices on 7/18 peaked only at $70/MWh, despite the level of demand.
* *June 1-July 19*: During the 50 hours of greatest load in this time period, wind and solar IBRs on average were 31% of the ERCOT generation mix, which translates to just over 25 GW of generation serving load.

**A common-sense alternative approach**

ERCOT should hit pause before leaping headlong into a retroactive application of NOGRR245 without (1) a clear understanding of the reliability need sought to be addressed, (2) a full understanding of the technical limitations on compliance for existing generation assets, (3) studies on the costs imposed on existing generation assets to comply with NOGRR245 and a cost/benefit analysis associated with those costs and the magnitude of benefit gained, and (4) a substantive analysis of the impact on resource adequacy should the costs of compliance prove uneconomic for existing generation assets.

To reduce the risk of a failure to ride-through in existing projects, Invenergy proposes that ERCOT establish a process to determine the need and technical options for improving the capability of existing IBRs, and for monitoring and identifying the actual system risk in real-time more accurately.  At the same time, ERCOT can explore ways to improve system strength through non-generation alternatives.  During this process, IBR owners would work with the OEMs to lay out a roadmap for determining the technical options, limits, approximate costs, and timelines for improving the capability of these existing projects.   Specifically, in light of the significant concerns and risks outlined above, Invenergy proposes the following:

**1. Bifurcate the NOGRR, allowing the new standard to go into effect for new projects while providing time to consider the consequences of applying the new standard to existing projects.**

The concerns identified in these comments apply to the retroactive application of NOGRR 245. There is no reason that ERCOT cannot institute the new standard for future generation projects while continuing to study and analyze the costs and impact on reliability attendant to applying this standard retroactively.

**2. In a separate NOGRR addressing the impact on existing generation assets, work with generators, OEMs and other affected market participants to undertake a systemic analysis to determine the most efficient, least detrimental (i.e., narrowly tailored) approach and then commission studies to look at each aspect of the potential impact (i.e., technical feasibility, cost, impact on resource adequacy).**

Only with this information, which ERCOT has acknowledged it does not currently have, can a reasonable decision be made concerning the appropriate standards to impose on existing generation assets.

**3. Eliminate the new “specificity” requirements for existing projects.**

**4. Account for the detrimental effects on resource adequacy and the impact on future investment in ERCOT caused by restricting or removing existing IBRs from the grid.**

**Conclusion**

Invenergy supports implementation of the proposed standards for projects with a Standard Generation Interconnection Agreement (SGIA) after the effective date of this NOGRR on a reasonable and achievable timeline.  This will initiate movement toward the new standards in an achievable and substantial way. With respect to existing facilities, Invenergy supports the development of additional studies so that ERCOT’s, and ultimately the Commission’s, decision avoids and/or mitigates the negative impact of applying this NOGRR to existing generation. There is not a “one size fits all” solution. ERCOT needs to develop its understanding of the problems and available solutions so that it can narrowly tailor the policy to obtain the most gains to reliability without the negative consequences discussed herein. Finally, Invenergy supports a process to determine the most feasible pathway to getting increased performance from the older fleet and retrofits when necessary and as commercially feasible.

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| **Revised Cover Page Language** |

None

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| **Revised Proposed Guide Language** |

None

1. NOGRR245 is likely to be considered a “statement of general applicability” as that term is defined in Texas Government Code 2001.003, which could render it a “rule” for purposes of that statute. [↑](#footnote-ref-2)
2. The Seasonal Assessment of Resource Adequacy for the ERCOT Region Summer 2023 (“SARA Summer 2023”) shows 37.7 GW of existing installed wind capacity and 15.7 GW of existing installed solar capacity. *Available at* [SARA\_Summer2023\_Revised.pdf (ercot.com)](https://www.ercot.com/files/docs/2023/05/05/SARA_Summer2023_Revised.pdf) at p. 2. [↑](#footnote-ref-3)
3. *See id* (assuming an installation cost of ~$1,500/kW based on EIA’s overnight capital costs for 2023 of $1566/kW for wind and $1443/kW for PV with tracking. *See* U.S. Energy Information Administration, *Annual Energy Outlook 2023: Table 55. Overnight Capital Costs for New Electricity Generating Plants*. *Available at* <https://www.eia.gov/outlooks/aeo/data/browser/#/?id=123-AEO2023&cases=ref2023&sourcekey=0>: [↑](#footnote-ref-4)
4. *See* *IEEE Standard for Interconnection and Interoperability of Inverter-Based Resources (IBRs) Interconnecting With Associated Transmission Electric Power Systems* at p. 19 (Section 1.4 “General Remarks and Limitations”). [↑](#footnote-ref-5)
5. *Request to Develop or Modify Reliability Rules and Requirements*, New York State Reliability Council (Policy No. 1-11). *Available at* <https://www.nysrc.org/wp-content/uploads/2023/04/PRR-151-3-12-2023.pdf> [↑](#footnote-ref-6)
6. *Inverter-Based Resource Performance Requirements*, MISO Interconnection Process Working Group (IPWG) (June 20, 2023) *Available at* https://cdn.misoenergy.org/20230620%20IPWG%20Item%2005%20IBR%20Performance%20Requirements629308.pdf [↑](#footnote-ref-7)
7. *See* NOGRR245 Key Documents page. *Available at* <https://www.ercot.com/mktrules/issues/NOGRR245#keydocs> [↑](#footnote-ref-8)
8. *See supra* n. 2 at pp. 15-17. [↑](#footnote-ref-9)
9. *See* NOGRR245, Inverter-Based Resource (IBR) Ride-Through Requirements, *Comment of ERCOT* (June 22, 2023). *Available at* <https://www.ercot.com/files/docs/2023/06/22/245NOGRR-22%20ERCOT%20Comments%20062223.docx> at 2.9.1(1)(a)(ii). [↑](#footnote-ref-10)
10. All existing generators passed ERCOT’s interconnection process, and they were not required or expected to comply with an infinite set of multiple-fault ride-through scenarios or 180 degrees of phase angle jumps. In its presentation to ERCOT’s IBR TF, EPRI noted that ERCOT currently has “no requirement” for phase angle jump and consecutive voltage dip ride-through. *See IEEE 2800-2022 Adoption; Preliminary Detailed Gap Assessment of ERCOT’s Nodal Protocols and Nodal Operating Guides relate to IEEE 2800-2022*, presented by EPRI (May 23, 2022). *Available* *at*

    <https://www.ercot.com/files/docs/2022/05/24/EPRI_ERCOT_IBRTF_Meeting_May_23_2022_PUBLIC_v2.pdf> at slide 17. [↑](#footnote-ref-11)
11. *See* NOGRR 245, Inverter-Based Resource (IBR) Ride-Through Requirements, *Comments of Vestas* (June 22, 2023) at pp 1-2. *Available at* [*https://www.ercot.com/mktrules/issues/NOGRR245#keydocs*](https://www.ercot.com/mktrules/issues/NOGRR245#keydocs) [↑](#footnote-ref-12)
12. *See* NOGRR 245, Inverter-Based Resource (IBR) Ride-Through Requirements, *Comments of GE Renewable Energy (Wind)* (May 3, 2023) at p 2. *Available at* [*https://www.ercot.com/mktrules/issues/NOGRR245#keydocs*](https://www.ercot.com/mktrules/issues/NOGRR245#keydocs) [↑](#footnote-ref-13)
13. The rule requires full compliance by December 31, 2025. By acting before knowing the scope of the problem, ERCOT limits the time for existing IBRs to comply with the new standards to 21 months. [↑](#footnote-ref-14)
14. GridStatus.io maintains a website providing ERCOT maximum renewable generation statistics. The figure sited is shown on the page “*ERCOT Maximum Solar Record*.” *Available at*  <https://www.gridstatus.io/records/ercot?record=Maximum%20Solar> [↑](#footnote-ref-15)
15. GridStatus.io maintains a website providing ERCOT maximum load statistics. The figure sited is shown on the page “*ERCOT Load Record*.” *Available at*  <https://www.gridstatus.io/records/ercot?record=Maximum%20Load> [↑](#footnote-ref-16)