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| PGRR Number | [109](https://www.ercot.com/mktrules/issues/PGRR109) | PGRR Title | Dynamic Model Review Process Improvement for Inverter-Based Resource (IBR) Modification |
| Date of Decision | January 24, 2024 |
| Action | Recommended Approval |
| Timeline  | Normal  |
| Estimated Impacts | Cost/Budgetary: None Project Duration: Not applicable  |
| Proposed Effective Date | First of month following Public Utility Commission of Texas (PUCT) approval |
| Priority and Rank Assigned | Not applicable |
| Planning Guide Sections Requiring Revision  | 5.2.1, Applicability5.5, Generator Commissioning and Continuing Operations6.2, Dynamics Model Development |
| Related Documents Requiring Revision/Related Revision Requests | None |
| Revision Description | This Planning Guide Revision Request (PGRR) introduces a new requirement for Interconnecting Entities (IEs) associated with Inverter-Based Resources (IBRs) to undergo a dynamic model review process prior to the Resource Commissioning Date. Additionally, this PGRR mandates that Resource Entities owning or controlling operational IBRs must undergo a review process before implementing modification to any control settings or equipment that impact the dynamic response (e.g., voltage, frequency, and current injections) at the Point of Interconnection (POI).As part of the review process, ERCOT shall review the model quality tests submitted by an IE or Resource Entity. In the case of operational IBRs, the review process may require the interconnecting Transmission Service Provider (TSP) conducting a limited dynamic stability study to compare and evaluate the electrical performance before and after the proposed modifications. |
| Reason for Revision |  [Strategic Plan](https://www.ercot.com/files/docs/2023/08/25/ERCOT-Strategic-Plan-2024-2028.pdf) Objective 1 – Be an industry leader for grid reliability and resilience [Strategic Plan](https://www.ercot.com/files/docs/2023/08/25/ERCOT-Strategic-Plan-2024-2028.pdf) Objective 2 - Enhance the ERCOT region’s economic competitiveness with respect to trends in wholesale power rates and retail electricity prices to consumers [Strategic Plan](https://www.ercot.com/files/docs/2023/08/25/ERCOT-Strategic-Plan-2024-2028.pdf) Objective 3 - Advance ERCOT, Inc. as an independent leading industry expert and an employer of choice by fostering innovation, investing in our people, and emphasizing the importance of our mission General system and/or process improvement(s) Regulatory requirements ERCOT Board/PUCT Directive*(please select ONLY ONE – if more than one apply, please select the ONE that is most relevant)* |
| Justification of Reason for Revision and Market Impacts | IBRs have distinct design and operational characteristics compared to conventional synchronous generators. Unlike synchronous generators, the performance of IBRs relies mainly on power electronics controls, which make them highly responsive and sensitive to even minor adjustments in control settings. Therefore, even minor adjustments to control settings can have a substantial impact on the grid.Currently, there is no review process in place for IBRs before the Resource Commissioning Date to ensure that the "as-built" data accurately represent the parameters and performance of the as-studied data that were used in the quarterly stability assessment. Before a new IBR can commence commercial operation, it should provide substantial evidence demonstrating that its as-built performance and installed control parameters align with the model utilized in the quarterly stability assessment.In addition, if modifications to operational IBRs fall outside of applicability as described in paragraph (1)(c) of Section 5.2.1 Resource Entities are not required to undergo any review process. The only requirement is for Resource Entities to submit dynamic model updates, model quality tests, and plant verification reports after implementing the changes in the field. Modifications made to settings or equipment by Resource Entities without undergoing a review process can potentially result in unexpected trips or unstable responses during disturbances. Having a proper review process in place is crucial to ensuring that such modifications are thoroughly reviewed before being implemented in the field.This PGRR is aligned with the recommendations from the North American Electric Reliability Corporation (NERC) as described in the 2022 Odessa Disturbance report.  |
| ROS Decision | On 8/3/23, ROS voted unanimously to table PGRR109 and refer the issue to the Inverter-Based Resource Working Group (IBRWG) and Planning Working Group (PLWG). All Market Segments participated in the vote.On 12/7/23, ROS voted unanimously to recommend approval of PGRR109 as amended by the 11/17/23 ERCOT comments. All Market Segments participated in the vote. On 1/8/24, ROS voted unanimously to endorse and forward to TAC the 12/7/23 ROS Report and the 7/18/23 Impact Analysis for PGRR109. All Market Segments participated in the vote.  |
| Summary of ROS Discussion | On 8/3/23, participants reviewed PGRR109 and commented that details such as modifications to settings need to be discussed further and recommended this item be referred to the PLWG and IBRWG.On 12/7/23, participants reviewed the 11/17/23 ERCOT comments. On 1/8/24, participants reviewed the 7/18/23 Impact Analysis. |
| TAC Decision | On 1/24/24, TAC voted unanimously to recommend approval of PGRR109 as recommended by ROS in the 1/8/24 ROS Report. All Market Segments participated in the vote. |
| Summary of TAC Discussion | On 1/24/24, there was no discussion beyond TAC review of the items below.  |
| TAC Review/Justification of Recommendation |  Revision Request ties to Reason for Revision as explained in Justification  Impact Analysis reviewed and impacts are justified as explained in Justification Opinions were reviewed and discussed Comments were reviewed and discussed (if applicable) Other: (explain) |
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| **Opinions** |
| Credit Review | Not applicable |
| Independent Market Monitor Opinion | IMM has no opinion on NPRR1207. |
| ERCOT Opinion | ERCOT supports approval of PGRR109. |
| ERCOT Market Impact Statement | ERCOT Staff has reviewed PGRR109 and believes the market impact for PGRR109 is that it improves the dynamic model review process for IBRs by establishing a new requirement for IEs associated with IBRs to undergo a dynamic model review process prior to Resource Commissioning Date, and requiring a review process for operational IBRs before implementing modification to any control settings or equipment that impact the dynamic response  (such as voltage, frequency, and current injections) at the POI. In certain cases for operational IBRs, it requires the interconnecting TSPs conducting a limited dynamic stability study to compare and evaluate the electrical performance before and after the proposed modifications. |

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| Market Segment | Not applicable |

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| **Comments Received** |
| **Comment Author** | **Comment Summary** |
| TAEBA 100423 | Proposed revisions condensing the process for new interconnections  |
| ERCOT 101023 | Indicated ERCOT does not support the 10/4/23 TAEBA comments |
| Joint Commenters 101723 | Explained PGRR109 would create a burdensome pre-approval process and may result in redundant efforts on IBR owners, TSPs and ERCOT Staff and proposed revisions to address these concerns  |
| ERCOT 110723 | Indicated ERCOT does not support most of the revisions reflected in the 10/17/23 Joint Commenters comments  |
| ERCOT 111723 | Clarified language concerning the temporary implementation of proposed modifications |
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| **Market Rules Notes** |

Administrative changes to the language were made and authored as “ERCOT Market Rules.”

Please note the baseline Planning Guide language in the following section(s) has been updated to reflect the incorporation of the following PGRR(s) into the Planning Guide:

* PGRR103, Establish Time Limit for Generator Commissioning Following Approval to Synchronize (incorporated 11/1/23)
	+ Section 5.5

Please note that the following PGRR(s) also propose revisions to the following Section(s):

* PGRR114, Related to NPRR1212, Clarification of Distribution Service Provider’s Obligation to Provide an ESI ID
	+ Section 5.5

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| Proposed Guide Language Revision |

***5.2.1 Applicability***

(1) The requirements in Section 5, Generator Interconnection or Modification, apply to the following:

(a) Any Entity proposing to interconnect any generator with an aggregate nameplate capacity of one MW or greater, including but not limited to any Generation Resource or Energy Storage Resource (ESR), to the ERCOT System;

(b) Any Entity proposing to interconnect a Settlement Only Generator (SOG) to the ERCOT System; or

(c) Any Resource Entity seeking to modify a Generation Resource, ESR, or SOG that is connected to the ERCOT System by:

(i) Increasing the real power rating from that shown in the latest Resource Registration data by one MW or greater within a single year;

(ii) Changing the inverter, turbine, generator, or power converter associated with a facility with an aggregate real power rating of ten MW or greater, unless the replacement is in-kind;

(iii) Modifying any control settings or equipment of Inverter-Based Resources (IBRs) that impact the dynamic response (such as voltage, frequency, and current injections) at the Point of Interconnection (POI) in a manner that is deemed to require further study in accordance with the process outlined in paragraph (5) of Section 5.5, Generator Commissioning and Continuing Operations;

(iv) Changing or adding a POI to a facility with an aggregate real power rating of ten MW or greater; or

(v) Increasing the aggregate nameplate capacity of a generator less than ten MW to ten MW or greater.

(2) For the purposes of Section 5, the term “generator” includes but is not limited to a Generation Resource, SOG, and ESR.

(3) For the purposes of determining the appropriate requirements in Section 5, a generator is considered a “large generator” if it currently has or is proposed to have an aggregate nameplate capacity of ten MW or greater. A generator is considered a “small generator” if it currently has or is proposed to have an aggregate nameplate capacity of less than ten MW.

(4) Notwithstanding paragraph (3), above, if a Resource Entity is proposing to increase the real power rating of an existing generator by one MW or greater but less than ten MW, that generator shall be considered a small generator for the purposes of the interconnection process described in Section 5.

(5) Notwithstanding paragraphs (3) and (4), above, if a Resource Entity is proposing to increase a generator’s real power rating by ten MW or more, or is proposing to increase a generator’s real power rating from less than ten MW to ten MW or more, that generator shall be considered a large generator for the purposes of the interconnection process described in Section 5.

(6) For the purposes of determining the appropriate requirements in Section 5, ERCOT may require two or more separate generator interconnection requests to the same substation to follow the interconnection process applicable to the large generators, if, following the proposed change, those generators would have an aggregate nameplate capacity of ten MW or greater, and the projects are proposed by the same Entity or Affiliates.

(7) For a new or modified generator that has been designated as a Self-Limiting Facility or as a component of a Self-Limiting Facility, the categorization of the generator as a small generator or large generator pursuant to paragraphs (3) through (5) above shall be determined using the Self-Limiting Facility’s established limit on the total MW Injection, or if applicable, the proposed increase in that value instead of the nameplate capacity of the Self-Limiting Facility.

**5.5 Generator Commissioning and Continuing Operations**

(1) For each interconnecting Generation Resource or Energy Storage Resource (ESR), each Interconnecting Entity (IE) shall meet the conditions established by ERCOT before proceeding to Initial Energization, Initial Synchronization, and commercial operations. These conditions may require proof of meeting applicable ERCOT requirements, which may include, but are not limited to, reactive capability, voltage ride-through standards, dynamic model template submission, Automatic Voltage Regulator (AVR), Primary Frequency Response, Power System Stabilizer (PSS), Subsynchronous Resonance (SSR) models, and telemetry.

(2) Within 300 days of receiving ERCOT’s approval for Initial Synchronization above 20 MVA of a new or repowered Generation Resource or ESR, a Resource Entity shall ensure the Resource meets the conditions established by ERCOT for commercial operations and shall submit a request to ERCOT to commission the Resource.

In the event a Generation Resource or ESR will be unable to complete all necessary construction and required testing to commence commercial operations and connect reliably to the ERCOT System within the 300 days, the Generation Resource or ESR may request a good cause exception with sufficient detail, and shall notify ERCOT prior to the planned commercial operation date and provide ERCOT with an updated commercial operation date that the Generation Resource or ESR can reasonably expect to commence operations in a reliable manner.

(3) Prior to the Resource Commissioning Date of an Inverter-Based Resource (IBR), the IE associated with the IBR shall submit the appropriate dynamic models for the “as-built” data and the data submitted for the quarterly stability assessment, documentation clearly indicating any differences, results of the model quality tests of the “as-built” data overlaid with the results of the data submitted for the quarterly stability assessment, and associated simulation files pursuant to paragraph (5)(c) of Section 6.2, Dynamics Model Development. Submissions shall be sent electronically to Dynamicmodels@ercot.com for ERCOT review, and the phrase "IBR prior to commissioning" must be included in the subject line of the submission email. ERCOT shall respond to the IE within 10 Business Days of the submission, indicating whether the submission is acceptable or if additional information is required. If additional time is needed for review, ERCOT can extend this review period by an additional 20 Business Days, and an email will be sent to notify the IE that it needs additional time to review the submission. The time for ERCOT to review models and associated documentation will be a qualified cause to extend the allowed time to complete the conditions established by ERCOT for commercial operations.

(4) No later than 30 days following the Resource Commissioning Date, the Resource Entity shall submit updates to the resource dynamic planning and operations models through the online Resource Integration and Ongoing Operations (RIOO) system based on “as-built” data and provide a plant verification report as required by paragraph (5)(b) of Section 6.2. Pursuant to paragraph (5)(c) of Section 6.2, the Resource Entity shall include model updates with model quality tests.

(5) During continuing operations:

(a) Prior to the implementation of modification to any control settings or equipment of an IBR that impacts the dynamic response (such as voltage, frequency, and current injections) at the Point of Interconnection (POI), the proposed modification shall be reviewed by the interconnecting Transmission Service Provider (TSP) and ERCOT:

(i) The Resource Entity shall submit the appropriate dynamic model for the proposed modification, results of the model quality tests overlaid with the results before the modification, and associated simulation files pursuant to paragraph (5)(c) of Section 6.2. Submissions shall be sent electronically to Dynamicmodels@ercot.com for ERCOT review, and the phrase "IBR proposed modification" must be included in the subject line of the submission email. The Resource Entity may withdraw its modification plan at any time during the review process if the Resource Entity no longer wishes to proceed with the modification.

(ii) ERCOT shall respond to the Resource Entity within 10 Business Days of the submission in paragraph (i) above, indicating whether the submission is acceptable or if additional information is required. ERCOT can extend this review period by an additional 20 Business Days, and an email will be sent to notify the Resource Entity that it needs additional time to review the submission.

(iii) Upon completing its review of the model quality tests, ERCOT shall notify the Resource Entity and the interconnecting TSP of its determination. The notification will indicate one of the following:

(A) ERCOT recommends that the interconnecting TSP conduct a limited dynamic stability study comparing electrical performance before and after the proposed modification, and reasonably evaluate whether the proposed modification may present dynamic stability risks that should be subject to further study.

(B) The proposed modification is applicable to paragraph (1)(c)(iii) of Section 5.2.1. The Resource Entity shall initiate a Generator Interconnection or Modification (GIM) request through RIOO.

(C) The proposed modification is deemed unacceptable.

(D) The proposed modification is deemed acceptable without need for a dynamic stability study.

(iv) Within 90 days of the receipt of the accepted submission in paragraph (iii)(A) above, the interconnecting TSP shall submit its dynamic stability study report to ERCOT electronically to Dynamicmodels@ercot.com.

(v) ERCOT shall review the dynamic stability study report submitted by the interconnecting TSP within 10 Business Days.  ERCOT can extend this review period by an additional 20 Business Days, and an email will be sent to notify the interconnecting TSP and the Resource Entity that it needs additional time to review the dynamic stability study report.

(vi) Upon completing its review and ERCOT acceptance of the dynamic stability study report, ERCOT shall notify the Resource Entity and the interconnecting TSP of its determination. The notification will indicate one of the following:

(A) The proposed modification is deemed acceptable.

(B) The proposed modification is applicable to paragraph (1)(c) of Section 5.2.1. The Resource Entity shall initiate a GIM request through RIOO.

(vii) ERCOT, in consultation with the interconnecting TSP, may allow the proposed changes to be temporarily implemented prior to the above review process in order to address any identified performance deficiency.

(b) Pursuant to paragraph (5)(c) of Section 6.2, the Resource Entity shall include model updates with model quality tests.

(c) The Resource Entity shall provide ERCOT with a plant verification report as required by paragraph (5)(b) of Section 6.2 at the following times:

(i) No later than 30 days after implementing a settings change as required by paragraph (7) of Section 6.2;

(ii) No earlier than 12 months and no later than 24 months following the later of the Resource Commissioning Date or March 1, 2021; and

(iii) A minimum of every ten years.

6.2 Dynamics Model Development

(1) To adequately simulate dynamic and transient events in the ERCOT System, it is necessary to establish and maintain dynamics data and simulation-ready study cases representing the dynamic capability and frequency characteristics of machines and equipment connected to the ERCOT System.

(2) Dynamics data is the network data and mathematical models required in accordance with the Reliability and Operations Subcommittee (ROS)-approved Dynamics Working Group Procedure Manual for simulation of dynamic and transient events in the ERCOT System.

(3) For Resource Entities, dynamics data includes the data needed to represent the dynamic and transient response of Resource Entity-owned devices and/or Loads including but not limited to generating units, plants, and other equipment when connected to the ERCOT System including the data for any privately owned transmission system or collection system used to connect the Resource to the ERCOT System.

(4) For Transmission Service Providers (TSPs), dynamics data needed to represent the dynamic and transient capability of TSP-owned devices including but not limited to Load shedding relays, protective relays, FACTS devices (e.g., SVC, STATCOMs), Direct Current Ties (DC Ties), variable-frequency transformers, automatically switched shunts, and transformers with automatic load tap changers.

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| [PGRR101: Replace paragraph (4) above with the following upon system implementation of NPRR1133:](4) For Transmission Service Providers (TSPs) and owners of Direct Current Ties (DC Ties), dynamics data includes the data needed to represent the dynamic and transient capability of dynamic devices including but not limited to Load shedding relays, protective relays, FACTS devices (e.g., SVC, STATCOMs), DC Ties, variable-frequency transformers, automatically switched shunts, and transformers with automatic load tap changers. |

(5) The owner of a generator Facility or any dynamic device shall provide appropriate dynamics data to ERCOT, including the data for a planned Facility, in accordance with the Dynamics Working Group Procedure Manual. The dynamic data shall include the following:

(a) A model with parameters that accurately represent the dynamics of the device and that is compatible with the current version of the planning and operations model software as described in the Dynamics Working Group Procedure Manual. If a user written model is provided:

(i) A model manual containing a technical description of the model characteristics, including descriptions for all model parameters and variables, a list of which parameters are commonly tuned for site-specific settings, and a description of procedures and considerations for using the model in dynamic simulations, including steady state representation and limitations for model adequacy and usability in the planning and operations model software; and

(ii) The user-written model shall allow the user to determine the allocation of machine identifiers (bus numbers, bus names, machine IDs etc.) without restriction.

(b) Verification reports that support the model data based on documented field settings shall be provided as specified in the Dynamics Working Group Procedure Manual for Generation Resources, Energy Storage Resources (ESRs), and for Transmission Elements represented by a dynamic model. The reports shall demonstrate that the model parameters which are commonly tuned match site-specific settings implemented in the field. For new Generation Resources and ESRs, these reports shall be provided as required in paragraph (4) of Section 5.5, Generator Commissioning and Continuing Operations. For existing Generation Resources and ESRs, these reports shall be provided as required in paragraph (5) of Section 5.5. For Transmission Elements represented by a dynamic model, these reports shall be provided no later than two years following energization of new equipment and updated a minimum of every ten years.

(c) Results of model quality tests and associated simulation files that demonstrate acceptable performance of the models in the planning model and operations software as described in the Dynamics Working Group Procedure Manual. The Facility owner shall provide updated information whenever it provides a new or updated dynamic model to ERCOT representing a Generation Resource, ESR, or Transmission Element. These tests ensure the quality of the provided dynamic data and models for use in numerous system studies and consistency across planning and operations software platforms. Therefore, the Facility owner shall also assess sufficient sensitivities, including but not limited to Voltage Set Point at the Point of Interconnection (POI), real power output, and Reactive Power output to ensure acceptable model performance over the entire range of operating conditions. The Facility owner shall provide an explanation if model responses do not match.

(i) Facility owners shall include all site-specific dynamic models representing the Facility in the model quality tests. Facility owners can perform the tests in a simple test system without requiring ERCOT System information.

(ii) For Intermittent Renewable Resource (IRR) equipment aggregated together to form an IRR in accordance with paragraph (13) of Protocol Section 3.10.7.2, Modeling of Resources and Transmission Loads, the dynamic model shall represent the aggregated IRR.

(iii) Results for the following model quality tests shall be provided to demonstrate acceptable model performance. Additional details about each test, including the set up and description of desirable response, are included in the Dynamics Working Group Procedure Manual.

(A) Flat start test: A no-disturbance test shall be performed to demonstrate appropriate model initialization and the Facility’s dynamic response under a no-disturbance condition.

(B) Small voltage disturbance test: A voltage step increase and decrease shall be applied to the POI to demonstrate the Facility’s dynamic response.

(C) Large voltage disturbance test:

(1) For IRRs, ESRs, and inverter-based transmission equipment, the high and low voltage ride-through profiles as described in Nodal Operating Guide Section 2.9.1, Voltage Ride-Through Requirements for Intermittent Renewable Resources Connected to the ERCOT Transmission Grid, shall be applied to the POI to demonstrate the Facility’s dynamic response.

(2) For Resources other than IRRs, ESRs, and inverter-based equipment, a fault shall be applied to the POI to demonstrate the Facility’s dynamic response.

(D) Small frequency disturbance test: A frequency step increase and decrease shall be applied to the POI to demonstrate the Facility’s dynamic response.

(E) System strength test: The model for IRRs and inverter-based Resources shall be tested under a few equivalent short circuit ratios, as described in the Dynamics Working Group Procedure Manual. This tests the robustness of the model to varying system conditions.

(d) Inverter-Based Resources (IBRs) shall provide results of the unit model validation to demonstrate that the PSCAD model, as described in the Dynamics Working Group Procedure Manual, accurately represents the dynamic responses of all inverter-based dynamic devices within the Facility. This validation is not intended to be site-specific; rather it is intended to be a hardware type test, where models representing different inverter hardware are benchmarked for accuracy. Validation results for a specific model of inverter can be submitted for multiple uses of that model of inverter.

(i) The validation results shall be included when submitting a PSCAD model to ERCOT.

(ii) Results for the following unit model validation tests shall be provided to demonstrate model accuracy. Additional details about each test are included in the Dynamics Working Group Procedure Manual.

 (A) Step change in voltage;

 (B) Large voltage disturbance (voltage ride-through tests);

 (C) System strength test;

 (D) Phase angle jump test; and

 (E) Subsynchronous test.

(6) Dynamics data for a planned Facility will be updated by the Facility owner upon completion of the design for the Facility.

(7) Updated dynamics data for an existing Facility shall be provided to ERCOT when field tests, inspections, or other information demonstrates that the dynamics data should be changed to accurately represent the dynamic characteristics of the Facility.

(8) Dynamics Data is considered Protected Information pursuant to Protocol Section 1.3, Confidentiality.

(9) Dynamics data shall be provided with the legal authority to provide the information to all TSPs. If any of the information is considered Protected Information, the Facility owner shall indicate as such.