

Order Nos. 2023/2023-A – Improvements to Generator Interconnection Procedures and Agreements



*Conforming Changes to ISO Planning Procedures and
Model Acceptance Tests for Inverter-Based Resources*

Alex Rost

DIRECTOR, INTERCONNECTION SERVICES AND RESOURCE QUALIFICATION



Order Nos. 2023/2023-A - Conforming Changes to ISO Planning Procedures

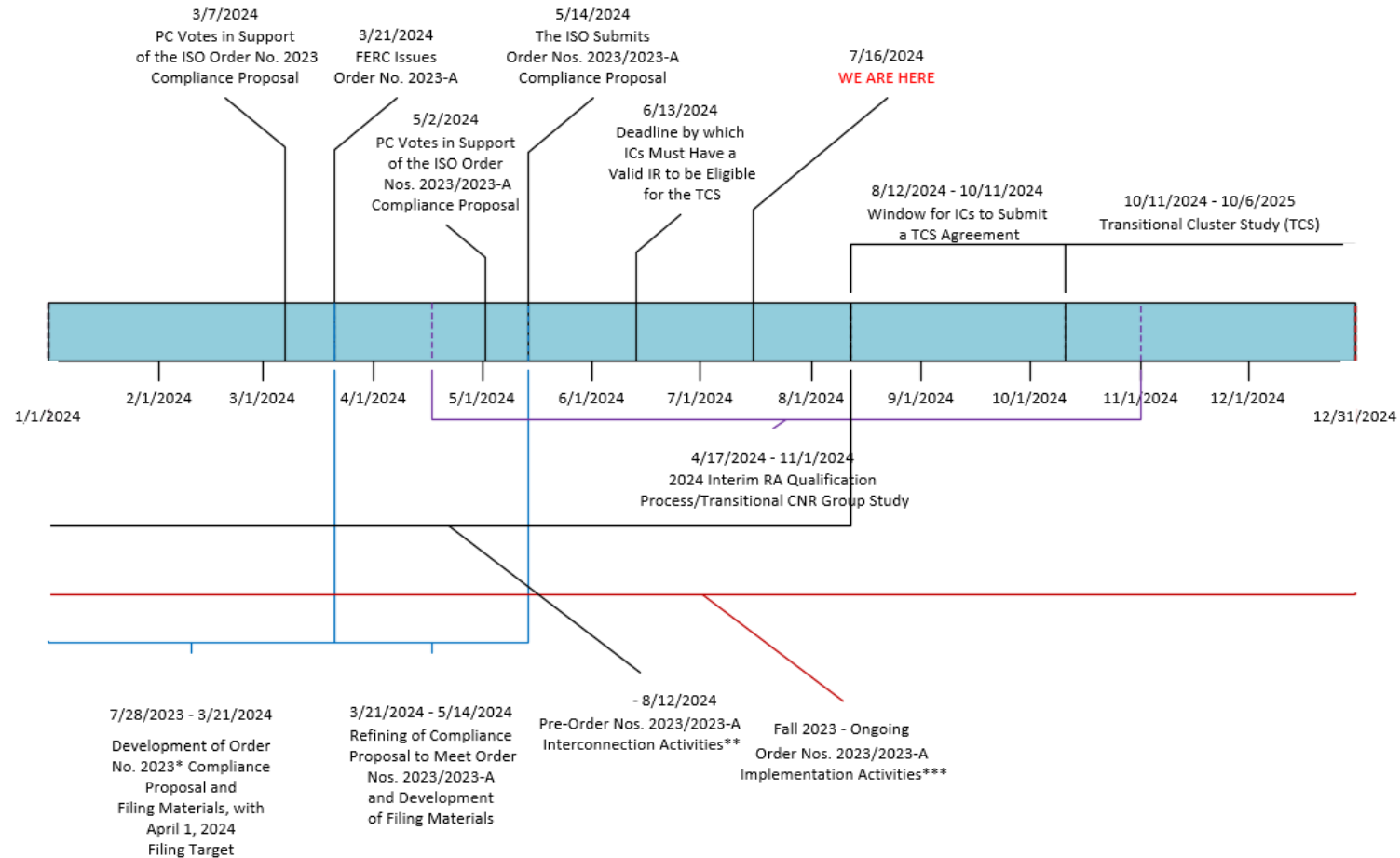
Proposed Effective Date: September 2024 (for PP5-6)

- The ISO identified the need for several conforming changes to Planning Procedure 5-6: Interconnection Planning Procedure for Generation and Elective Transmission Upgrades (PP5-6) and Planning Procedure 10: Planning Procedure to Support the Forward Capacity Market (PP10), as a result of Order Nos. 2023/2023-A
 - Order Nos. 2023/2023-A result in significant reforms to the interconnection process to move to a “first ready, first served” Cluster Study construct with clustered Interconnection Requests equally queued
- The ISO also discussed the need for enhanced model acceptance tests for inverter-based resources
- This is the third RC meeting where the ISO will discuss the proposed PP5-6 modifications
 - This presentation discusses updates to the Order Nos. 2023/2023-A related PP5-6 revisions presented at the [June 18, 2024 meeting](#) made in response to submitted stakeholder comments
 - A separate presentation addresses proposed PP5-6 updates on Affected System Operator (ASO) study coordination
 - Background on the rationale for the PP5-6 revisions was first discussed at the [March 19, 2024 meeting](#)

ILLUSTRATION OF RECENT AND UPCOMING ORDER NOS. 2023/2023-A ACTIVITIES AND MILESTONES



Summary of Recent and Upcoming Order Nos. 2023/2023-A Activities and Milestones



* FERC Issued Order 2023 on July 28, 2023.

**August 30 is the deadline for Interconnection Customers with late stage System Impact Studies (SISs) to accept the SIS results. The ISO will stop work related to late stage SISs after this deadline.

*** The ISO expects Order Nos. 2023/2023-A interconnection process improvements to occur over the years beyond 2025.

OVERVIEW OF PP5-6 CHANGES



Approach to PP5-6 Changes

- The currently effective PP5-6 outlines requirements that broadly apply to different types of Interconnection Studies
 - For example, it does not contain a section dedicated to Feasibility Studies or System Impact Studies
- This first set of proposed Order Nos. 2023/2023-A related changes maintains this current PP5-6 approach of outlining Interconnection Study requirements, while:
 - Incorporating Capacity Network Interconnection Standard (CNIS) concepts from PP10 (Planning Procedure to Support the Forward Capacity Market)
 - Ensuring the described requirements are compatible with the Cluster Study approach



Approach to PP5-6 Changes (cont'd)

- The proposed set of Order Nos. 2023/2023-A related changes also includes the following additions:
 - A section dedicated to Cluster Study concepts and requirements (Section 10)
 - A section and appendix dedicated to ASO study coordination concepts (Section 11 and Appendix I, detailed in a separate presentation)
 - An appendix on model acceptance testing requirements for inverter-based resources
 - An appendix on cost allocation calculation examples (Appendix G)
 - An appendix on project acreage requirements (Appendix H)



Approach to PP5-6 Revisions (cont'd)

- Approach for proposed PP5-6 changes for each previously listed item:
 - **Section Modifications:** Modify the description of studies performed to meet the Network Capability Interconnection Standard (NCIS) in a Cluster Study for projects with equal queue positions
 - **Section Modifications:** Add a description of studies performed to meet the Capacity Capability Interconnection Standard (CCIS) in a Cluster Study for projects with equal queue positions
 - **New Section/New Appendix:** Include implementation details on cost allocation for upgrades identified through a Cluster Study
 - **Section Modifications:** Update charging related study assumptions for battery energy storage facilities
 - **New Section:** Provide details on the evaluation of alternative transmission technologies when identifying upgrades in a Cluster Study
 - **Section Deletion:** Remove material related to the Preliminary Nonbinding Overlapping Impacts (PNOI) Studies
 - **Appendix Modification:** Align Material Modification determination procedures with the Cluster Study process
 - **Appendix Modification/New Appendix:** Provide additional guidance on model acceptance testing
 - **New Section/New Appendix:** Address coordination between Cluster Studies and ASO studies, (detailed in a separate presentation)
 - **New Appendix:** Address acreage requirements for Interconnection Requests, as required by the Order



Applicability of Proposed PP5-6 Changes

- The proposed PP5-6 changes apply to both Cluster Studies and the Transitional Cluster Study

1.2 Interconnection Studies

~~An~~ The definition and scopes of Interconnection ~~Study is an Interconnection Feasibility Study, an Interconnection System Impact Study, an Optional Interconnection Study or a re-study thereof. The scopes of these s~~Studies are described in the LGIP, SGIP and ETU IP of the Tariff. ~~An Interconnection System Impact~~ A Cluster Study⁹, or a ~~re-study thereof~~ Cluster Restudy, shall meet all of the requirements of this procedure. ~~When the alternative Interconnection Feasibility study scope is elected, the analysis may consist of a limited subset of the analyses in this procedure, focusing on the issues that are expected to be most significant for the proposed Generating Facility or ETU.~~

⁹ Also applicable to the Transitional Cluster Study.

MODEL ACCEPTANCE TESTS FOR INVERTER-BASED RESOURCES



Revised Model Acceptance Tests for Inverter-Based Resources

- The primary objectives of the revised model acceptance tests for inverter-based resources are to evaluate:
 - a) PSSE and PSCAD model dynamic performance for defined test conditions
 - b) Consistency and accuracy of PSSE and PSCAD model performance through benchmarking
 - c) Readiness of PSSE and PSCAD models for use in large network studies
- The revised model acceptance tests involve a series of tests run on a single-machine infinite bus (SMIB) test case, resulting in a set up that:
 - Is more flexible for testing varying system strength conditions
 - Focuses on model performance by eliminating the influence of larger network dynamics
 - Is computationally less intensive and can be mostly automated



Revised Model Acceptance Tests for Inverter-Based Resources (cont'd)

- The evaluation will include the following distinct tests (bounded by weak grid and strong grid conditions, where applicable):

Test No	Test Name
1	Flat Run
2	Steady-state Reactive Power Limit
3	Dynamic Reactive Power Limit
4	Voltage Reference Step Change
5	Active Power Reference Step Change
6	Grid Frequency Magnitude Change
7	Balanced Fault Ride-Through with Reclosing
8	Balanced Remote Fault Ride-Through
9	Unbalanced Fault Ride-Through
10	Voltage Protection Verification
11	NERC PRC-024 Voltage Ride-Through
12	Frequency Ride-Through
13	Rate of Change of Frequency (ROCOF) Ride-Through
14	Grid Voltage Phase Angle Change Ride-Through
15	Point of Interconnection SCR Change Ride-Through

Revised Model Acceptance Tests for Inverter-Based Resources (cont'd)

- The required model acceptance test documentation include the following major sections:
 - Scope of Model Acceptance Tests
 - Test System
 - PSSE and PSCAD Simulation Setup
 - Model Acceptance Tests
 - Benchmarking Report
- Each model acceptance test provides information on the following items:
 - The test objective and procedure
 - Dynamic performance acceptance criteria
 - Benchmarking acceptance criteria

Feedback on Revised Model Acceptance Tests for Inverter-Based Resources

- The ISO did not receive stakeholder feedback on the proposed PP5-6 changes related to revised model acceptance tests for inverter-based resources
- The ISO identified one update to the proposed new Appendix C-2
 - The next slide describes this update
- The ISO received some questions on how the revised model acceptance test requirements contained in the proposed new Appendix C-2 will be administered for projects seeking to participate in the Transitional Cluster Study (TCS)
 - Upcoming slides discuss this topic

Appendix C-2 Update

- In Table 19 of Section 4.13 (Test 13 – Rate of Change of Frequency (ROCOF) Ride-Through), updated the “Active Power at POI (MW) parameter”

Table 19 Rate of Change of Frequency Ride-Through Test

Test No	Minimum Simulation Time (s)	SCR and X/R	Active Power at POI (MW)	Initial Reactive Power at POI (MVAR)	Simulation Tool	Acceptance Criteria
13a	30	SCR=3, X/R=10	0.5 * Pnet	~0	PSCAD	Dynamic Performance The plant successfully rides through with a stable and damped response.
13b	30	SCR=10, X/R=10	0.5 * Pnet	~0	PSCAD	Benchmark Performance Not applicable.

Application of Revised Model Acceptance Test Requirements for the TCS

- Projects that submitted all technical data before August 12, 2024, and that do not make changes to the previously submitted technical data, do not need to submit technical data with their TCS agreement
 - Projects subject to the currently effective (*i.e.*, pre-Order Nos. 2023/2023-A) Schedules 22 and 25 provide their technical data with their System Impact Study Agreements
 - Projects subject to the currently effective (*i.e.*, pre-Order Nos. 2023/2023-A) Schedule 23 provide their technical data with their Interconnection Request
 - The ISO will perform model acceptance tests consistent with the proposed updated PP5-6 for these models and any identified deficiencies will need to be addressed in order for a project to proceed in the TCS
- All other projects will need to submit technical data with their TCS agreement

Application of Revised Model Acceptance Test Requirements for the TCS (cont'd)

- Technical data submittals pursuant to Schedules 22, 23 and 25 of the Tariff need to meet the requirements of the version of PP5-6 in effect at the time of submission
 - The expected effective date of the updated PP5-6 containing the revised model acceptance test requirements is soon after the September 5, 2024 Participants Committee meeting (*i.e.*, sometime the week of September 9, 2024)
 - **Note that model attestation requirements are contained in the currently effective version of PP5-6**
- When a project requires the submission of technical data with its TCS Agreement, the submission date of the TCS Agreement determines the version of PP5-6 that the required technical data needs to meet
 - For example, the revised model acceptance test requirements do not apply for a project that submits a TCS Agreement and technical data before the updated PP5-6 becomes effective
 - A project that submits a TCS Agreement and technical data after the updated PP5-6 becomes effective would need to meet the revised model acceptance test requirements

Application of Revised Model Acceptance Test Requirements for the TCS (cont'd)

- The ISO will perform model acceptance testing for project technical data submittals that are not required to meet the revised model acceptance test requirements, and will notify Interconnection Customers of any identified deficiencies
 - All projects entering the TCS are encouraged to provide the revised model acceptance tests (or evaluate their models according to these revised requirements) to reduce the likelihood of needing to address deficiencies identified by the ISO through its own model acceptance tests



Application of Revised Model Acceptance Test Requirements for the TCS (cont'd)

- Technical data submittal deficiencies identified by the ISO during the August 12, 2024 – October 11, 2024 TCS Agreement submission window need to be cured by the October 11, 2024 deadline
 - Such deficiencies most likely will be identified without detailed model testing, such as missing information, missing model acceptance testing documentation (if applicable), and inadequate equipment-level EMT model attestations for each component of the plant (inverter, separate OEM provided plant controller and any applicable auxiliary devices) and plant-level EMT model attestations
 - There is no opportunity to cure such deficiencies after the October 11, 2024 deadline
- Technical data submittal deficiencies identified by the ISO after the October 11, 2024 deadline will trigger the withdrawal provisions of Section 3.7 of the Order Nos. 2023 compliant Schedules 22, 23 and 25
 - These provisions include a 15-Business Day period to respond with information or actions that cure the deficiency, pursuant to Section 3.7 of the Order Nos. 2023/2023-A compliant Schedules 22, 23 and 25

Importance of Accurate and Validated Models for Interconnection Studies, Including the TCS

- The ISO must have accurate and validated project models in order to perform accurate Interconnection Studies
 - Interconnection Studies must be able to assess and model all facilities' ability to respond appropriately to transmission system disturbances
 - This helps prevent potential reliability concerns if non-synchronous generating facilities do not perform as modeled during the interconnection process when in service
- Projects with accurate and validated project models benefit when all other projects in a Cluster Study also have accurate and validated project models
 - Accurate and validated models are necessary to minimize study delays and to ensure that the ISO conducts Interconnection Studies that identify the appropriate and necessary interconnection facilities and network upgrades to accommodate all applicable Interconnection Requests (and properly allocated costs for network upgrades)
 - Data issues (*e.g.*, poorly parametrized, inaccurate or non-fully validated models) are commonly a major source of study delays (*e.g.*, study work stoppages in order to address modeling deficiencies, the need to re-perform study work done with inaccurate models, etc.), which creates uncertainty in the timing and cost of interconnecting to the transmission system and hinders the timely development of new generation

Importance of Accurate and Validated Models for Interconnection Studies, Including the TCS (cont'd)

- Concern: Accurate models for inverter-based facilities may not be available early in the Interconnection Study process and may need to be updated during that process
- Supporting FERC response in Order No. 2023, excerpt for 1669: *“We find that the reforms we adopt herein are consistent with the principles behind other requirements in the pro forma LGIP and pro forma SGIP, namely those that set forth requirements for an interconnection request, including requirements that requests be viable and well defined. The requirement to submit accurate models also reduces the chance that a transmission provider would need to perform additional studies, in this case if an interconnection customer submits models that are inaccurate and those inaccuracies are not discovered until late in the interconnection process. In that instance, i.e., if model validation occurs at a point further into the interconnection process, inaccurate models that are used in interconnection studies could create errors in the studies, potentially leading to restudies and subsequent delays which would frustrate the efficiency gained by moving to a first-ready, first-served cluster study process.”*

Importance of Accurate and Validated Models for Interconnection Studies, Including the TCS (cont'd)

- Concern: The value obtained from models that must meet the modeling requirements is low because of the likelihood that the study will be outdated as project components are substituted with more advanced technology
- Supporting response in FERC Order No. 2023, excerpt for 1668: *“We recognize that the project components for non-synchronous generating facilities may change during the interconnection process. We find, however, that this does not diminish the value of a transmission provider receiving the identified information from interconnection customers requesting to interconnect a non-synchronous generating facility and receiving models that represent the best information interconnection customers have available about their proposed generating facilities because these models will ensure that the transmission provider can accurately model the impact of the proposed generating facility throughout the interconnection process.”*

Importance of Accurate and Validated Models for Interconnection Studies, Including the TCS (cont'd)

- The industry continues to enhance requirements that promote accurate and validated models for use in Interconnection Studies:
 - On [June 4, 2024, NERC issued an industry recommendation on inverter-based resource model quality deficiencies](#):
 - The recommendation stated *“Several of NERC’s published disturbance reports included analyses of the models for the affected facilities, which revealed systemic dynamic model inaccuracies. These analyses also revealed that the models provided for conducting generator interconnection studies or other system studies failed to accurately reflect the dynamic performance of the plants.”*



Importance of Accurate and Validated Models for Interconnection Studies, Including the TCS (cont'd)

- The industry continues to enhance requirements that promote accurate and validated models for use in Interconnection Studies (cont'd):
 - On [June 4, 2024, NERC issued an industry recommendation on inverter-based resource model quality deficiencies](#) (cont'd):
 - Recommendation 1 states *“All models should be detailed and accurate representations of expected or as-built facilities across all expected operational conditions. Changes to any model parameters, including plant controller parameters that change the performance of the IBR plant, should be studied to ensure BPS reliability before implementation.*
 - a. Models should be validated at the individual inverter level and plant level to ensure that the performance of the plant model matches the expected performance of the in-service IBR plant.*
 - b. Models should be updated throughout the lifecycle of the plant to capture any proposed changes that could alter a plant’s performance (e.g., hardware, firmware, control settings, or any qualified changes). Proof of model accuracy should be documented and retained by the GO and supplied to all affected stakeholders any time a model update is performed. Updated models should be used to perform studies to confirm whether or not the proposed changes affect BPS reliability prior to implementation of those proposed changes at the in-service plant.*
 - c. Preferably, models should be verified by the equipment manufacturer to be accurately and appropriately parameterized to represent site- and equipment-specific capabilities, site-specific controls, settings, and protections with supporting documentation and attestations. They should also be validated against actual product performance according to NERC Reliability Standards and local TP and PC requirements.”*

UPDATES TO PROPOSED PP5-6 CHANGES



Updates to the Proposed PP5-6 Changes

- The following slides review updates to the proposed PP5-6 changes in response to stakeholder feedback to date



Additional Clarity on Retirement Date

- In Section 2.2 (System Configuration), added language to footnote 14 to provide more clarity on retirement dates

¹⁴ The retirement date of the Asset associated with a Generating Capacity Resource or Import Capacity Resource. The retirement date may be the first day of the Capacity Commitment Period associated with a cleared Retirement Delist Bid related to the facility (or a Permanent Delist Bid for CCIS), or the date the facility actually retires if it meets all requirements to retire early pursuant to Section III.13.2.5.2.5.3(a)(ii) of the Tariff, or the date that a facility is deemed retired due to not operating commercially for a period of three calendar years pursuant to Section III.13.2.5.2.5.3(d) of the Tariff.

Consistency of Terminology

- In Sections 3.5.1 (NCIS Steady-State Load Levels), 4.3 (Stability Analysis Scenarios) and 4.4 (Stability Load Levels), changed instances of “full capacity” to “full capability” for consistent use of terminology in these sections

Analysis shall be performed at Intermediate Load with the Generating Facility or ETU operating at full capability in the cases where conditions such as the preservation of transfer capability are a concern:

- Two scenarios may be analyzed:
 - A shoulder load scenario characterized by intermediate load, no solar, and energy storage available for charging, while wind and conventional resources are available up to their full capacity capability.
 - A shoulder load scenario characterized by intermediate load, no solar, and energy storage available for discharging, while wind and conventional resources are available up to their full capacity capability.

Projects Requesting Regional Network Service (RNS) and Cost Allocation Calculations

- In Sections 10.4.2 (Cost Allocation Calculation Details for System Network Upgrades) and 10.4.4 (Impact Calculations to Address Thermal Violations), included language to make clear that projects requesting RNS are included in cost allocation calculations
 - May need to use equivalent models for projects requesting RNS when calculating DFAXs for use in thermal cost allocation calculations



Projects Requesting Regional Network Service (RNS) and Cost Allocation Calculations (cont'd)

- Step 3: Calculate the cost allocation for each project. This calculation is:

$$\text{project cost allocation} = \text{project impact proportionality} \times \text{cost of System Network Upgrades}$$

Projects requesting Regional Network Service (RNS) are included in cost allocation calculations.

- DFAX = the DFAX associated with the highest violation seen on an element resulting from the project (either for meeting the NCIS or CCIS) under post-contingency/pre-upgrade conditions:
 - For meeting the NCIS, the DFAX is calculated by transferring from the project under study to New England load.
 - For meeting the CCIS, the DFAX is calculated by transferring from the project under study to the Load Zone where the project is seeking to interconnect.
 - An equivalent model that allows for the calculation of a DFAX may be used for projects requesting Regional Network Service.



MW Ratings Used In Cost Allocation Calculations

- In Sections 10.4.4 (Impact Calculations to Address Thermal Violations), 10.4.6 (Impact Calculations to Address Stability Violations), and 10.4.7 (Impact Calculations to Address Violations Identified Through an Analysis that is not a Short Circuit, Steady-State Thermal, Steady-State Voltage and Stability Analysis), revised language to specify that the most appropriate rating is used for cost allocation calculations
 - The ratings used to identify applicable violations requiring System Network Upgrades should be used in cost allocation calculations



MW Ratings Used In Cost Allocation Calculations (cont'd)

10.4.4 Impact Calculations to Address Thermal Violations

The impact calculation for a project on an element for a thermal violation is:

$$\text{project impact} = \text{project MW} \times \text{DFAX}$$

where:

- project MW = requested applicable summer or winter NRC/NIS or CNRC/CNIC for a Generating Facility, or equivalent capability for an ETU, and



Updated Acreage Requirements

- In Appendix H (Acreage Requirements):
 - Revised the photovoltaic (PV) minimum expected acreage requirement to 4 Acres/MW
 - Revised the electrical energy storage minimum expected acreage requirement to 1 Acres/100 MWh
 - Added a footnote stating that all MW or MWh values shown in Table H.1 (minimum expected acreage requirements) are in AC at the Point of Interconnection, and reflect the maximum nameplate rating of the facility
- Adjustments to PV and electrical energy storage minimum expected acreage requirements supported by stakeholder feedback and values used in other areas
- The acreage requirements described in Appendix H provide for flexibility since projects with acreage requirements below those listed in Table H.1 can submit additional documentation supporting their stated acreage requirements for review by the ISO

Updated Acreage Requirements (cont'd)

Acreage Requirement

Table H.1 – Minimum Expected Acreage Requirements⁶⁶

<u>Photovoltaic (PV)</u>	<u>Electrical Energy Storage</u>	<u>Onshore Wind</u>	<u>Offshore Wind</u>	<u>Conventional</u>
<u>5.4 Acres/MW</u>	<u>0.1 1 Acres/100 MWh</u>	<u>15 Acres/MW</u>	<u>35 Acres/MW</u>	<u>Attestation</u>

⁶⁶ All MW or MWh values shown in table H.1 are AC at the POI, and reflect the maximum nameplate rating.

Listing of Appendices C-1 and C-2 in the Table of Contents

- Listed Appendices C-1 (Electromagnetic Transient Modeling Requirements, currently effective appendix) and C-2 (Model Acceptance Tests for Inverter-Based Resources, proposed new appendix) as attachments after the table of contents, and included language and hyperlinks in the body of PP5-6 indicating that these appendices are attachments to PP5-6
 - Appendices C-1 and C-2 will be posted separately from the main body of PP5-6

Listing of Appendices C-1 and C-2 in the Table of Contents (cont'd)

Attachments

Appendix C-1 Electromagnetic Transient Modeling Requirements

Appendix C-2 Model Acceptance Tests for Inverter-Based Resources

event response, and islanding performance (for example) would require a model which must meet the requirements stated in **Appendix C-1 attached to this planning procedure**, and unless specified otherwise, this type of model is what is required.

against the PSSE model using the same set of tests. The specific details of the tests, expected outcomes and benchmarking report are outlined in **Appendix C-2 attached to this planning procedure**.

UPDATES TO OTHER DOCUMENTS



Updates to Other Documents

- PP10 will require updates to remove language associated with milestones and studies needed to achieve a capacity interconnection
 - This language needs to remain in PP10 until the 2024 interim reconfiguration auction qualification process is completed (*i.e.*, November 1, 2024)
- Other documents will require revisions to remove references to FSs, SISs, and overlapping interconnection impacts analyses (revisions will be separately brought to stakeholders, starting in Q4, 2024):
 - Transmission Planning Technical Guide
 - PP5-5 (Requirements and Guidelines for Application on Remedial Action Schemes and Automatic Control Schemes)

CONCLUSION



Conclusion

- Modifications to PP5-6 are required to support an Order Nos. 2023/2023-A compliant interconnection process
 - Modifications to PP5-6 are also required to provide additional guidance on model acceptance testing and document coordination of ASO studies with ISO performed Cluster Studies
- The ISO is targeting a September 2024 effective date for the proposed PP5-6 changes
 - The expected effective date will be soon after the September 5, 2024 Participants Committee (*i.e.*, sometime the week of September 9, 2024)
- The ISO will bring other Planning Procedures and documents through the stakeholder process, starting in Q4 2024



Next Steps

- Feedback can be sent to irtt@iso-ne.com; with “PP5-6 Feedback” included in the subject line



Stakeholder Schedule

Stakeholder Committee and Date	Scheduled Project Milestone
Reliability Committee March 19, 2024	Initial Presentation
Reliability Committee June 18th, 2024	Present PP5-6 Redlines
Reliability Committee July 16, 2024	Review PP5-6 Redlines
Reliability Committee July 25, 2024	Additional meeting to continue discussion on PP5-6 redlines from the July 16, 2024 RC and introduce any related amendments. Please contact the RC Secretary (dpatnaude@iso-ne.com) by no later than July 18 to request time to present on the agenda
Reliability Committee August 13-14, 2024	Review PP5-6 Redlines and Stakeholder Amendments; Vote
Participants Committee September 5, 2024	Vote

*The schedule applies to PP5-6 changes; other document revisions will be presented to the RC starting in Q4 2024

Questions

