



The ERCOT Generation Interconnection Study Process

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ESIG/NAGF/NERC/EPRI Joint Generation Interconnection Workshop

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Agenda



- FERC’s Generation Interconnection NOPR – “Modeling and Performance Requirements for Non-Synchronous Generating Facilities”
- ERCOT Large Generator Typical Timeline
- Interconnection Studies
- Quarterly Stability Assessment (QSA)
- Study Process Improvements post-QSA Implementation
- Moving Forward

FERC's Generation Interconnection NOPR



A bit of context...

- In paragraphs 303 through 341 of the NOPR titled “Modeling and Performance Requirements for Non-Synchronous Generating Facilities”^[1], FERC proposes requiring interconnection customers requesting to interconnect non-synchronous generators to:
 - Provide accurate and validated user-defined models, generic WECC-approved models, and EMT models
 - Continue current injection inside the “no trip zone” of the VRT and FRT curves defined by NERC during and following a disturbance
- ERCOT has implemented several requirements to enforce generator model fidelity when compared to what can be and/or is installed in the field as grounds for interconnecting to its grid
- ERCOT requires resources following a disturbance to not “cease providing real or reactive power except to the extent needed to provide frequency support or aid in voltage recovery”^[2]. Potential improvements to ERCOT’s requirements are under discussion in ERCOT’s Inverter-Based Resources Task Force (IBRTF)^[3]

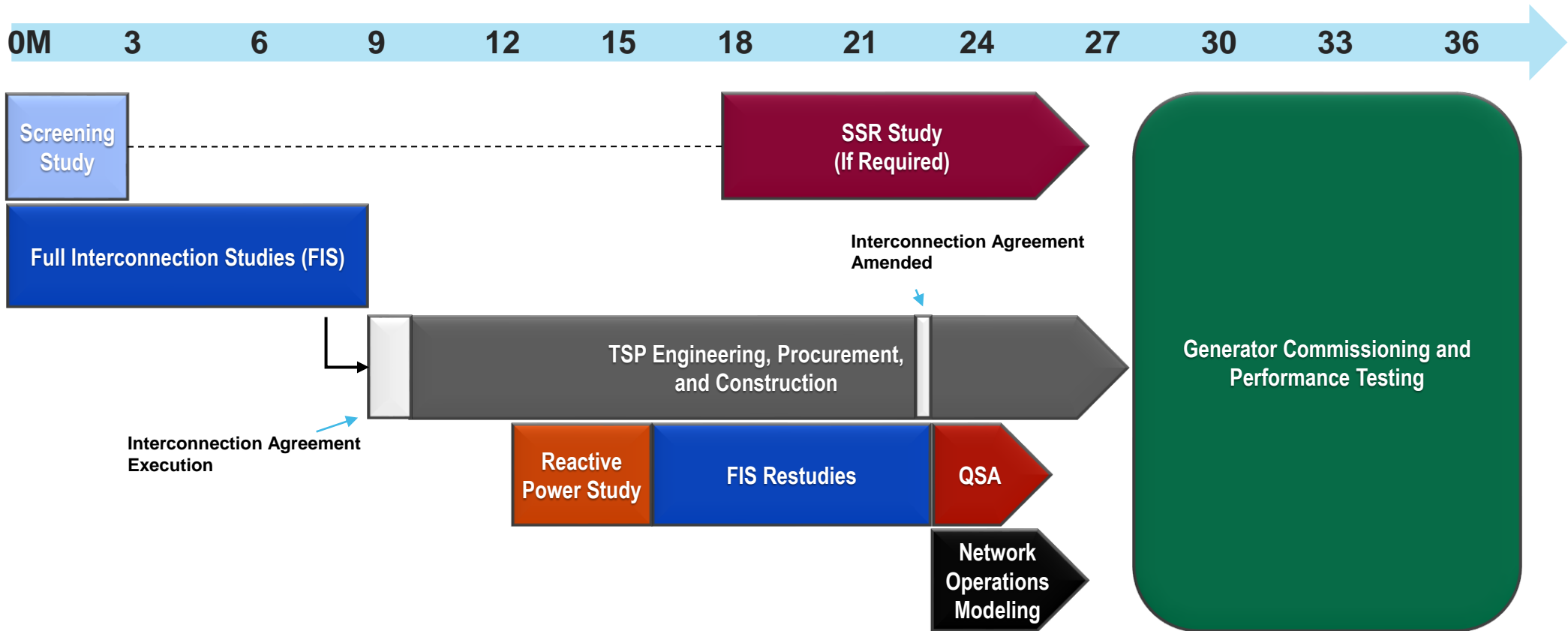
[1] <https://www.ferc.gov/news-events/news/ferc-proposes-interconnection-reforms-address-queue-backlogs>

[2] <https://www.ercot.com/mktrules/issues/NOGRR204>

[3] <https://www.ercot.com/committees/ros/ibrft>

ERCOT Large Generator Typical Timeline

Simultaneous FIS Request + One Inverter Change



Screening Study

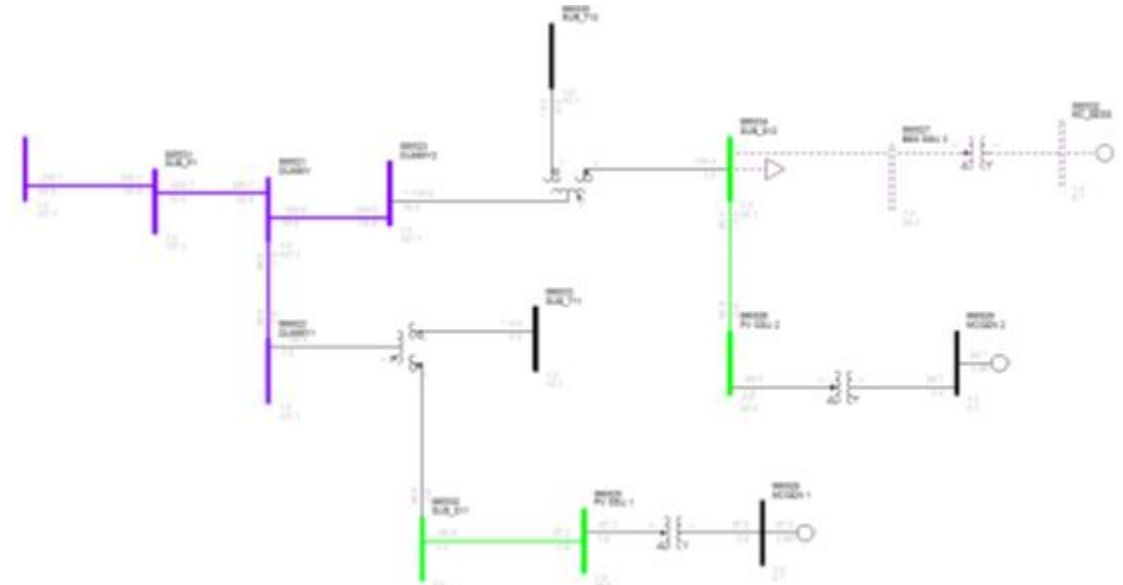


- High-level First Contingency Incremental Transfer Capacity (FCITC) analysis based on the selected Point of Interconnection and Commercial Operations Date
- No generator-specific model is necessary at this stage
- ERCOT performs at a minimum a topology screening of the POI to determine if an SSR study will be required
- Limited value to Interconnection Entities (IEs) beyond the SSR determination

Full Interconnection Studies



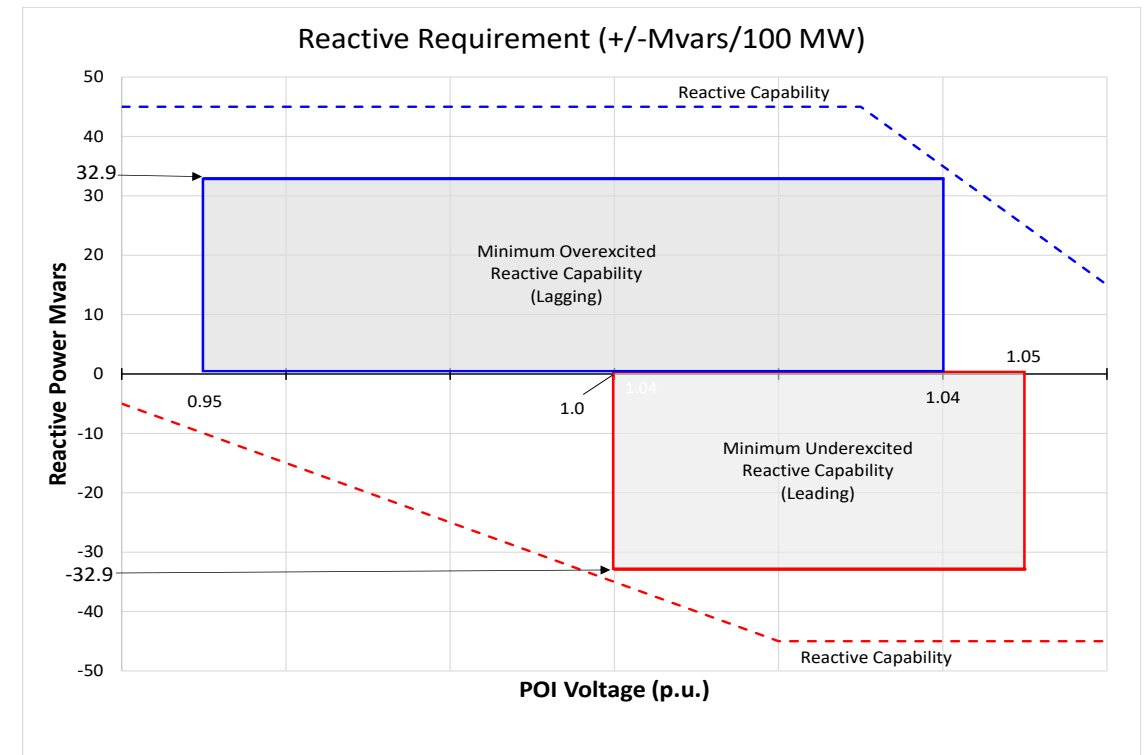
- The FIS consists of a Steady State, Short Circuit, Stability, and Facility Study performed by the TSP and approved by ERCOT
- An FIS application requires more details such as both a detailed and equivalent plant model with valid collector system connectivity to be approved
- Stability additionally requires a plant-level positive sequence dynamic model package including a **Model Quality Test**
- The Facility Study describes the EPC scope of the TSP to interconnect the generator



Reactive Power Study



- Interconnecting generators are required to demonstrate their plant design can meet the Voltage Support Service requirements at a minimum temperature of 35 C
- Dynamic Reactive Capability is assessed to determine if the plant design is deficient (before losses)
- Reactive capability at the POI can include shunt devices to make up for losses up to the POI
- Sites with co-located resources are required to be assessed as standalones, as well as with all resources are online to account for additional losses at high plant output



Source: ERCOT Reactive Study Scope (April 2020)

Subsynchronous Resonance Study



- If ERCOT determines the POI requires an SSR study, the TSP will perform the study and submit the completed study for ERCOT approval
- All inverter-based resources in ERCOT are required to provide a plant PSCAD model package, regardless of whether an SSR study is required. This package includes a plant Model Quality Test and **Unit Model Validation** report on a hardware-specific basis -- one for each unique inverter/turbine model
- SSR studies typically require the generator owner to facilitate tight coordination between the OEMs supplying the models and the TSP performing the study
- Where applicable, an ERCOT-approved SSR study is required before a resource is permitted to synchronize with the ERCOT grid during commissioning.

Quarterly Stability Assessment

Overview



- The QSA is a cluster study ERCOT performs to assess stability concerns in the Operations Planning time horizon.
- This is often the first time generators likely to interconnect in a similar timeframe are studied together
- Stability studies containing unstable scenarios for generators qualifying for the QSA, as well as known areas of system instability help define the study areas in the QSA
- ERCOT's implementation of Generic Transmission Constraints (GTCs) in recent years are a result of the analysis performed in the QSA in conjunction with a subsequent GTC assessment, and further analysis in the operational time horizon
- ERCOT published a whitepaper in July 2020 to describe the methodology behind GTCs in greater detail: https://www.ercot.com/files/docs/2020/11/27/The_Use_of_GTCs_in_ERCOT_July_2020.pdf

Quarterly Stability Assessment

Deadlines and Earliest Available Synchronization



Generator Initial Synchronization Date	Last Day for an IE to meet prerequisites as listed in paragraph (4) below	Completion of Quarterly Stability Assessment
Upcoming January, February, March	Prior August 1	End of October
Upcoming April, May, June	Prior November 1	End of January
Upcoming July, August, September	Prior February 1	End of April
Upcoming October, November, December	Prior May 1	End of July

Source: ERCOT Planning Guide Section 5.3.5 (<https://www.ercot.com/mktrules/guides/planning/library>)

PGRR075 and PGRR085

Overview



PGRR075 (Effective May 1, 2020)

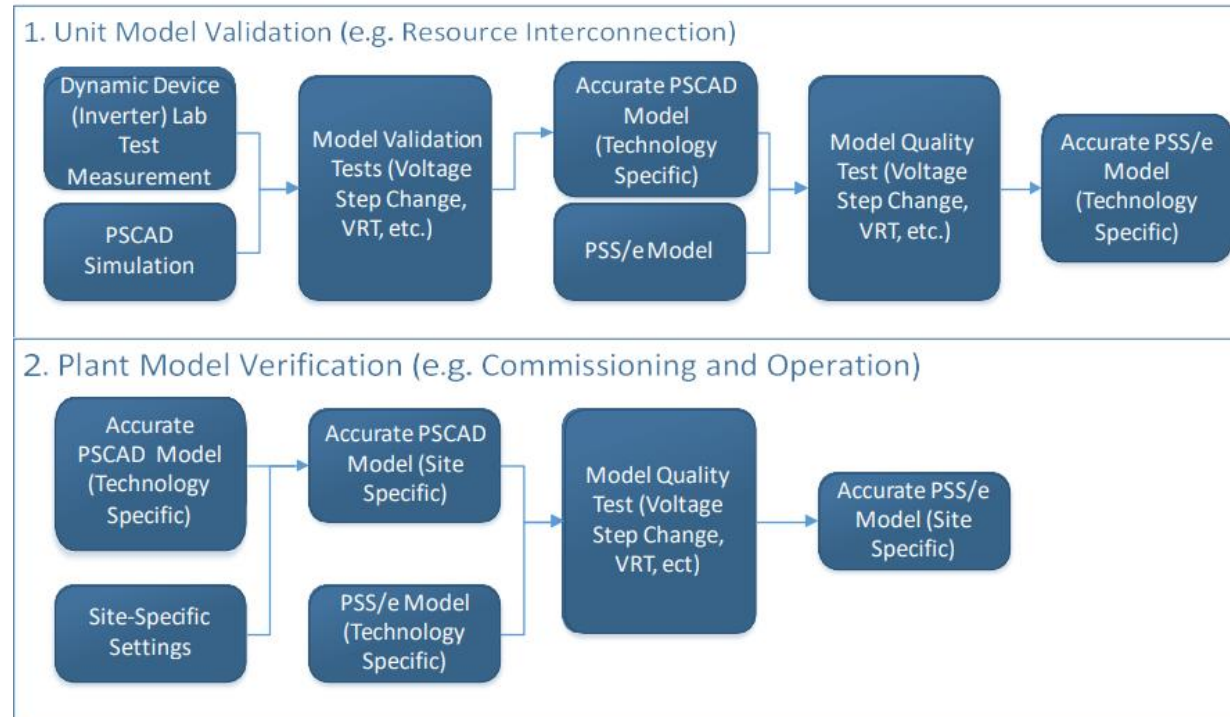
- Introduced a Model Quality Test requirement for all plant dynamic models in **PSS/E**
- Clarified requirement to use ERCOT's dynamic model template to better standardize the formatting of dynamic models
- Created a more efficient means for TSPs to run Voltage Ride Through assessments of generator-submitted dynamic models, and better communicate any issues with the models for quicker resolution

PGRR085 (Effective March 1, 2021)

- Introduced a Model Quality Test requirement for all plant **PSCAD** models, allowing ERCOT to enforce better consistency with **PSS/E**
- Introduced PSCAD Unit Model Validation (UMV) requirement for individual models to be compared against lab tests of the underlying hardware
- Created parameter verification requirements to ensure the model parameters match field settings that would be enforced shortly following commissioning

PGRR075 and PGRR085

Model Validation and Verification Concept



Source: https://www.ercot.com/files/docs/2022/03/18/7_PGRR085_IBRTF_MAR22.pdf

PGRR075 and PGRR085

Summary of Dynamic Model Requirements



Requirement	Applicable Equipment	Required Tests ⁽¹⁾	When to Update	Responsible Entity	Language
Model Quality Test for PSS/e Model	All Resources and Dynamic Transmission Elements (system strength test is only required for inverter-based devices)	Flat start, small and large voltage disturbance, small frequency disturbance, and system strength tests	A new or updated model	Equipment owner (RE, IE or TSP)	PG 6.2(5)(c)
Model Quality Test for PSCAD Model	Inverter-based Resources (IBRs) and Dynamic Transmission Elements	All above tests plus phase angle jump test	A new or updated model	Equipment owner (RE, IE or TSP)	PG 6.2(5)(c)
Unit Model Validation for PSCAD Model ⁽²⁾	Inverter-based Resources (IBRs)	Step change in voltage, large voltage disturbance, system strength, phase angle jump, and subsynchronous tests	A new PSCAD model provided after 3/1/21. (Validation tests should not need updating for model parameter updates on an existing model.)	Resource owner (RE or IE)	PG 6.2(5)(d)
Model Parameter Verification ("Verification Report")	All Resources and Dynamic Transmission Elements	Provide evidence that tunable model parameters match what is implemented in the field. Evidence can take the form of screenshots, nameplate photographs, signed manufacturer commissioning reports, etc.	<ol style="list-style-type: none"> 1. Required within 30 days of COD (i.e., Part 3 approval), 2. 12 to 24 months after COD or 12-24 months after March 1, 2021 for existing resources, 3. A minimum of every 10 years. 4. Within 30 days of a change at the plant 	Equipment owner (RE, IE or TSP)	PG 5.5, PG 6.2(5)(b)

Other Notable Study Process Improvements



Post-QSA Implementation

- PGRR067 – Clarified what generator modifications would be subject to Planning Guide Section 5, and ultimately the QSA where changes to existing models are not “in-kind” from a dynamic model perspective (<https://www.ercot.com/mktrules/issues/PGRR067>)
- NPRR926/PGRR071 – Removed what previously was a 90-day waiting period from SSR study approval to initial synchronization, and defined an ERCOT 30-day study review period for ERCOT to comment on or approve the study (<https://www.ercot.com/mktrules/issues/NPRR926>)
- PGRR081 – Introduced Self-Limiting Facility language to be effective upon system implementation. Creates more nuance in the way plants are modeled and studied when co-located with an Energy Storage Resource (<https://www.ercot.com/mktrules/issues/PGRR081>)
- RRGRR027/PGRR086 – Clarified the language introduced by PGRR075 to align the timing of the dynamic model requirements with the start of the Stability Study instead of the FIS application (<https://www.ercot.com/mktrules/issues/RRGRR027>)

Moving Forward



- Further Study Scope Improvements related to Co-located Resources
- Continued efforts to align PSS/E and PSCAD models earlier in the interconnection process
- Continued alignment between OEMs and other stakeholders on ride through requirements
- The FERC GI NOPR proposes UDMs, generic models, **and** EMT models be provided. This will require more clarity in terms of *when* in the LGIP these will each be mandatory. In ERCOT, the timing of the model requirements align very closely to when the models will be used. There is also not a requirement to supply both UDMs and generic models for the same plant
- While rule proposals and technical discussions are ongoing in the industry, Enel Green Power is utilizing lessons learned and best practices from ERCOT's process in other regions outside ERCOT



Thank You!

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