INTERCONNECTION
INNOVATION e-XCHANGE
U.S. DEPARTMENT OF ENERGY

i2X Interconnection Office Hours FAQ

Q1: Are there frameworks for demonstrating IBR plant reactive power capability in regions with POI-based requirements but no clear guidance on study methods and expected performance?

Some areas focus on performance-based requirements without prescribing demonstration methods, whereas e.g. ERCOT provides more detailed guidance, including requirements for detailed plant models and structured reactive power studies, making expectations clearer for developers. Developers usually build detailed plant models, including collector network, and simulate performance under various conditions edge points of reactive requirement (e.g., Qmax/Qmin tests at different POI voltages) to demonstrate that the plant can meet voltage and reactive requirements. Check if all the voltages at the inverters are within acceptable operating limits; if not, some reactive compensation may be needed (or add more inverters).

Q2: Why are projects passing EMT studies but failing SCR/WSCR screens?

Screening methods (SCR/WSCR) are simplified and conservative, while EMT studies have ability to capture detailed dynamic behavior. This can lead to false negatives in screening outcomes, where projects appear non-compliant but are actually technically viable. The lack of alignment between these methods creates uncertainty for developers.

Q3: What mitigation options exist if a project fails SCR-based screening?

Common mitigation approaches include installing synchronous condensers or modifying system strength locally, but these can be costly and may not always be necessary if detailed EMT analysis demonstrates acceptable performance. Failing SCR-based screening showed be followed by detailed EMT analysis and mitigations can then be proposed and tested in EMT.

Q4: What are the key engineering concerns when a PV + BESS system operates as a microgrid?

The primary concerns include safe transitions between islanded and grid-connected modes, proper synchronization and reconnection procedures, controller behavior (especially when BESS regulates frequency of the microgrid in iso-synchronous mode and then needs to switch to grid-connected mode), and ensuring robust protection schemes such as anti-islanding (how to make sure that a bigger distribution island is not formed with the microgrid back-feeding into it). Utilities must also assess voltage regulation and thermal impacts during various operating conditions.

Q5: How should BESS be considered in interconnection studies for hybrid systems (by a distribution utility)?

BESS should be evaluated based on its operating mode (e.g., no export, export-limited, grid charging), its contribution to fault current (which depends on system configuration such as DC vs. AC coupling between BESS and PV), and its potential impact on system loading and voltage. In some cases, it may need to be studied similarly to a generator, particularly when capable of exporting or dynamically interacting with the grid.

Q6: Why is industry struggling with PPC modeling and validation requirements?

Transmission providers and planning coordinators are increasingly requiring validated PSCAD models, positive-sequence UDMs, hardware-in-the-loop testing, and detailed model verification documentation for inverter-based resources. However, many PPC OEMs are not yet fully equipped to consistently deliver models and validation artifacts that meet these expectations. Model quality and accuracy vary significantly across vendors, and formal validation reports are often unavailable. In many cases, OEMs also attempt to shift the cost and responsibility for model development and maintenance onto project developers, despite industry sentiment that these capabilities should be part of the standard PPC product offering. This gap between evolving grid requirements and current OEM practices is becoming increasingly visible in interconnection and compliance processes such as ERCOT QSA activities.

Q7: Can a PSCAD model simply be converted into a PSSE or TSAT UDM?

No. While PSCAD models and positive-sequence UDMs may represent the same physical equipment, they are fundamentally different model types intended for different simulation domains and applications. Developing a PSSE or TSAT UDM from a PSCAD model typically requires significant additional engineering, simplification, tuning, and validation to ensure the model behaves appropriately in positive-sequence stability simulations. The industry continues to see misconceptions that a PSCAD model can be directly “converted” into a UDM with minimal effort, but in practice, high-quality positive-sequence model development remains a specialized and resource-intensive process.

Q8: What are the primary concerns with implementation of MOD-026-2 and related reliability requirements?

Industry stakeholders are increasingly concerned about the practical implementation challenges associated with MOD-026-2, PRC-029, and evolving TP/PC-specific modeling and validation requirements. Many existing inverter technologies and OEM practices may not be capable of meeting emerging expectations without substantial redesign, testing, or retroactive engineering effort. There is also concern that some provisions within MOD-026-2 may be difficult to implement in practice given current OEM capabilities, particularly requirements related to detailed model verification and validation. In addition, stakeholders identified potential ambiguities in the standard language itself, including sections where TP/PC-established requirements are referenced inconsistently, creating uncertainty regarding the enforceability of utility-defined modeling and validation obligations for generator owners.

Q9: How can system operators model large power electronic loads in stability studies when detailed models are not available?

When detailed vendor models are unavailable, operators typically rely on generic representations in tools like PSS/E or PSLF, such as the PERC1 model with reasonable parameterization. However, these approaches have limitations and may not capture fast dynamics or oscillatory behavior accurately. They should be supplemented with EMT studies, where possible and where needed, as well as understanding synchronous generator capabilities and limitations regarding torsional impacts, subsynchronous oscillations, and fatigue that may be inflicted by oscillatory AI training in large load data centers.

Q10: How should the impact of slower load variability (i.e., ramping up and down within seconds) on voltage control needs and reactive power sufficiency on the grid be assessed?

The present version of the PERC1 model does not allow load modulation (i.e., variability/ramping). Load modulation may need to be done outside of the dynamic model using bespoke code that can vary the load up and down pausing the simulation timestep. Another approach is to use a play-in model; however, there are limitations about around 5 Hz in phasor domain tools.

Voltage issues should ideally be resolved during large load interconnection studies by making sure the load complies with flicker and power quality requirements as well as maintain stability of the local system.

Q11: How should utilities establish interconnection and “material modification” processes for large loads, particularly on smaller or islanded power systems?

Large load interconnection requests can introduce significant reliability, operational, and resource adequacy impacts, especially for smaller or islanded systems where a single facility may represent a substantial portion of system demand. Utilities should establish formal interconnection requirements and material modification criteria that define study triggers, data/modeling obligations, commissioning requirements, operational coordination procedures, and thresholds for reassessment when load characteristics materially change. Many utilities are also evaluating cluster-based study approaches, standardized modeling requirements, and staged review processes to better manage uncertainty, cost allocation, and long-term system planning for emerging computational loads, industrial facilities, and other high-impact customers.

Q12: What reliability studies should be performed for large load interconnections?

Large load interconnections should be evaluated through a combination of steady-state, dynamic, short-circuit, and possibly electromagnetic transient (EMT) studies to assess both local and broader system impacts. Utilities generally include power flow and contingency analysis to evaluate thermal loading, voltage performance, and transfer capability, as well as phasor domain stability studies to understand broader system voltage and transient stability impacts under a range of operating conditions. Short-circuit studies may be needed when co-located generation is introduced or other unique factors exist. Additionally, assessments may include protection coordination studies and power quality assessments (e.g., flicker, harmonics, rapid voltage change), as well as variability and ramping impacts. EMT studies may explore weak grid conditions, inverter-based resource interactions, fast-changing load behavior, or other controls interactions that can create reliability risks.

Study scope should reflect the size, characteristics, and operational behavior of the proposed large load including ramp rates, variability, flexibility, co-located generation or storage, and potential highly dynamic or oscillatory behavior. Utilities should establish clear triggers for when updated studies are required due to material changes in load magnitude, operating characteristics, equipment configuration, or local system conditions. For systems with limited generation diversity, isolated operation, or constrained transmission infrastructure, additional resource adequacy, restoration, and operational coordination studies may also be necessary to ensure reliable system operation under both normal and contingency conditions.

Q13: How should reactive power requirements be applied to large loads that include both load and on-site generation?

For facilities that combine large loads with co-located generation or storage, reactive power requirements should be clearly defined at the point of interconnection and allocated appropriately among the participating resources. Ambiguity can arise when generation and load components are studied separately or when facilities are modified through repowering or expansion. Utilities should establish transparent requirements regarding power factor, reactive capability, and compliance demonstrations, while ensuring that studies reflect the net behavior observed at the point of interconnection. Clear requirements can help avoid overbuilding reactive support equipment and reduce uncertainty during project development.

Q14: At what stage of the interconnection process should developers be required to submit detailed EMT, PSCAD, and user-defined models?

There is growing concern across regions that increasingly detailed and complex modeling requirements are being imposed very early in the interconnection process (i.e., at the initial interconnection application), often before equipment selection, financing, and final plant design decisions have been completed. While detailed EMT and PSCAD models can provide significant value for assessing weak-grid performance and controls interactions, requiring highly specific models too early may result in developers submitting placeholder assumptions that are later superseded through the material modification process. A risk-based approach may be more effective, where generic positive-sequence models are used during early screening stages and more detailed EMT, PSCAD, and user-defined models are required only when justified by study needs, project maturity, or identified system risks.

Q15: How should utilities determine whether EMT studies are necessary for a large load interconnection?

Not all large loads require EMT studies. The need for EMT analysis should be based on the characteristics of the facility and the specific reliability concerns being evaluated. Factors that may justify EMT studies include high concentrations of power electronic equipment, weak-grid conditions, expected interactions with nearby IBRs, unusual fault ride-through behavior, or evidence of oscillatory or control-related risks. Screening metrics, system strength assessments, and prior operational experience can help identify cases where EMT analysis provides additional value beyond traditional steady-state and phasor-domain studies.