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IEEE P2800: Enhancing the Dynamic Performance of High-IBR Grids

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The increase in levels of inverter-based resources (IBRs) is changing the dynamic performance of power grids around the world that were historically dominated by the characteristic performance of synchronous generators. Recent events in southern California have highlighted this change, for example, the Blue Cut Fire (https://www.nerc.com/pa/rrm

/ea/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_/1200_MW_Fault_Induced_Solar_Photovoltaic_Resource_Interruption_Final.pdf) which resulted in the

loss of nearly 1200 MW of solar PV generation. What is evident from the event report developed by the North American Electric Reliability Corporation (NERC) is that there is a risk to not having clear, verifiable minimum technical capability and performance requirements for IBRs connecting to the transmission and sub-transmission networks.

With this motivation, at the general meeting of the Institute of Electrical and Electronics Engineers (IEEE) Power and Energy Society (PES) in summer 2018, a jointly sponsored project authorization request was presented by the PES Energy Development and Power Generation Committee, Electric Machines Committee, and Power System Relaying Committee, and approved by IEEE Standards Association. The scope of P2800 is to develop technical minimum capability and performance requirements for IBRs connecting to the transmission and sub-transmission networks. These include IBRs' ride-through capability, ride-through performance, reactive power (voltage) control, active power (frequency) control, power quality, protection, modeling data, measurement data, and test and verification. Figure 1 illustrates the specific requirements that are within and outside of the scope of P2800 in relation to international leading practices. Note that this illustration reflects a snapshot of where the P2800 working group stood when it issued Draft 3.1 in July 2020; some requirements, and whether they are inside or outside of P2800, are subject to change between now and when the standard is published.

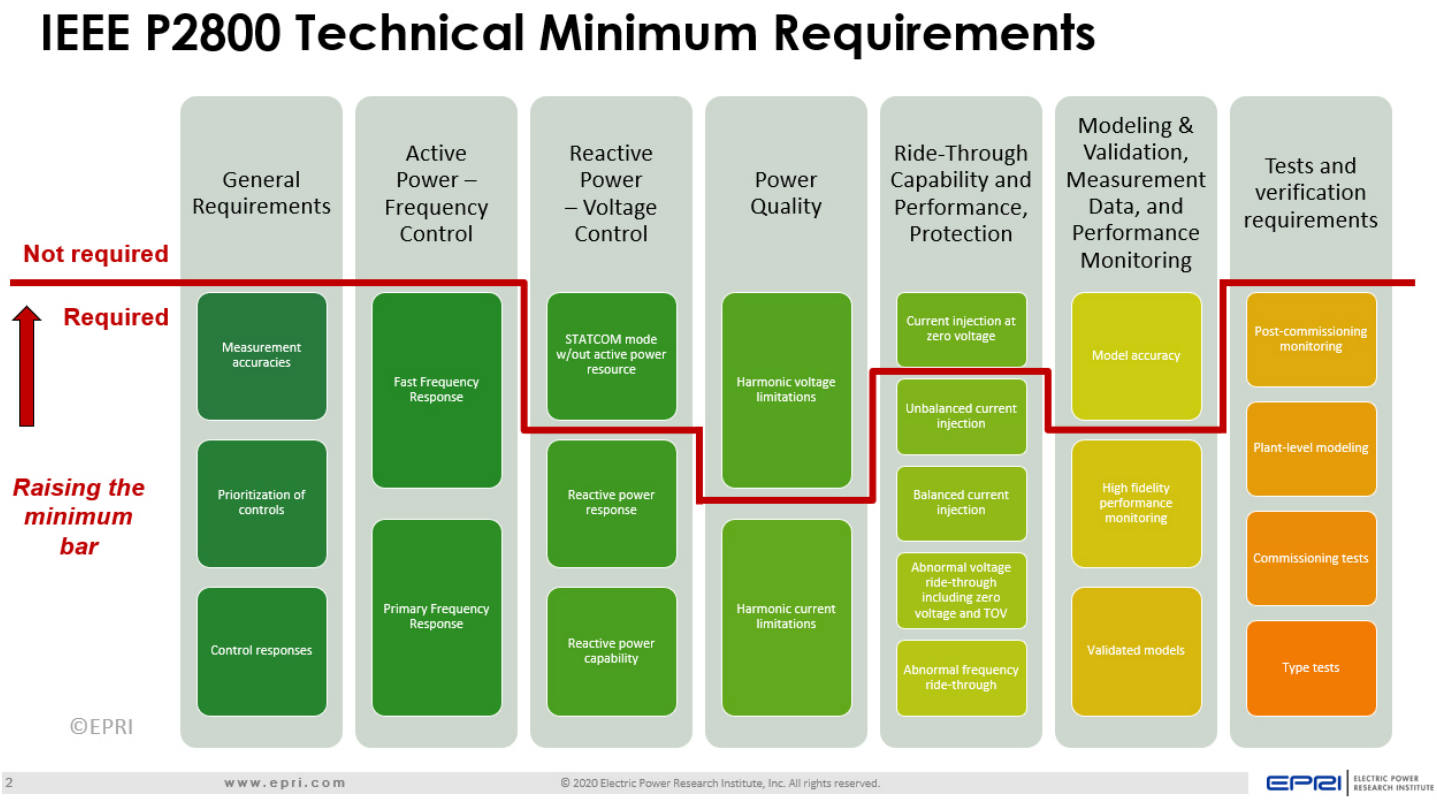

Figure 1. Specific requirements within and outside the scope of P2800 (as of Draft 3.1, and subject to change).

A Delicate Balancing Act

The goal of P2800 is to strike the appropriate balance between the capability and performance of the current state-of-the-art IBRs and forward-looking performance requirements for grids with increasing levels of IBRs. It's a delicate balance to ensure that the performance capabilities are present that will be needed for the life of the IBR while considering the cost-effectiveness of each requirement. Given that the lifespan of these projects can be more than two decades, this is a tough challenge as it entails trying to predict the future. As such, the development of P2800 has participation from more than 150 industry experts representing many stakeholder groups including manufacturers, developers, transmission planners, grid operators, and researchers. The expertise of these contributors is paramount in finding this balance. If you are interested in getting involved, please visit the IEEE P2800 working group website. (https://sagroups.ieee.org/2800/)

Test, Verification, and Model Validation

P2800 also puts forth a framework for the testing and verification of IBR capabilities and performance requirements. Without verification of the requirements defined in P2800, the standard would do little to move IBRs' capabilities and performance forward, nor would it reduce the uncertainty of the response of the IBRs. While P2800 will prescribe *which* verification method is required for each requirement, the specifics of *how* to verify performance requirements are in the scope of the P2800.1, "Guide for Test and Verification Procedures for Inverter-Based Resources Interconnecting with Associated Transmission Electric Power Systems," which will be developed subsequently to P2800.

Testing is the gold standard for verifying performance requirements. Some requirements are not easily or realistically able to be verified through unit-level type tests or plant-level commissioning tests. For these, the use of a combination of analysis with validated unit and auxiliary models, and long-term, post-commissioning monitoring, are proposed in a fashion similar to some of the leading international practices. For example, for low voltage fault ride-through performance, the requirement would be verified by a combination of type testing of the IBR unit, IBR design evaluation with validated models, as-built evaluation, post-commissioning model validation, and post-commissioning monitoring. This framework will be the starting point for P2800.1, which will detail the procedure for each of these steps.

P2800 is also an important piece of the continuation of IBR model development, improvement, and validation. Interconnection performance standards, test and verification procedures, and unit-level and plant-level models will evolve over time (figure 2). Building on P2800's definitions of minimum technical capability and performance requirements for IBRs, and P2800.1's definitions of testing and verification procedures to verify these performance requirements, input from laboratory testing and

field measurements will help develop and/or improve validated IBR unit models and plant-level models. These plant-level models can be used for future case studies to ultimately inform future revisions of performance standards, and the cycle repeats.

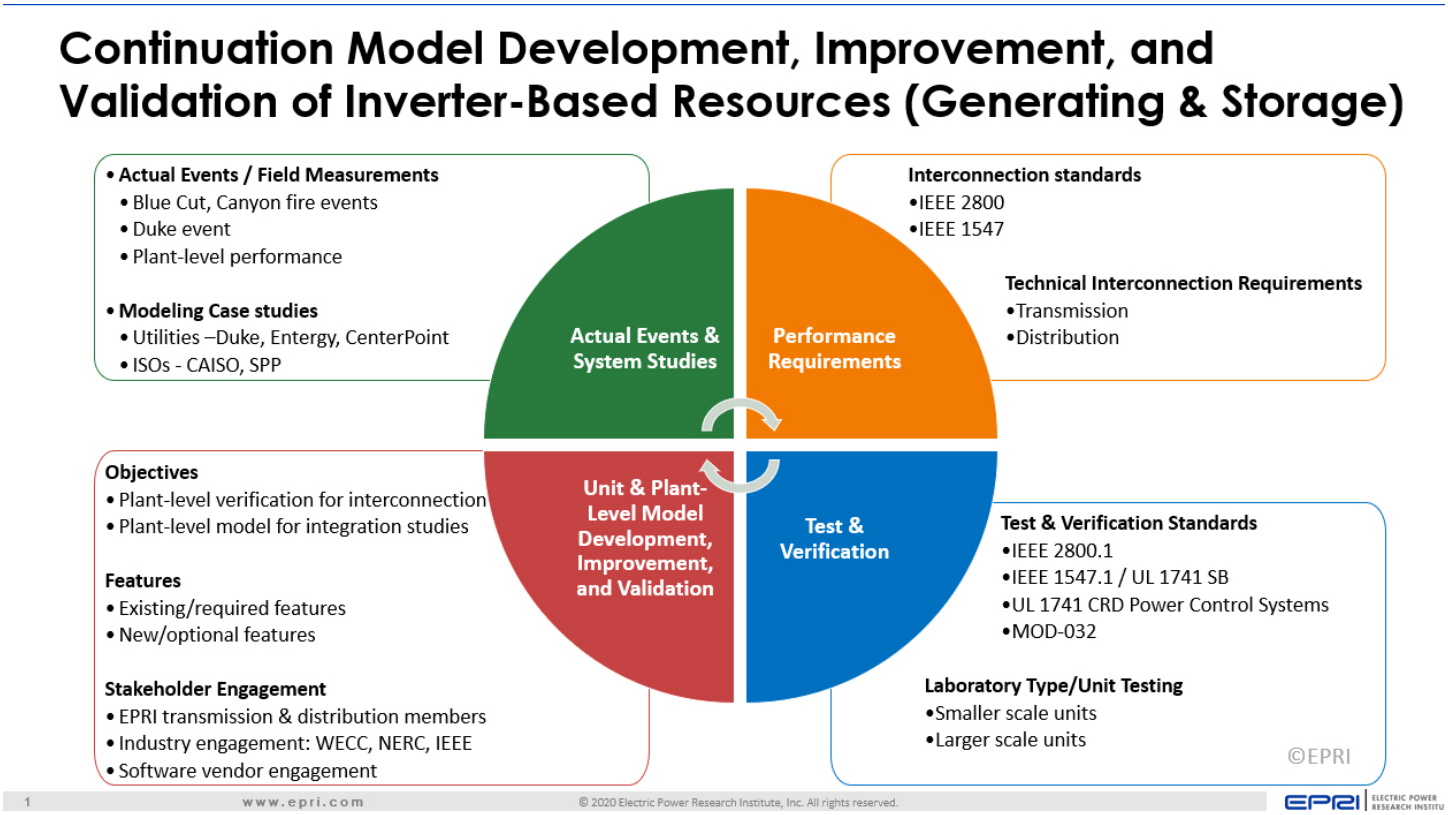

Figure 2. The ongoing evolution of interconnection performance standards, test and verification procedures, and unit-level and plant-level models.

Getting Across the Finish Line

It is acknowledged that the timeline of P2800 is aggressive, but this is warranted to address the influx of IBRs connecting to the grid in North America and around the world. The goal is to have a published standard by the end of 2021. To accomplish this, the P2800 leadership team has convened 11 sub-groups which meet bi-weekly to focus on the major topics and clauses of the performance standard. P2800 can only meet this aggressive timeline due to the dedication of the sub-group contributors. It is also important to acknowledge the previous works by the NERC Inverter-Based Resource Performance Task Force (IRPTF), IEEE 1547-2018, and various international grid codes leveraged as part of the initial starting point strawman for this effort. Both NERC and the U.S. Department of Energy are providing financial support to accelerate the drafting and timely publication of P2800.

Lastly, as with all standards, P2800 will ultimately need to be adopted by a cognizant regulatory authority and/or by most transmission owners in their interconnection requirements to see the benefits of these minimum technical capability and performance requirements.

Please join the working group today, or join the balloting group in 2021, to contribute to making IEEE P2800 a success. Visit the IEEE P2800 working group website (https://sagroups.ieee.org/2800/) for further details on how to get involved.

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Further Reading

IEEE P2800 working group website: https://sagroups.ieee.org/2800/ (https://sagroups.ieee.org/2800/)

IEEE Standards Association website on P2800: https://standards.ieee.org/project/2800.html (https://standards.ieee.org/project/2800.html)

IEEE Standards Association website on P2800.1: https://standards.ieee.org/project/2800.1.html (https://standards.ieee.org/project/2800.1.html)

“Improvements to Interconnection Requirements for BPS-Connected Inverter-Based Resources. NERC Reliability Guideline”: https://www.nerc.com/comm/OC_Reliability_Guidelines_DL/Reliability_Guideline_IBR_Interconnection_Requirements_Improvements.pdf (https://www.nerc.com/comm/OC_Reliability_Guidelines_DL/Reliability_Guideline_IBR_Interconnection_Requirements_Improvements.pdf)

“BPS-Connected Inverter-Based Resource Performance. NERC Reliability Guideline”: https://www.nerc.com/comm/OC_Reliability_Guidelines_DL/Inverter-Based_Resource_Performance_Guideline.pdf (https://www.nerc.com/comm/OC_Reliability_Guidelines_DL/Inverter-Based_Resource_Performance_Guideline.pdf)

Impact of Inverter Based Generation on Bulk Power System Dynamics and Short-Circuit Performance. IEEE PES Industry Technical Support Task Force. Technical Report PES-TR68: http://resourcecenter.ieee-pes.org/pes/product/technical-publications/PES_TR_7-18_0068 (http://resourcecenter.ieee-pes.org/pes/product/technical-publications/PES_TR_7-18_0068)

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