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As Large Loads Reshape the Grid, ESIG Offers Modeling Guidance for Engineers Doing Transmission Planning, Load Interconnection Assessments, and Large Load Model Development

As data centers and other large electronic loads reshape demand on the power system, the models used for grid stability studies weren't built for these technologies. A new ESIG report addresses that gap.

Reston, VA. – The Energy Systems Integration Group (ESIG) has released a new report, [Large Load Modeling for Dynamic Studies: Current Practices and Recommendations](#), developed through ESIG's [Large Loads Task Force](#). The report outlines the power system modeling needs for large electronic loads such as data centers, cryptocurrency mining operations, hydrogen production plants, and advanced manufacturing.

New large electronic loads are fundamentally different from traditional residential, commercial, and industrial demand. They are often concentrated geographically, have consumption similar to that of a mid-sized city, and are composed of tightly controlled power electronic equipment that can respond to grid disturbances on much faster time scales than traditional industrial loads. Their behavior has a powerful effect on local power quality, bulk power system stability, and reliability.

“The power system is changing faster than our modeling practices have kept up,” said Parag Mitra of EPRI, dynamic modeling project team lead for ESIG’s Large Loads Task Force. “Large electronic loads behave in ways that existing load models weren’t designed to capture—and as these loads make up a growing share of system demand, that gap has real consequences for planning and reliability.”

Major components of large electronic load facilities are highly sensitive to voltage and frequency excursions. These loads can also interact with inverter based resources (solar and wind plants, battery storage and high-voltage DC infrastructure) as well as with other power electronic loads. Recent grid disturbances have shown that large load facilities can disconnect or rapidly change operating state during minor faults on the system, leading to over-frequency or over-voltage conditions and, in some cases, cascading disconnections of generation and additional load. Existing load models are not able to capture these behaviors, while the stakes of modeling these loads accurately are rising as the number of these facilities is increasing.



“Getting large load modeling right affects whether planners can trust their study results, how interconnection timelines play out, and ultimately whether these loads can be integrated without introducing risk to the system reliability,” said Julia Matevosyan, associate director and a chief engineer at ESIG. “This report gives transmission planners and interconnection engineers a practical resource focused on important aspects and considerations of large load modeling for various study types.”

This report walks through recommended large load modeling approaches for both bulk system dynamic studies and local specialized studies. **Bulk system dynamic studies** focus on system-wide phenomena such as transient stability, voltage recovery, frequency response, and inter-area oscillations. Load models must capture relevant low-frequency dynamics, ride-through behavior, and control responses while remaining computationally feasible. **Local specialized dynamic studies** address higher-frequency and localized phenomena that can arise at a large load facility’s point of interconnection, and are computationally intensive.

As large loads become a larger share of system demand, the modeling practices that engineers use for planning and interconnection studies need to keep pace—and this report provides a common reference point for that work. Continued collaboration and refinement of these practices will be essential to maintaining system reliability and enabling efficient integration of new demand. Joint efforts can be encouraged between manufacturers, facility owners, and transmission service providers to improve model fidelity, and knowledge-sharing can be promoted through technical workshops and working groups.

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About Energy Systems Integration Group

ESIG began in 1989 as the Utility Wind Interest Group, an organization created to educate utilities about wind power. Within ten years, it developed into a significant technical educational organization and convener of peer-to-peer workshops to assist utilities, system operators, project developers and equipment manufacturers from around the world with the integration of wind power, and then by 2011, also with the

integration of solar power. With renewables becoming the mainstream sources of new generation and reliability services, the organization expanded its mission, branding and international participation in 2018 through a merger with the International Institute of Energy Systems Integration (IIESI) to become the Energy Systems Integration Group (ESIG), taking on not just the planning and operations of electricity systems and power



markets, but also the growing issues for other energy vectors, including the electrification of transportation, buildings and industry for decarbonizing the entire energy supply.

ESIG now serves as a resource for a broad cross-section of the global energy industry, including utilities, ISOs, independent power producers, project developers, manufacturers, forecasters, consultants, educational institutions, and government agencies, including regulatory bodies.

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