



ESIG Large Load Task Force: Overview and Recommendations

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Energy Systems Integration Group

- ESIG is a member-driven organization that addresses technical challenges for transforming energy systems. We do this through collaboration, education and knowledge sharing.
- >300 members worldwide broadly focused on power systems transformation and integration of energy systems
- Workshops, webinars, reports available freely on our website (<https://www.esig.energy/>) and on YouTube (@EnergySystemsIntegrationGroup). Join our mailing list!
- We create [task forces](#) to address topics such as multi-value transmission benefits or grid-forming technology or large loads and these task forces do analysis, run simulations, synthesize best practices, etc.



ESIG Large Loads Task Force Project Teams

Large Loads Task Force (LLTF)

- ESIG Working Groups:
- Reliability
 - Systems Operations & Market Design
 - Systems Planning

Interconnection Process

- Large load interconnection processes and studies

Interconnection Performance

- Requirements and performance specifications of large loads

Modeling Requirements

- Modeling requirements of large loads for power system studies

Load Forecasting

- Policies and practices for forecasting large loads to inform resource and transmission planning

Transmission Planning

- Consideration of large loads in transmission planning processes

Resource Adequacy












- Practices for evaluating large loads in resource adequacy studies

Markets & Operations

- Market design and operations for large loads and associated co-located resources

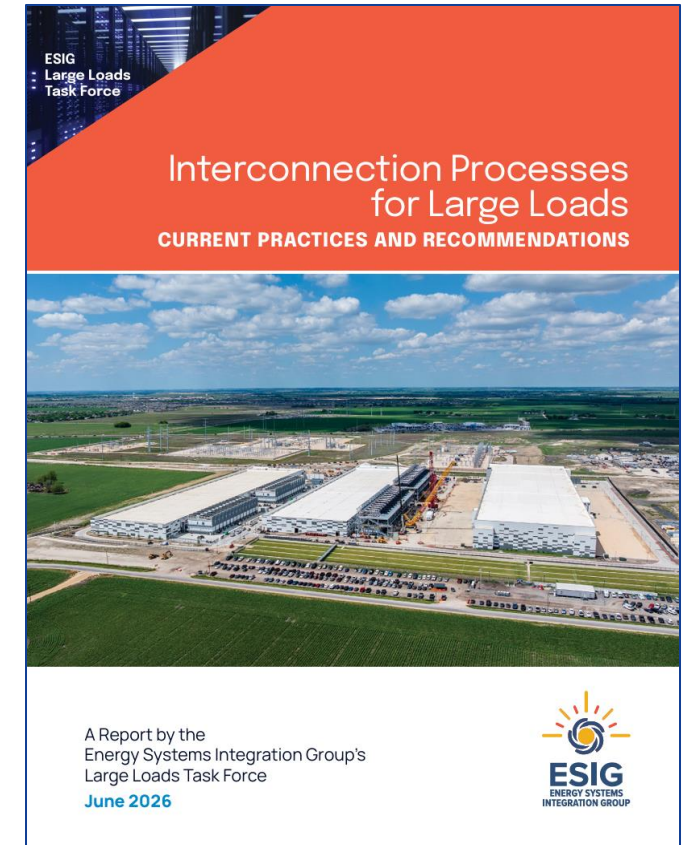


Reliability Challenges: Studies, Models, Standards

 RELIABILITY CONCERNS	 CHALLENGES FOR ISOs / RTOs / UTILITIES	 CHALLENGES FOR LARGE LOAD (LL) DEVELOPERS
 Large single contingency size	<ul style="list-style-type: none"> Sudden loss of one large or multiple LLs can create severe grid impacts comparable to large generator trips 	<ul style="list-style-type: none"> Developers may face operational restrictions, curtailment obligations, or phased energization restrictions
 Power electronics interface (PEI)	<ul style="list-style-type: none"> PEIL may introduce oscillations, harmonics, or control interactions not captured in models and studies 	<ul style="list-style-type: none"> Need to provide detailed vendor- and site-specific models, for PSPD and EMT studies despite IP concerns
 Modeling limitations	<ul style="list-style-type: none"> Existing PSPD and EMT load models may not accurately represent fast dynamics, ride-through behavior, or recovery characteristics of LLs 	<ul style="list-style-type: none"> Developers may need to coordinate among multiple OEMs to produce validated dynamic models not traditionally required for loads
 Need for EMT studies	<ul style="list-style-type: none"> More projects require EMT analysis to capture fast dynamics introduced by PEILs 	<ul style="list-style-type: none"> EMT studies can increase study cost, schedule, confidentiality concerns, and technical complexity
 Voltage stability	<ul style="list-style-type: none"> Dynamic voltage behavior can reduce stability margins and increase need for dynamic support devices 	<ul style="list-style-type: none"> Developers may be required to install STATCOMs, synchronous condensers, or dynamic VAR systems
 Co-located generation configurations	<ul style="list-style-type: none"> Hybrid load-plus-generation facilities complicate study assumptions, protection coordination, and operational accountability 	<ul style="list-style-type: none"> Uncertainty regarding injection/withdrawal rights, market participation rules and study assumptions
 Reliability standards	<ul style="list-style-type: none"> Existing interconnection standards were developed for generation, not large PEILs 	<ul style="list-style-type: none"> Rapidly evolving requirements create uncertainty for equipment procurement and project design
 Post-commissioning compliance	<ul style="list-style-type: none"> Need for monitoring, disturbance analysis, and ongoing validation of LL performance after energization 	<ul style="list-style-type: none"> Ongoing testing and model maintenance obligations may persist throughout facility life



Interconnection Process Recommendations



Large Load Performance Requirements



NORMAL OPERATION REQUIREMENTS

- Voltage range & regulation
- Frequency band
- Power quality (flicker, harmonics)
- Steady-state performance



DISTURBANCE PERFORMANCE REQUIREMENTS

- Low/High Voltage Ride-Through (LVRT / HVRT)
- Frequency response
- Phase jump & unbalance tolerance
- Fault current contribution



DYNAMIC INTERACTION & CONTROL REQUIREMENTS

- Ramp-rate & output change limits
- Control system performance
- Oscillation risk management
- Inverter & plant control tuning



PROTECTION & COORDINATION REQUIREMENTS

- Protection system settings
- Protection coordination
- Fault contribution & ride-through
- Transfer trip & isolation schemes



MODELING & VERIFICATION REQUIREMENTS

- EMT / aggregate / positive-sequence modeling
- Model validation & accuracy
- Monitoring & performance verification
- Testing & commissioning



OPERATIONAL CAPABILITIES & COORDINATION

- Curtailment & active power control
- Reactive power & voltage support
- Telemetry & data sharing
- Communications & dispatchability



Examples of Sources Reviewed

ERCOT | IESO | SPP | ENTSO-E | TenneT | Fingrid | EirGrid | Dominion












A Report by the Energy Systems Integration Group's Large Loads Task Force
February 2026



Large Load Modeling for Dynamic Studies

WHAT MODELS SHOULD CAPTURE





Key Characteristics

 Active Power & Frequency Control	 Reactive Power & Voltage Control	 Load Profiles
 Ride-Through Behavior	 Ramp Rate Limits	 Mechanical Load Behavior
 Blackstart Consideration	 Onsite Generation Behavior	 Unbalanced Voltage Operation



MODELING RECOMMENDATIONS

How We Should Build & Use Models

-  **Standardized Modeling Requirements**
Establish clear guidelines and minimum data needs for both PSPD and EMT large load models.
-  **Generic Library Model Development**
Create generic models to support bulk-system studies and assess impacts of emerging large loads.
-  **Model Quality Testing & Validation**
Implement structured testing, verification, and validation to ensure trustworthy model behavior.
-  **Industry Collaboration & Integration**
Enhance collaboration among stakeholders; integrate modeling into interconnection processes.

ESIG
Large Loads
Task Force

Large Load Modeling for Dynamic Studies

CURRENT PRACTICES AND RECOMMENDATIONS

A Report by the
Energy Systems Integration Group's
Large Loads Task Force
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Purpose: Accurately represent large load behavior and integrate high-quality models into planning, operations, and interconnection processes.



Thank You

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