

ESIG Large Load Task Force: Interconnection Process



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Interconnection Process Scope



Objective

Establish a standardized & improved large load interconnection process for transmission and distribution interconnections that creates efficiency, commercial readiness requirements, data and model sharing, change management, and addresses the unique configurations & operational characteristics of large loads

Key Topics & Sessions

Review Existing LL Int. Processes

Lessons learned from IBRs

Identify Key Gaps & Issues

Interconnection Type & Jurisdictional Considerations

Develop Recommendations

Coordinate with other LLTF Project Teams

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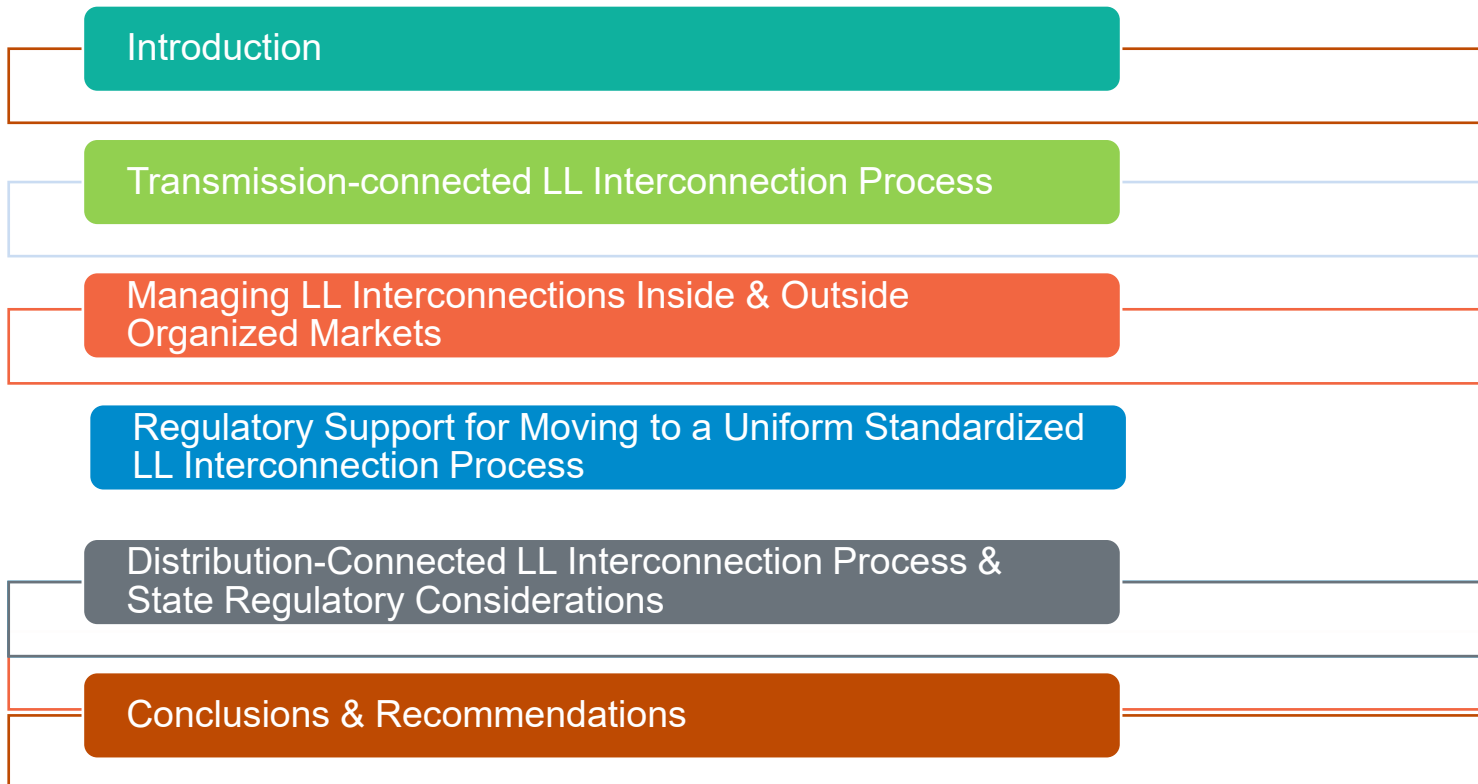
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Chapter Breakdown



Interconnection Processes for Large Loads: Current Practices and Recommendations

Final Report

Contents

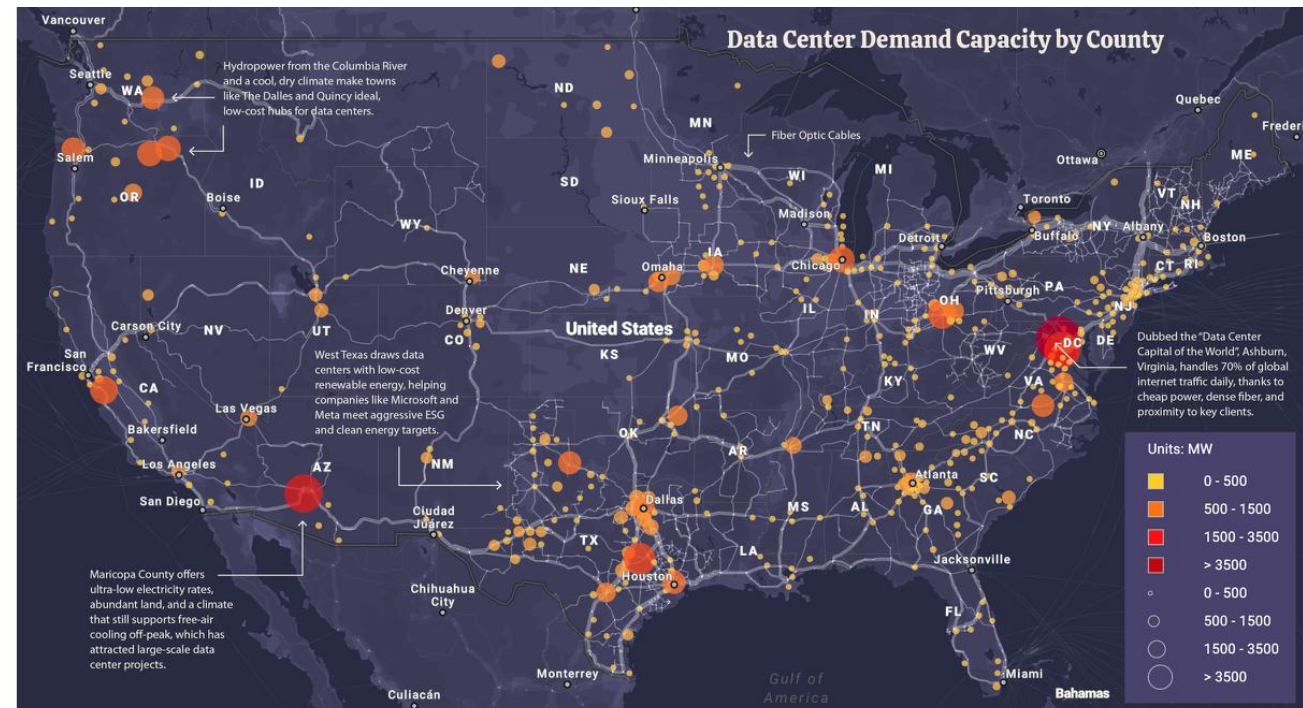
1. Introduction	2
2. Transmission-Connected Large Load Interconnection Process	9
3. Managing Large Load Interconnections Inside & Outside Organized Markets	26
4. Regulatory Support for Moving to a Uniform Standardized Large Load Interconnection Process	37
5. Distribution-Connected Large Load Interconnection Process & State Regulatory Considerations	45
6. Conclusions and Recommendations	50
7. References	55

Report Development Activities



1. Survey existing LL processes/queues
2. Identify gaps/issues in these processes
3. Document lessons learned from IBR generation interconnection reforms
4. Provide recommendations for a baseline, standardized LL interconnection process
5. Include study recommendations during LL interconnection processes
6. Highlight integration with other ESIG LLTF project teams

LL Interconnections are occurring everywhere



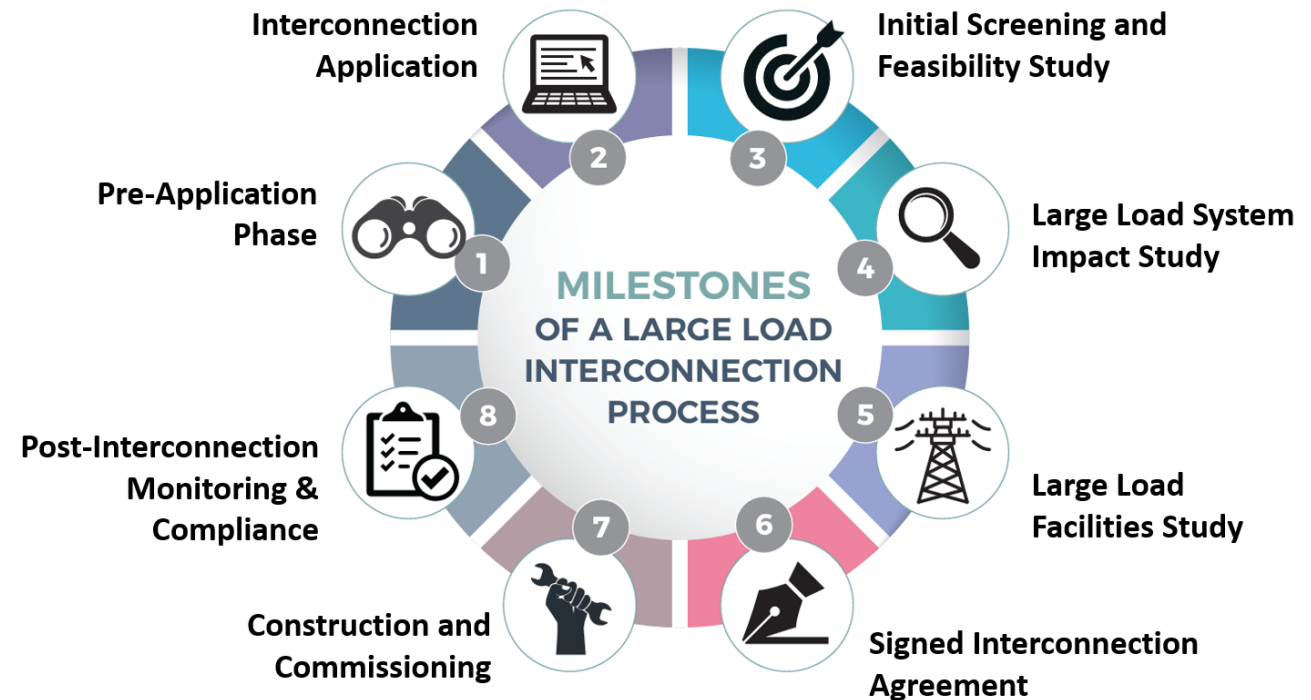
Source: NREL, Visual Capitalist

Transmission-connected LL Interconnection Process



- Any LL Interconnection should have these defined core milestones
- Each location, region, entity, state, etc. may have additional steps or enhancements to this, but core milestones should be there
- One fundamental challenge is the coordination of these milestones among multiple different transmission entities
- Throughout this process, it is essential to include:
 - Modeling & Data Requirements (see ESIG LLTF Modeling Report)
 - Interconnection Performance Requirements (see ESIG LLTF Reqs. Report)

Core Milestones of a LL Interconnection Process



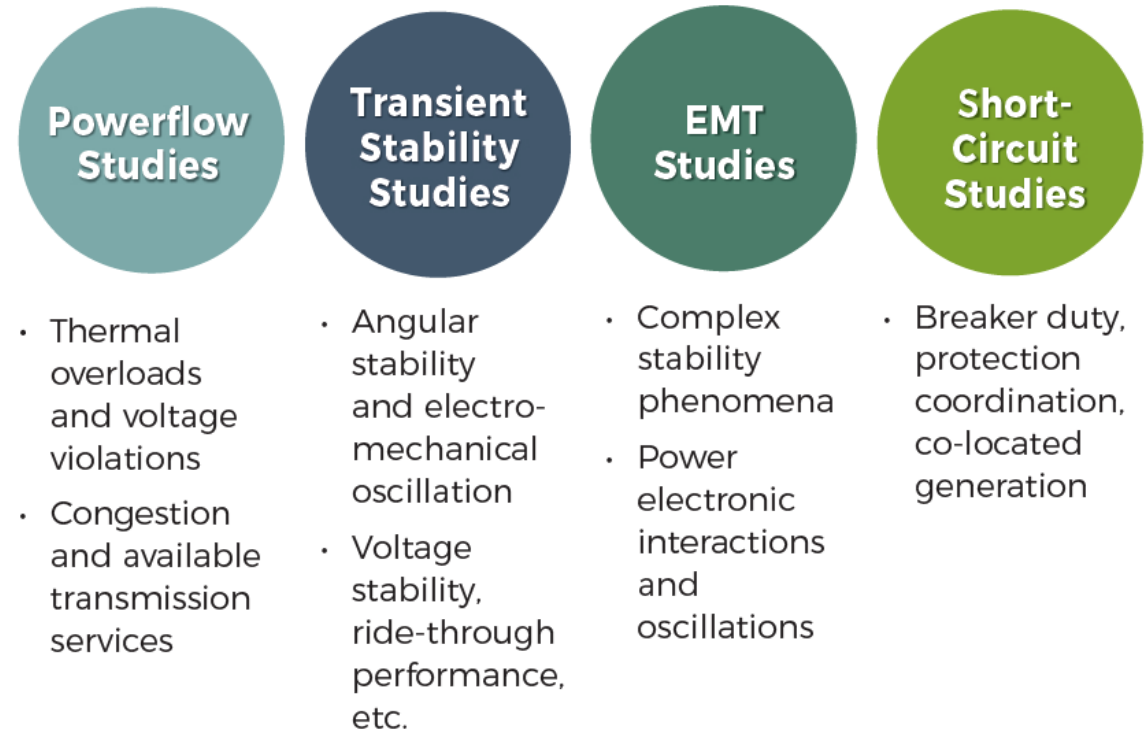
Source: GridLab/Elevate

Transmission-connected LL Interconnection Process



- The LL interconnection process must include a mandatory, standardized set of advanced studies
- Tier 1: RMS Studies & Screening
 - Powerflow studies
 - Short Circuit studies
 - Dynamic Stability Studies
 - Risk-based Screening Analysis (to help determine if/when EMT studies are necessary)
 - Size of facility, system strength (SCR<5 for ex.), located near sensitive/complex FACTS or has a highly cyclic load profile (AI training)
- Tier 2: EMT Studies
 - Detailed EMT-based Sub-synchronous Oscillation (SSO) Study
 - Broadband damping & control stability
 - Power Quality studies (harmonics, voltage flicker, etc.)

Types of reliability studies for LL Interconnections



Source: GridLab/Elevate

Transmission-connected LL Interconnection Process

Different transmission entities have differences in regulations, structure, etc.



Process Elements	TDU / VI-ISO	VI-NonISO	Cooperative
Study Timeline	Hybrid (6-24 months)	Flexible (3-12 months)	Flexible (6-18 months)
Customer Interface	Direct/Coordinated	Direct	Direct
Technical Standards	Hybrid Standards	Utility Standards	G&T/Regional Standards
Cost Allocation	Complex Hybrid	Utility-Specific	Member-Impact Based
Regulatory Oversight	FERC/ISO/State	State PUC	State/Rural Utilities Service
Study Complexity	High (System-Wide)	Medium (Utility System)	Low-Medium
Resource Availability	Specialized/Integrated	Integrated	Limited/Outsourced

- Common Challenges across all Transmission Entity types:
 - Lack of standardized LL modeling & performance requirements
 - Limited transparency of queues
 - Resource constraints (staffing & tools)
 - Inadequate processes for handling material modifications of the LLs
 - Coordinating co-located LLs
 - Uncertainty in handling flexible/curtailable load

TDU = Transmission & Distribution Only Companies
VI-ISO = Vertically Integrated Utilities within ISO/RTO Markets
VI-NonISO = Vertically Integrated Utilities outside ISO/RTO Markets

ISO/RTO Large Load Interconnection Involvement



- Historically transmission utilities have been responsible for **load interconnections**, while ISO/RTOs have been responsible for **generation interconnections & transmission planning activities**
- The introduction of large load facilities, their enormous size and rapid growth, along with being **co-located with new and/or existing generation** is forcing closer coordination between transmission entities & ISO/RTOs
- Close coordination between transmission utilities is essential, both groups deeply involved in making this work
- Rapidly evolving space with new rules and policies being set in the different regions

HIGH IMPACT LARGE LOAD (HILL)

Definition	<ul style="list-style-type: none"> A new commercial or industrial load, or increase in commercial or industrial load, at a single site connected through one or more shared Points of Interconnection (POIs) or delivery points
MW Threshold	<ul style="list-style-type: none"> Less than or equal to 69 kV: Greater than or equal to 10 MW Greater than 69 kV: Greater than or equal to 50 MW
Excludes	<ul style="list-style-type: none"> Electric Storage Resource
Requirements	<ul style="list-style-type: none"> Register in Market (Forecasting and ramp) Study requirements including stability SPP Ride-through Requirements Compliance
Perform within 90 Calendar Days	<ul style="list-style-type: none"> Transient Stability considering SPP HILL ride through requirements Electromagnetic Transient (EMT) Screening Short-Circuit Ratio and Critical Clearing Time Note: If issues occur, perform full EMT analysis

PATHS FOR LOAD AND SUPPORTING GENERATION



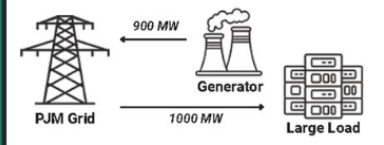
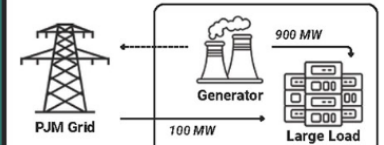
More load = need for more generation		
Faster path than the traditional Generation Interconnection queue	 Same POI	 Local Area
Supporting generation follows the same direct assign cost allocation as other generation connecting in SPP	<ul style="list-style-type: none"> Study delivered in 90 days* HILL and supporting generation are behind the same point of interconnection Generation will not be injected to the grid 	<ul style="list-style-type: none"> Study delivered in 90 days* HILL and supporting generation are within two buses Energy flow on the grid will be limited by HILL's need and system capacity 5-year service term

Figure 1: "Front-of-Meter" Network Integration Transmission Service



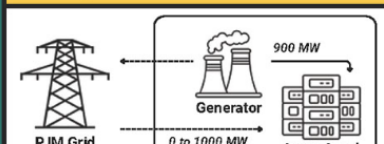
- PJM plans **all transmission and generation to serve load**
- Requires more transmission infrastructure and can take longer, but provides the broadest benefits

Figure 2: New Firm Contract Demand Transmission Service



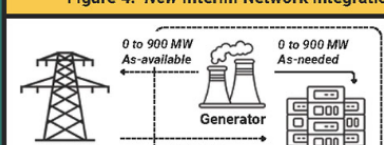
- Load pays for 100 MW of firm transmission service
- PJM has **no obligation to serve load above 100 MW**
- All or portion of the generator is devoted to co-located load

Figure 3: New Non-Firm Contract Demand Transmission Service



- Load pays for non-firm transmission service on an as-reserved basis
- PJM has **no obligation to serve load if grid is unavailable**
- All or portion of the generator is devoted to co-located load

Figure 4: New Interim Network Integration Transmission Service



- Load & Generator **get non-firm service ASAP, and convert to firm service (Fig. 1) when grid upgrades are complete**
- Generator can serve load while awaiting grid connection or when grid is unavailable

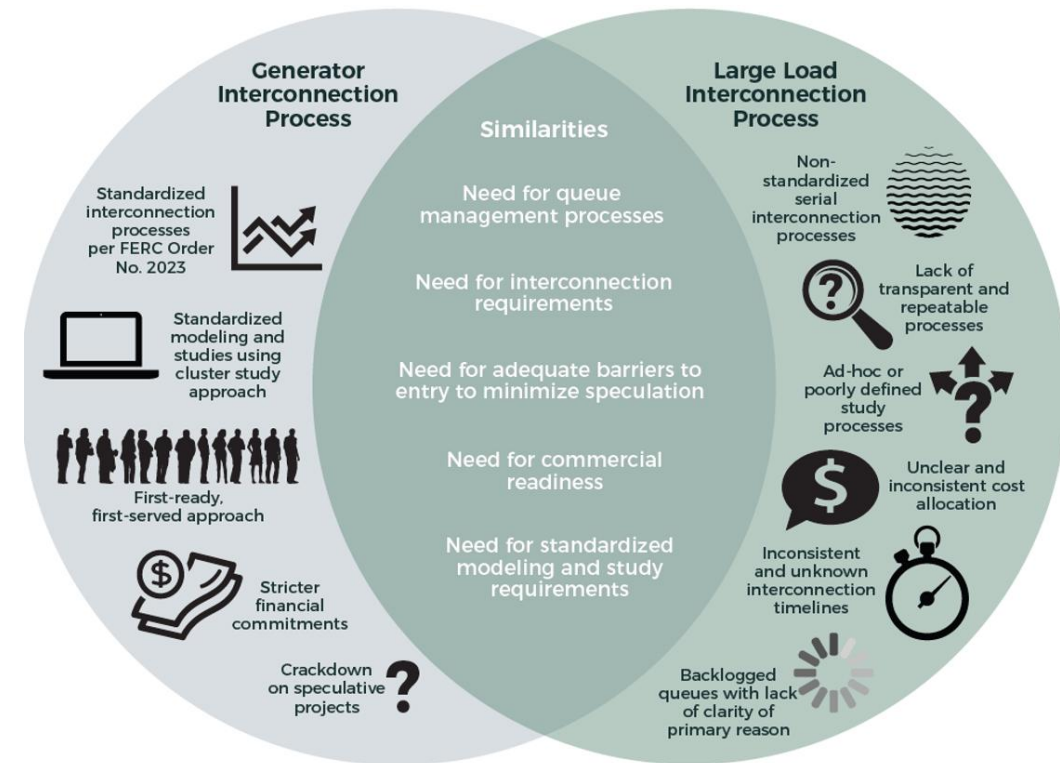
SPP's HILL study process & HILLGA process approved by FERC in January 2026. [Source: SPP]

FERC orders to PJM for co-locating generation & large loads
[Source: FERC]

Regulatory Support for Moving to a Uniform Standardized LL Interconnection Process



- FERC policies (Order 2003→Order 2023) on generation interconnections led to standardized LGIA/LGIP with the goals of:
 - expedited generator interconnections
 - transparent and nondiscriminatory market entry rules
 - preserving system reliability
 - ensuring rates remain just and reasonable
- DOE/FERC ANOPR's 14 principles lay out similar frameworks and goals for large load interconnections
- European Union established the Demand Connection Code (DCC) in 2016 setting mandatory technical rules for LL interconnections, including process steps such as data/model sharing, cost allocation, material modifications, and more
- In short, lots of regulatory policy already available to take lessons learned & adopt for large load interconnection processes



Source: GridLab/Elevate

Distribution Large Load Interconnection Process

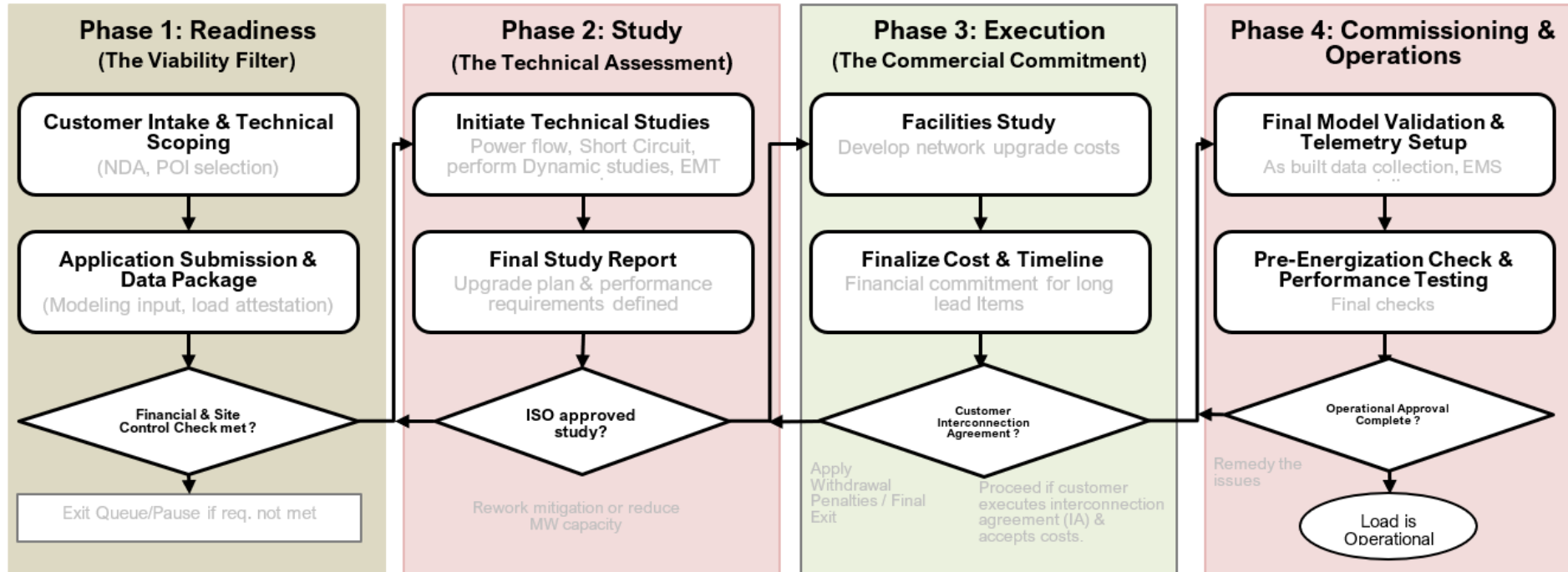


- Distribution systems seeing rapid growth in “large load” type facilities as well
- Same challenges exist with these interconnections, and adopting the standardized baseline interconnection process will add efficiencies & help ensure reliability
- State-level regulations and utility-driven rules/processes oversee these interconnections
- Ensure distribution LL queue information, models, etc. are shared with transmission utilities & ISO/RTOs for close coordination, forecasting, modeling, etc.

Common Distribution-Connected Large Load Types (1–30 MW) with Key Characteristics

Load Type	Typical MW Range	Key Characteristics
Small Enterprise Data Centers	1–5 MW	High redundancy, sensitive to power quality, 24/7 operation
Large Enterprise Data Centers	5–30 MW	Continuous load, backup generation, strict uptime requirements
Automotive Manufacturing	10–25 MW	Large motors, welding equipment, robotics, high short-circuit contribution
Steel Mini-Mills	20–30 MW	Arc furnaces, fluctuating load, high reactive power demand
Semiconductor Fabs	10–30 MW	Precision equipment, clean rooms, constant load profile
Cement Plants	15–30 MW	Kilns, grinding mills, continuous heavy-duty operation
Water/Wastewater Treatment	5–20 MW	Large pumps, seasonal variability, motor starting impact
Medical/Research Campuses	1–15 MW	Imaging equipment, labs, backup power requirements

Ideal Interconnection Process for Large Loads with Recommendations



Key Recommendations

- | | | | |
|---|--|---|--|
| Implement standardized application packages, and financial readiness to filter speculative load | ISOs should implement transparent queue processes, address duplicate requests, and standardize interconnection requirements. | Standardize financial commitment requirements to mitigate stranded asset and utility rate recovery risks. | Finalize material modification rules to maintain queue and study integrity |
| Utilize hosting capacity maps early to guide siting and reduce initial study complexity. | Develop consistent technical requirements for load modeling (e.g., Dynamic, EMT). | Ensure adequate resources (staffing and tools) at ISOs and utilities | May execute processes in parallel to accelerate the load interconnection |

Each step may need to include nuances depending on the utility type



THANK
YOU