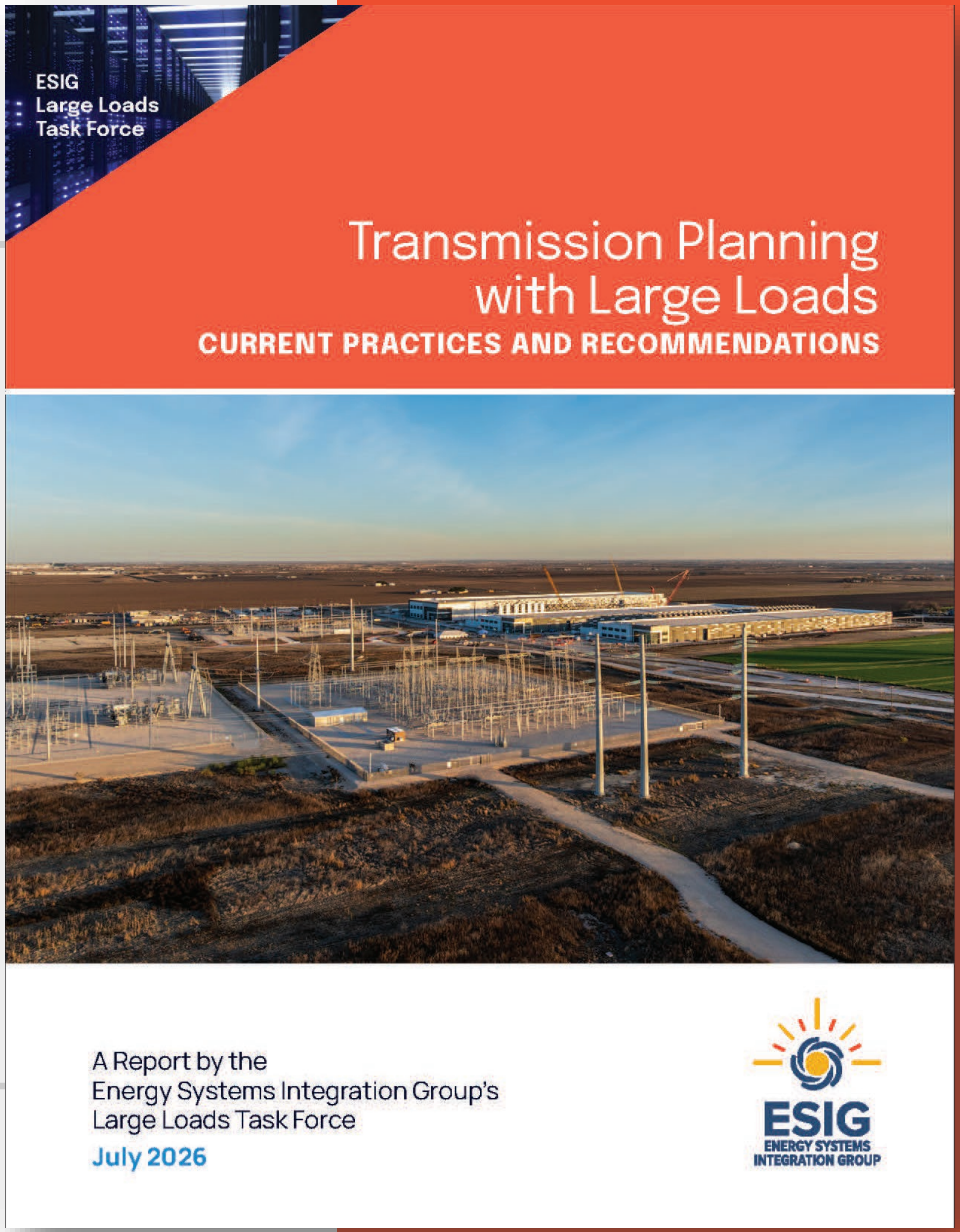
ESIG
ENERGY SYSTEMS INTEGRATION GROUP

Transmission Planning with Large Loads

Current Practices and Recommendations

A Report by the ESIG Large Loads Task Force

Published July 2026



Agenda

1. **Welcome & Introduction**
   Meet today's speakers and the ESIG Large Load Task Force
2. **Framing the Problem**
   The pressure large loads put on existing planning processes
3. **Three Structural Challenges**
   Silos, timing mismatch, and demand uncertainty
4. **Urgent, Near-Term, & Long-Term Fixes**
   What planners can do now, over the next few years, and over the long term
5. **Recommendations**
   Who needs to act, and how, across three timeframes
6. **Discussion & Q&A**
   Your questions for the report's authors

Meet the Speakers

Johannes P. Pfeifenberger

Principal, Electricity Wholesale Markets & Planning, The Brattle Group

Lead author

"Most of the U.S. transmission investment is still driven by planning processes built to solve one transmission need at a time, rather than identify solutions that can better address the multiple near- and long-term needs we face to deliver the most value across the system. Large loads are exposing how costly that siloed approach can become when the problem in front of you is only one piece of a much bigger picture."

Meet the Speakers

Warren Lasher

Lasher Energy Consulting, LLC

Lead author

"Planners don’t need to wait for perfect long-term forecasts to make better near-term decisions. This report outlines practical steps of what can be done now, without new legislation or the need to redesign the entire planning process."

Meet the Speakers

James Okullo

Director, System Planning, ESIG

Co-author

"Every large load interconnection request that comes in today gets evaluated through a siloed planning process built for a world of slower, steadier load growth. This report identifies where the current planning process breaks down and lays out what needs to change to more quickly and cost-effectively address both near- and longer-term transmission needs."

This Is One Part of ESIG's Large Loads Task Force

Large Loads Task Force	Interconnection Process	Interconnection Performance	Dynamic Modeling Requirements
ESIG working groups: • Reliability • System operations and market design • System planning	• Large load interconnection processes and studies	• Requirements and performance specifications of large loads	• Modeling of power systems dynamic assessments for large loads

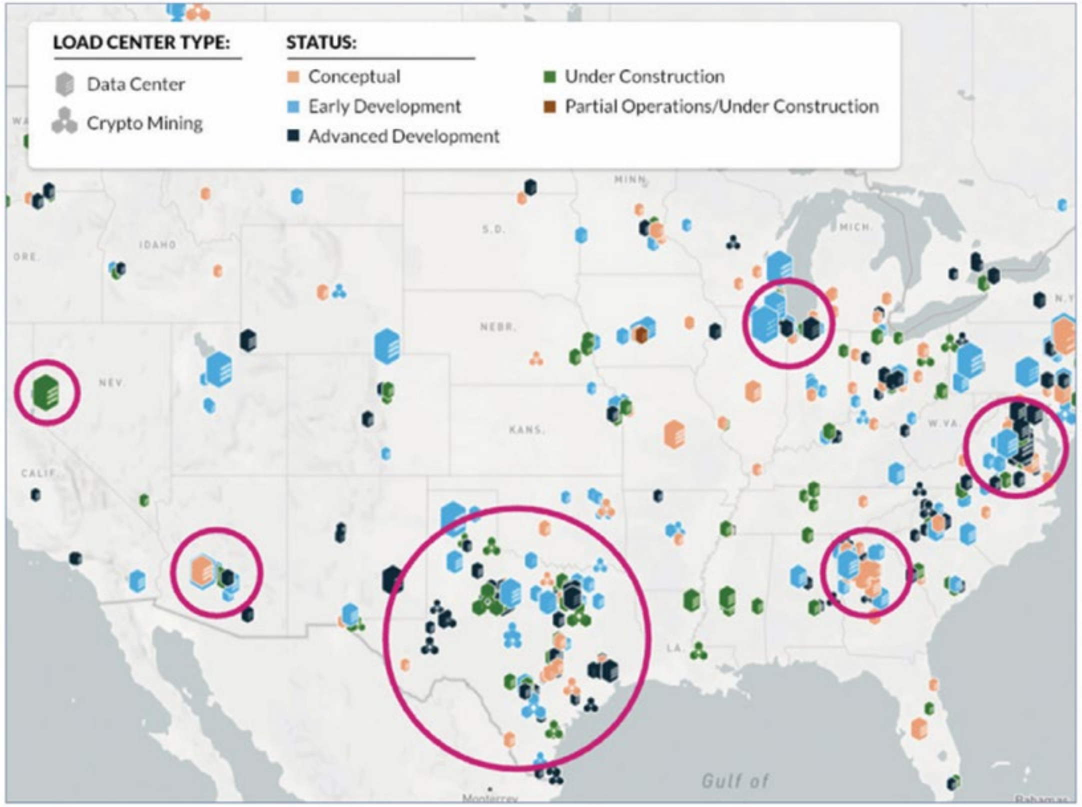
Load Forecasting	Transmission Planning	Resource Adequacy	Markets and Operations
• Policies and practices for forecasting large loads to inform resource and transmission planning	• Consideration of large loads in transmission planning processes	• Practices for evaluating large loads, including their flexibility potential, in resource adequacy studies	• Market design and operations for large loads and associated resources

Each project team of the ESIG Large Loads Task Force addressed a key topic in the integration of large loads, investigating their system impacts, possible solutions to reliability challenges, and best practices.

Framing The Problem

- Large loads reach gigawatt scale, cluster together, and want service in a few years—not the 5–10 years required to build new transmission.
- Data centers are projected to drive over 50% of peak-demand growth; U.S. electricity demand may rise 33% over the next 4 years (by 2030).
- In ERCOT alone, **410 GW of large-load requests** as of April 2026**—nearly 5x the current 90 GW peak.**
- Over 90% of the ~$25 Bn invested in U.S. transmission each year is driven by near-term, reliability needs, rather than using proactive, multi-driver planning
- The result: **piecemeal upgrades** that solve today's request but create no durable headroom for the next one.

High Levels of Geographically Concentrated Data Center Grid Interconnection Demand, as of December 2025



Source: Yes Energy's Infrastructure Insights, https://www.yesenergy.com/products/infrastructure-insights.

Structural Challenge 1: Planning Silos

- Transmission planning in the U.S. is fragmented by function, time horizon, study method, and institutional and geographic boundaries.
- Load interconnection, generator interconnection, reliability planning, economic studies, and long-range planning often run as separate processes with different timelines, tools, and assumptions.
- The same system need can be studied several times, by different teams, on different schedules—without ever producing one comprehensive transmission plan.
- Because right-sized solutions are more cost effective, the siloed incremental approach leads to higher cost outcomes.

Transmission Owner Planning Processes

Local Transmission Owner Load Interconnection Projects
Upgrades to meet load transmission needs

Local Transmission Owner Reliability Projects
Upgrades to meet local standards

RTO Planning Processes

Generator Interconnection Projects
Reliability upgrades for generator interconnection requests

Long-Term Transmission Service Projects
Reliability upgrades for transmission service requests

Regional Reliability Projects
Address remaining reliability needs

Regional Economic and Public Policy Projects
Often address only a narrow set of remaining needs

Joint RTO Interregional Planning Processes
Narrow assessment of benefits and few remaining system needs make these studies generally ineffective

Multiple planning tracks.

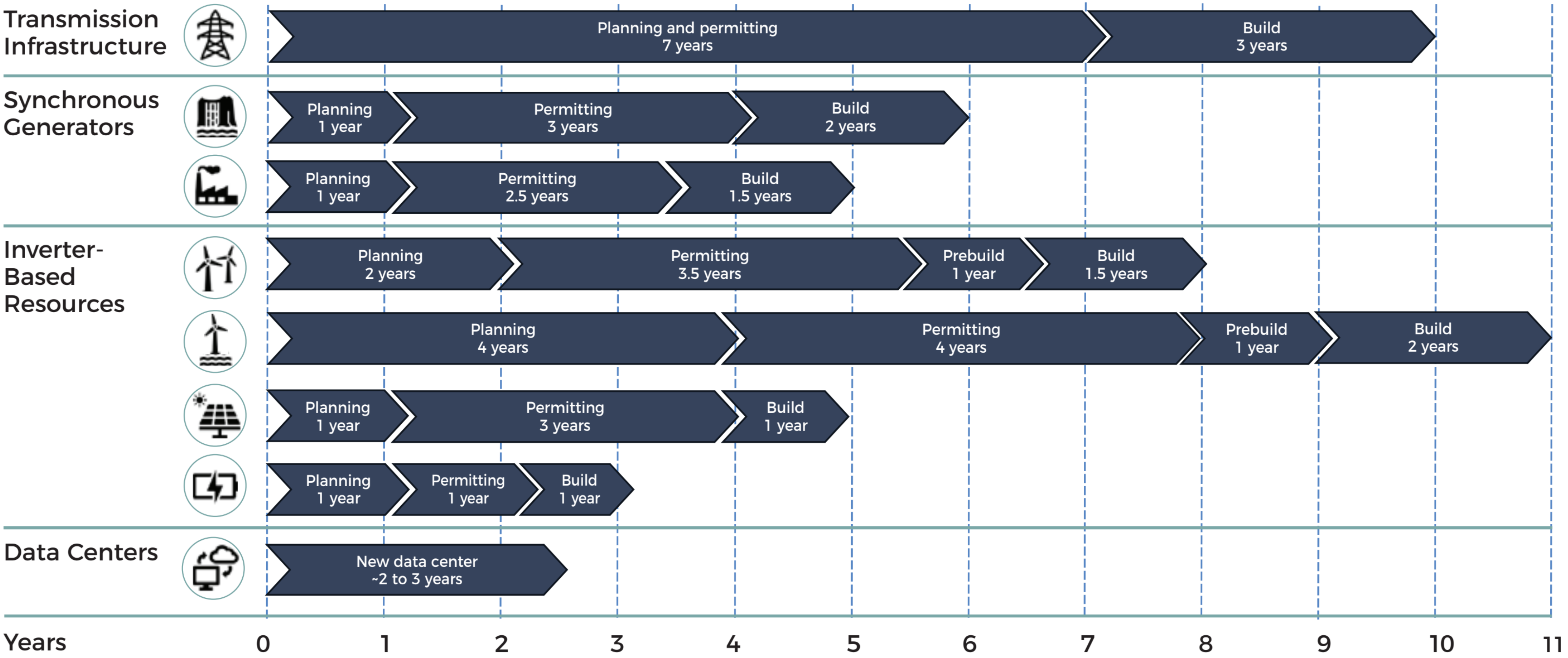
Evaluated one at a time.

Not together.

Source: Pfeifenberger, A Roadmap to Interregional Transmission Planning (2021), modified for Energy Systems Integration Group, Transmission Planning with Large Loads, 2026.

Structural Challenge 2: Timing Mismatch

- Large loads are seeking interconnection on timelines of months to a few years, which is far faster than the 5- to 10-year horizons of most transmission planning, permitting, and construction processes.
- Some facilities reach gigawatt scale and cluster geographically, so a single interconnection request can trigger regional-scale transmission needs.
- That gap leaves near-term reliability and interconnection needs to drive large, expensive, long-lasting transmission investments—
often before the broader regional and longer-term picture is clear.

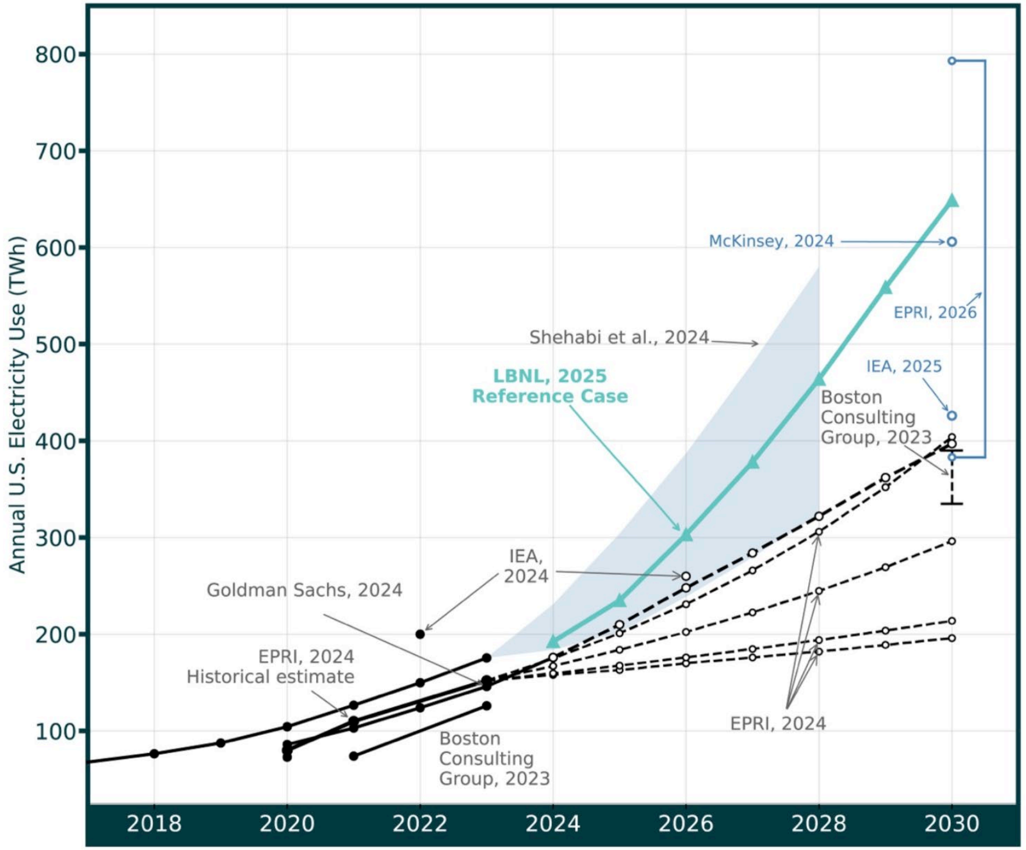


Data centers can be developed on relatively short timelines, much shorter than the time it takes to plan, permit, procure equipment for, and build transmission, distribution, and generation infrastructure to support these loads.

Source: R. Quint et al., Practical Guidance and Considerations for Large Load Interconnections (Elevate Energy Consulting and GridLab, 2025)

Structural Challenge 3: Uncertainty

- Large loads bring an unprecedented level of uncertainty: will a project materialize at all, when will it energize, and how quickly will it ramp once connected?
- A single base-case forecast can no longer capture the range of plausible outcomes planners face even over the next several years.
- Better forecasting helps, but it won't eliminate the problem—planning needs to consider explicitly that the future is uncertain (even in the near-term).



A dozen published forecasts — a nearly 4× spread by 2030. No single number to plan around.

Source: Lawrence Berkeley National Laboratory, 2025.

Recommendations: Three Groups, Working in Parallel

Group 1: Urgent Actions

≤ 12 months

Goal: Maximize existing assets; avoid locking-in inefficient decisions.

Focus: Headroom maps · quickly deployable tools · flexibility · shared dataset

Leads: Planning, operations & interconnection teams

Group 2: Near-Term Fixes

1–3 years

Goal: Fix study processes before growth locks in higher-cost outcomes.

Focus: Scenario sets · least-regrets evaluation · flexible, future-fit grid designs

Leads: RTO/ISO and utility planning teams

Group 3: Long-Term Solutions

3+ years

Goal: Build durable grid solutions that single requests can't support alone.

Focus: Development zones · automated workflows · interregional planning

Leads: States, RTOs/ISOs & interregional planners

Urgent Actions: What Planners Can Do Now

Group 1: Within 12 months — Maximize existing transmission assets and halt the lock-in of inefficient decisions.

Publish Headroom & Locational Signals

Conduct and publish a standardized headroom study showing where and how much load can interconnect today, under all relevant operating conditions.

Quickly-Deployable Solutions

Utilize GETs, advanced transmission technologies, reconductoring, and RASs to resolve (as bridge or permanent solutions) load-driven constraints on faster timelines.

Flexible-Load & Co-Location

Facilitate flexible load, back-up generation, and co-located resources in studies — when defined, visible, and controllable/enforceable.

Shared Large-Load Dataset

Adopt a consensus, version-controlled, scenario-based dataset used across interconnection, reliability, economic, and long-horizon studies.

Near-Term Fixes: What Planners Can Do Next

Group 2: 1–3 years — Change study processes and early project choices before growth locks in higher-cost, less-durable outcomes.

Standard Scenario Sets

Use one standard set of near- and long-term scenarios every planning cycle, replacing single "base-case" projections to bracket plausible future outcomes.

Least-Regrets Evaluation

Build a framework with metrics and criteria to compare transmission alternatives across futures by net benefits and regret to select the grid designs that perform best across plausible future outcomes.

Linked Study Cadence

Put interconnection, reliability, and long-horizon planning on one calendar with shared assumptions and handoffs.

Scalable, Future-Fit Design

Check that each major upgrade preserves expansion options before approval; default to expandable structures.

Near-Term Fixes: Least-Regrets Planning

Example: Three possible futures need 800 MW, 1,600 MW, or 2,400 MW of new capacity.
The cheapest solutions for each future cost $500M, $600M, and $800M—but only if planners guess right.

Scenario	Need	Optimal Solution	Cost
Future 1	800 MW	1 × 500 kV line	$500 million
Future 2	1,600 MW	2 × 500 kV line	$600 million
Future 3	2,400 MW	765 kV line	$800 million

Source: Energy Systems Integration Group, Transmission Planning with Large Loads (2026), Example 5

Near-Term Fixes: Least-Regrets Planning (Continued)

Built incrementally, one request at a time, the probability-weighted average cost of Approch A is **$866M**.
The scalable 2x500kV and 765 kV solutions cost only **$750M** on average.

	Future 1	Future 2	Future 3		Weighted Avg.
Outcome if Actual Future is Different from Optimized					
Solution A+	**1×500 kV**	+1×500 kV	+2×500 kV	*The system would need to add another 500 kV line (or 2 x 500 kV line) if Future 2 (or Future 3) is realized.*	
Solution B+	Op. as 1×500 kV	**2×500 kV**	+1×500 kV	*The system would need to add another 500 kV line if Future 3 is realized; the solution is oversized for Future 1.*	
Solution C+	Op. at 500 kV	765 kV	**765 kV**	*The solution is oversized in Futures 1 and 2. The line is operated at 500 kV in Future 1 (saving $150 million in transformation costs).*	
Ultimate Cost					
Cost A+	**$500M**	$1,000M	$1,100M		**$866M**
Cost B+	$550M	**$600M**	$1,100M		**$750M**
Cost C+	$650M	$800M	**$800M**		**$750M**

Lowest (weighted) average cost across scenarios ($750M, $750M)

Blue = optimal solution per future

Near-Term Fixes: Least-Regrets Planning (Continued)

The flexible, scalable 765kV Solution has the **lowest worst-case regret ($200M**) of the three solution.
The incremental, request-by-request Approach A has the largest possible regret.

Solution	Future 1	Future 2	Future 3	Regret Summary
Regret A	$0	**+$400M**	+$300M	Up to $400M extra cost from underbuilding
Regret B	+$50M	$0	**+$300M**	$300M extra from underbuilding (Future 3); $50M extra from overbuilding (Future 1)
Regret C	+$150M	**+$200M**	$0	**Least regret:** up to $200M extra from overbuilding

Near-Term Fixes: Proven Planning Models

Australia: Integrated System Plan

A national, whole-of-system plan that coordinates transmission across many future scenarios — the leading example of scenario-based, least-regrets planning at scale.

United States: ATC Scenario-Based Study

ATC's 2007 Paddock–Rockdale study was among the first U.S. scenario-based benefit-cost analyses, showing a line that paid off in six of seven plausible futures.

Longer-Term Solutions: What Planners Can Build

Group 3: 3+ years — Build the larger, durable grid solutions that individual interconnection requests can't support alone.

State-Designated Development Zones

States, with RTO/ISO and utility input, establish zones where large load and generation can be located so transmission can be planned and developed proactively.

Connected & Automated Workflows

Link (or consolidate) and automate interconnection, reliability, and long-range studies with shared assumptions — replacing serial, manual work.

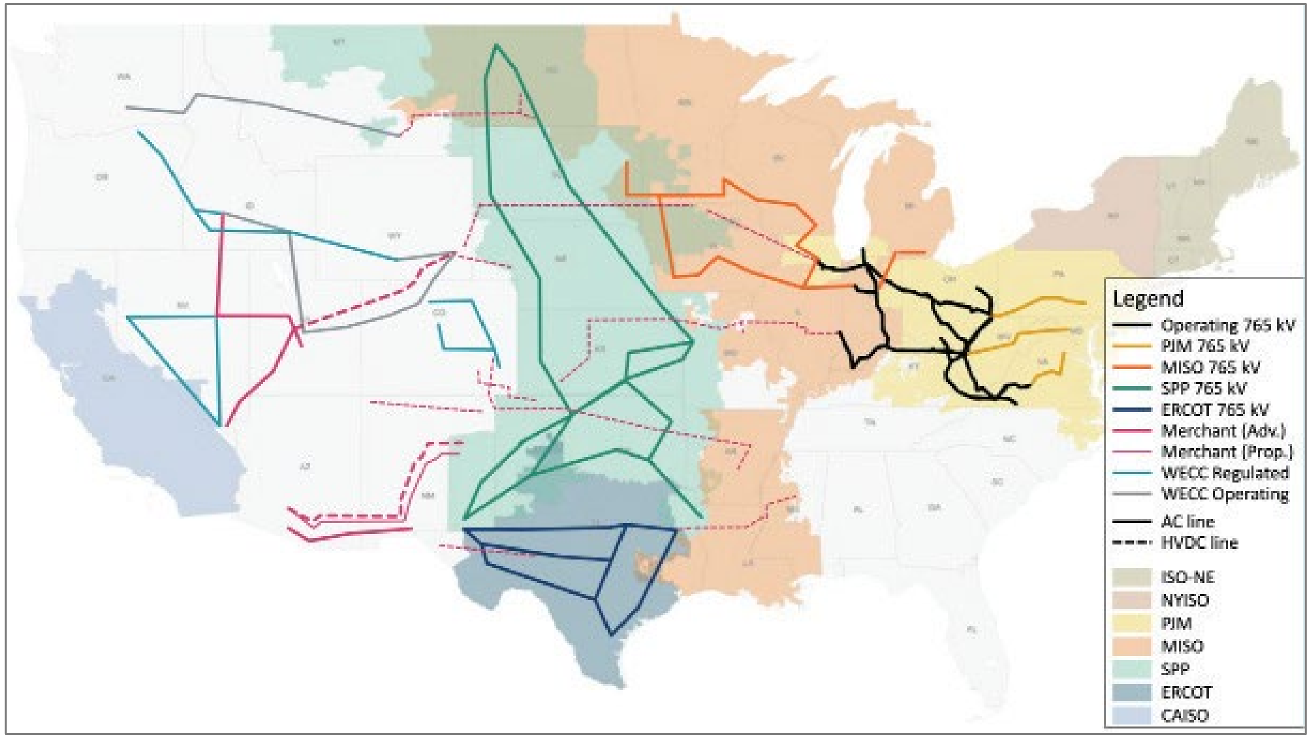
Comprehensive, Coordinated Planning

Evaluate the full range of near- and long-term needs—local, regional, and interregional—using multi-value, least-regrets analysis to identify the most cost effective and robust solutions.

Proactive Planning example: MISO's LRTP portfolios: 1.8–3.8 benefit-cost, ~136 GW supported.

Longer-Term Solutions: Interregional Planning

- MISO, PJM, SPP, and ERCOT have each recently proposed or approved 765 kV transmission overlays
- Multi-value planning that considers all future needs recognizes the value of extra-high-voltage backbone investment, including their greater ability to serve load growth.
- These regional overlays would be enhanced further if integrated inter-regionally.
- That requires the inter-regional coordination of the multi-value planning this report recommends.



Planned and Proposed High-Voltage Transmission Overlays and High-Voltage DC Lines

Source: The Brattle Group, Interregional Transmission: Opportunities to Improve Market Seams

Longer-Term Solutions: Proven Models

ERCOT: Comprehensive Transmission Planning

Combining large-load “batch” interconnection studies with broader transmission planning into one comprehensive process.

SPP: Consolidated Planning Process

Merges interconnection, reliability, economic, and public policy transmission studies into one process, which was approved by FERC in March 2026.

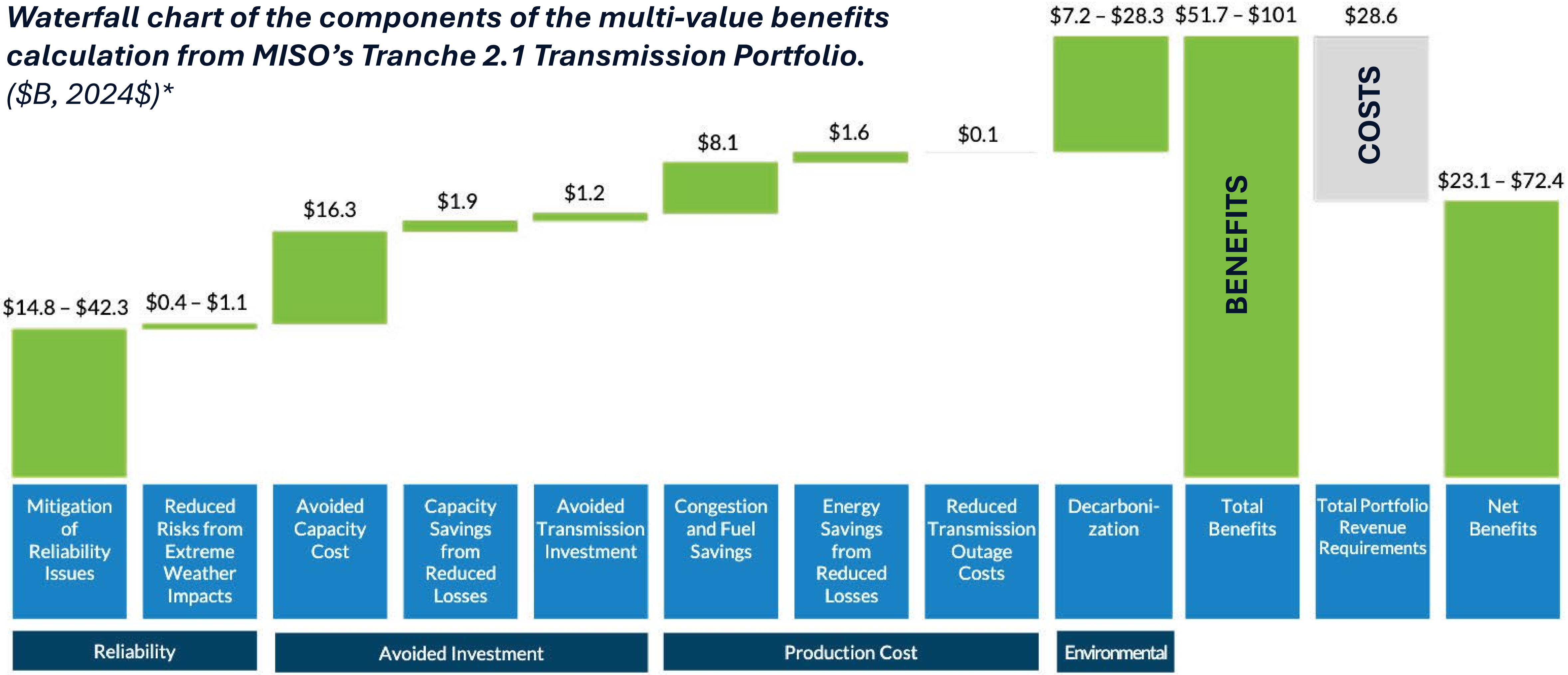
MISO & SPP: Long-Range & Joint Queue Planning

MISO's long-range planning evaluates larger multi-value solutions.

SPP-MISO Joint Transmission Interconnection Queue (JTIQ) study: 9 GW existing and 20 GW additional generation at $58/kW, less than half the typical $100–130/kW cost of individual queue processes.

Example: MISO Multi-Value Benefit-Cost Analysis

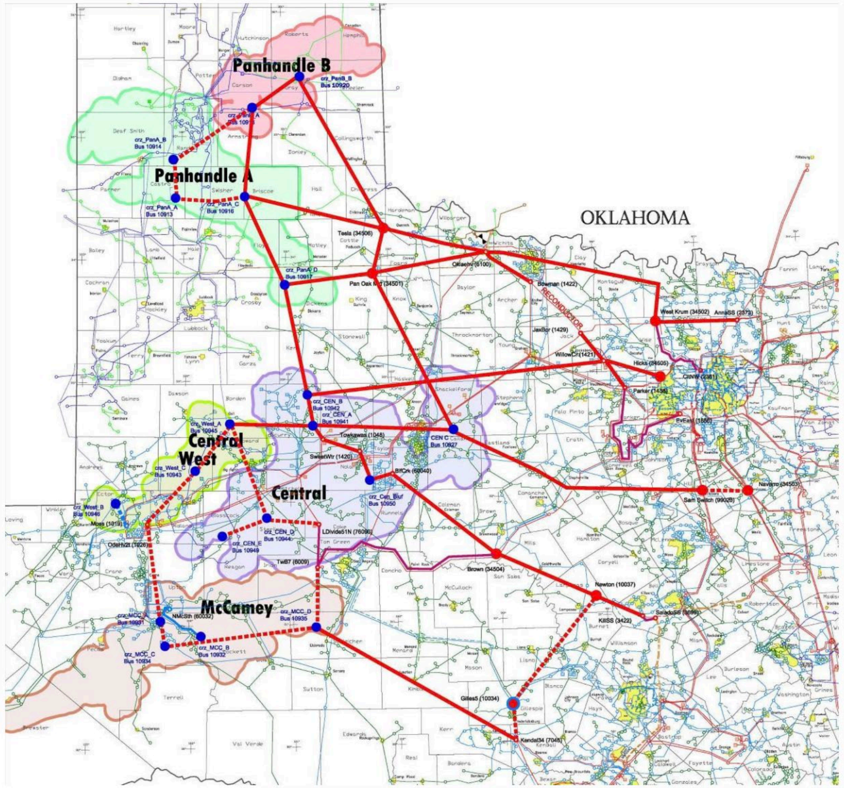
Waterfall chart of the components of the multi-value benefits calculation from MISO's Tranche 2.1 Transmission Portfolio.
*($B, 2024$)**



Longer-Term Solutions: Development Zones in Practice

Texas: CREZ

Competitive Renewable Energy Zones identified development areas in advance and proactively built transmission to reach them — not one request at a time.



Source: https://www.ercot.com/files/docs/2014/08/14/ghg_combined_c.pdf

Illinois: REAP

Illinois's 2024 Renewable Energy Access Plan applies the same idea, mapping where new resources and transmission should develop together.

Who Needs to Act

FERC

Report implication: extend Order 1920's coordination beyond long-term planning to also span interconnection and near-term reliability.

NERC

Report implication: treat headroom studies and shared large-load datasets as compliant tools within near-term reliability planning standards.

ISO/RTO

Scale ERCOT-, SPP-, and MISO-style proactive planning processes; adopt shared assumptions, datasets, and least-regrets project selection.

States

Establish or support development zones where large load, supply, and transmission can be planned and advanced together.

Utilities

Publish headroom maps; use near-term tools and flexible-load arrangements; design near-term grid upgrades for long-term robustness.

Discussion & Q&A

Share your questions in the chat.

Our speakers will address as many as we can before we close.

Thank you

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Supplemental Slides

More Info & How To Get Involved

Read the Full Report

Transmission Planning with Large Loads: Current Practices and Recommendations — a report by ESIG's Large Loads Task Force.

esig.energy/reports-briefs/transmission-planning-large-loads

Explore the Full Series

This report is one of 11 from ESIG's Large Loads Task Force — covering forecasting, interconnection, performance requirements, reliability, and more.

esig.energy/working-groups/large-loads

Stay Involved

Questions, or want to get involved in future ESIG large loads work?

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