Generation Interconnection Queue and Withdrawals

PRESENTED TO

i2x STITCH Meeting

PRESENTED BY

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Brattle



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Generation Interconnection and FERC Order 2023

A Generation Interconnection (GI) study serves to determine what changes to the transmission system are required to accommodate a proposed interconnection consistent with the applicable interconnection service and reliability standards.

In a cluster study, this inquiry requires answering three related but separate questions, in sequence:

(i) whether a transmission limitation or need exists under the pre-existing conditions;
(ii) to what extent that need is incrementally caused by the interconnection requests under study; and
(iii) if an upgrade is incrementally required by those requests, how its cost should be allocated among the projects and load that contribute to the need.

In Order No. 2023, FERC directed the transition from a "first-come, first-served" serial study approach to a "first-ready, first-served" cluster study model. Some RTO/ISOs were also required to conduct a transitional study as a bridge. The Order also asks for higher at-risk deposits and withdrawal penalties to ensure stricter readiness criteria to enter and advance in the GI queue.

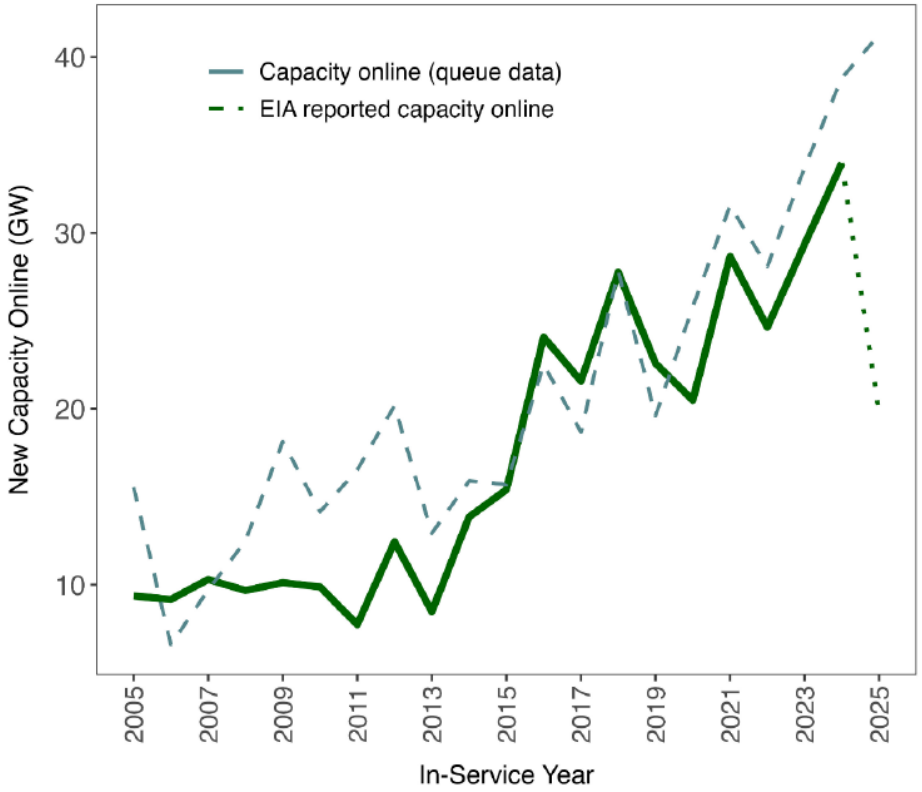
The majority (>70%) of GI requests are withdrawn. Just 13% of capacity submitted into queues from 2000-2020 had come online as of the end of 2025.

- ✓ Limited available transmission capacity has resulted in high interconnection upgrade costs, which contributes to high withdrawals and may deter developers from submitting new requests.
- ✓ Several regions experienced significant withdrawals in 2025, likely due to reforms (e.g., developers required to resubmit to remain in the queue) as well as other external drivers, such as policy and market changes (e.g., federal tax credit expiration).

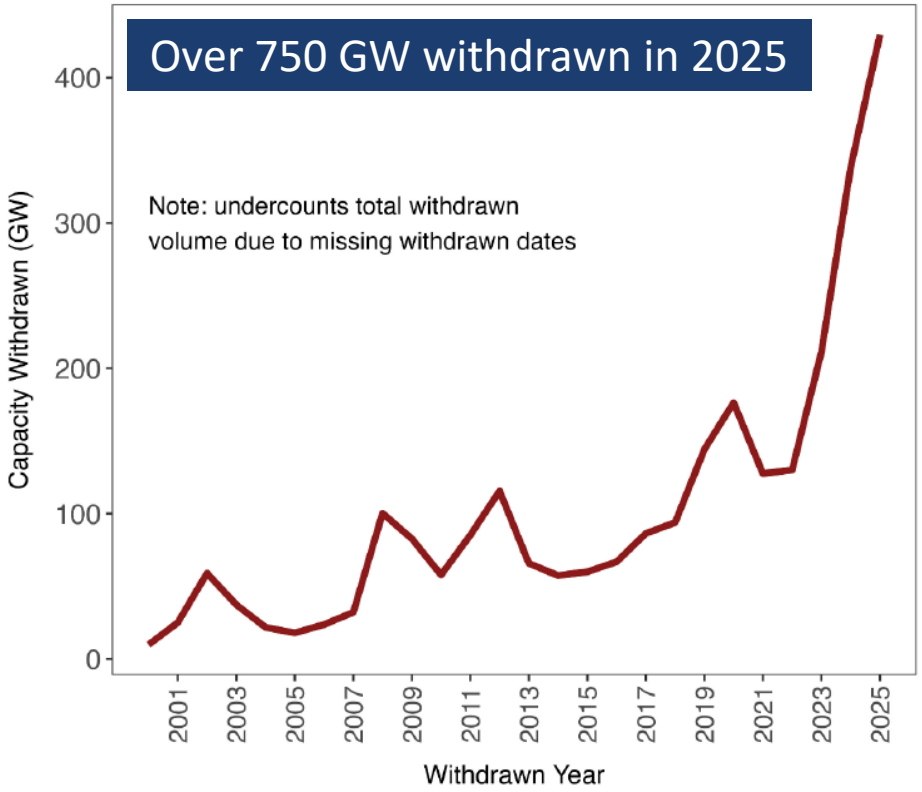
GI Queue Withdrawals: 1/2

While both Operational Projects and Withdrawn Projects are trending upwards, Withdrawals have increasingly become much higher in recent years.

Operational Projects



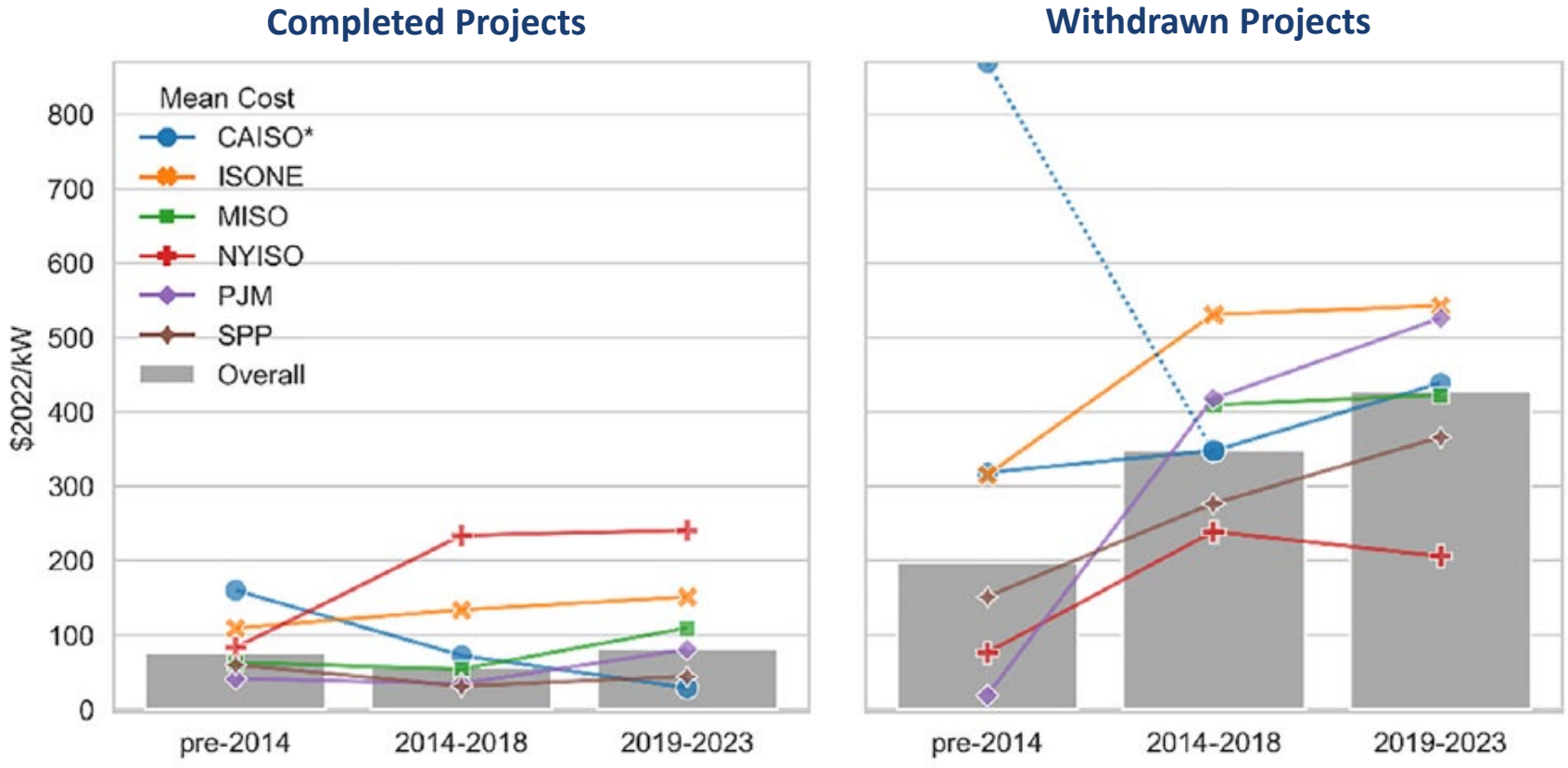
Withdrawn Projects



Source: P 34, Lawrence Berkely National Laboratory, Queued Up: 2026 Edition Characteristics of Power Plants Seeking Transmission Interconnection, As of the End of 2025, published June 2026, available at: https://eta-publications.lbl.gov/sites/default/files/2026-06/queued_up_2026_edition.pdf.

GI Queue Withdrawals: 2/2

Observing the mean-cost of Completed and Withdrawn projects suggests increase in Withdrawals is strongly correlated with higher GI costs.



Source: P 7, Joule Article, Grid connection barriers to renewable energy deployment in the United States, published February 2025, available at: https://www.sciencedirect.com/science/article/pii/S2542435124005038.

Coordinated Long-term Planning Could Lower GI Costs

MISO and SPP's Joint Targeted Interconnection Queue (JTIQ) Study shows that proactively addressing a larger interregional set of GI requests offers substantial cost savings.

Lower GI costs enabled by JTIQ:

- ✓ $58/kW with 100% participant funding; and $28/kW if production cost savings to regional loads are netted.
- ✓ Less than half of SPP's and MISO's individual GI costs of $100-130/kW.

JTIQ studied a portfolio of seven projects, totaling $1.65 billion, which is expected to fully address the transmission needs along the MISO-SPP seam previously identified in MISO and SPP individual GI studies.

- ✓ Able to quickly allow for 9 GW of existing generator interconnection requests and enable an additional 20 GW of projects near the SPP-MISO seam.
- ✓ Additionally yields estimated $1 billion in production cost savings ($724 million in MISO and $247 million in SPP) due to congestion relief.

While proactive planning can lower GI costs, the opposite is also true!



See MISO-SPP Joint Targeted Interconnection Queue Study, March 2022.
Tsuchida, Proactive Planning for Generation Interconnection A Case Study of SPP and MISO (August 17, 2022) at 9.

GI Costs Observations

GI costs vary by location and service required (network/capacity or energy only). Part of this is caused by the different GI approach.

Region	GI Type	Estimated GI Costs ($/kW)	Notes and Source
PJM	Energy	$117	Transition Cycle 1, Phase III, September 18, 2025 report
	Capacity	$263	
	Energy	$114	Transition Cycle 2, Phase II, June 3, 2026 report
	Capacity	$176	
SPP	Energy	$62 - $85	Estimates from SPP Interconnection Cluster Study Process Overview, varies by SPP region (North, Nebraska, Central, Southeast, Southwest)
	Capacity	$94 - $125	
ISO-NE	Energy	N/A	Transitional Cluster Study (TCS), August 6, 2026 final report (see next slide)
	Capacity	$828	

ISO-NE shows extremely high GI costs, allocating $3.2 billion of upgrade costs to 23 GI requests* (~4.8 GW summer capacity). The average system upgrade is estimated to require 71 months (median of 69 months). The $3.2 billion cost is roughly 2x of the $1.65 billion cost for JTIQ, which can immediately interconnect 9 GW (~2x of the 4.8 GW studied in the ISO-NE TCS).

*Five of the 23 projects, adding to roughly 1,000 MW, applied for energy only interconnection requests.

ISO-NE Transitional Cluster Study Outline

ISO-NE published its Transitional Cluster Study (TCS) in August 2026.

The Final TCS Report analyzed 23 projects:

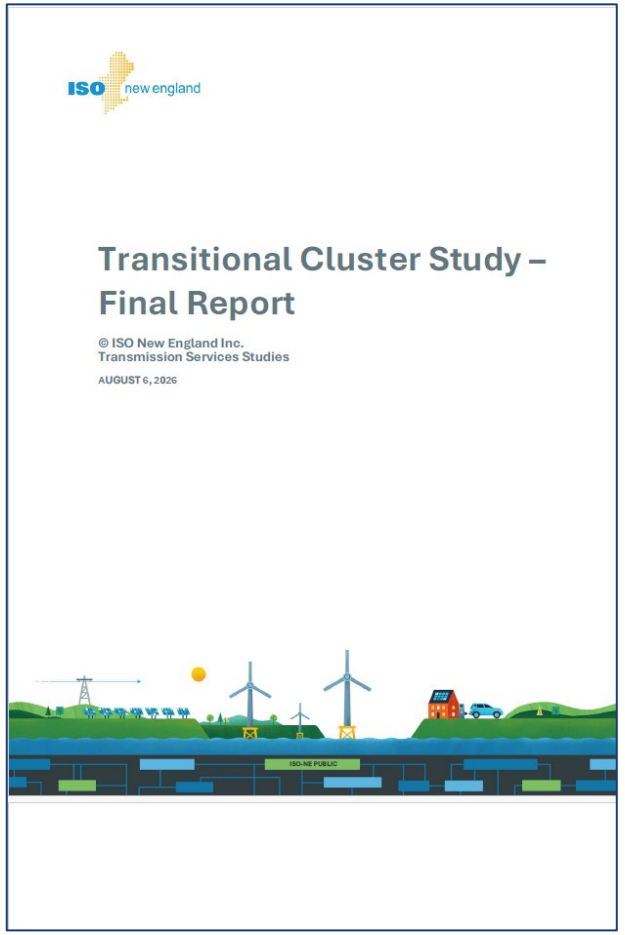
- ✓ Total capacity analyzed was approximately 4.8 GW (summer) / 5.4 GW (winter).
- ✓ 18 projects add to 3.8 GW (summer) requested capacity interconnection (CCIS).
- ✓ 5 projects add to 1.0 GW requested energy only interconnection (NRIS).

The study identified interconnection costs totaling $3.2 billion for the 23 projects.

- ✓ Approximately 80% of this amount, or $2.5 billion, consists of System Network Upgrades.
- ✓ Nearly 70% of total interconnection costs and 86% of System Network Upgrade costs (approaching $2.2 billion) are associated with thermal upgrades identified through the CCIS capacity-deliverability analysis.

The TCS differs materially from the permanent cluster process.

- ✓ The transition process proceeded from an interim report and customer comment period to a final report and Interconnection Agreement development, without a separate Facilities Study or a defined, scheduled cluster-restudy sequence.
- ✓ Although ISO-NE may require a restudy where withdrawals or other changed circumstances warrant one, TCS customers do not have an automatic opportunity for a restudy before substantial commercial obligations arise.



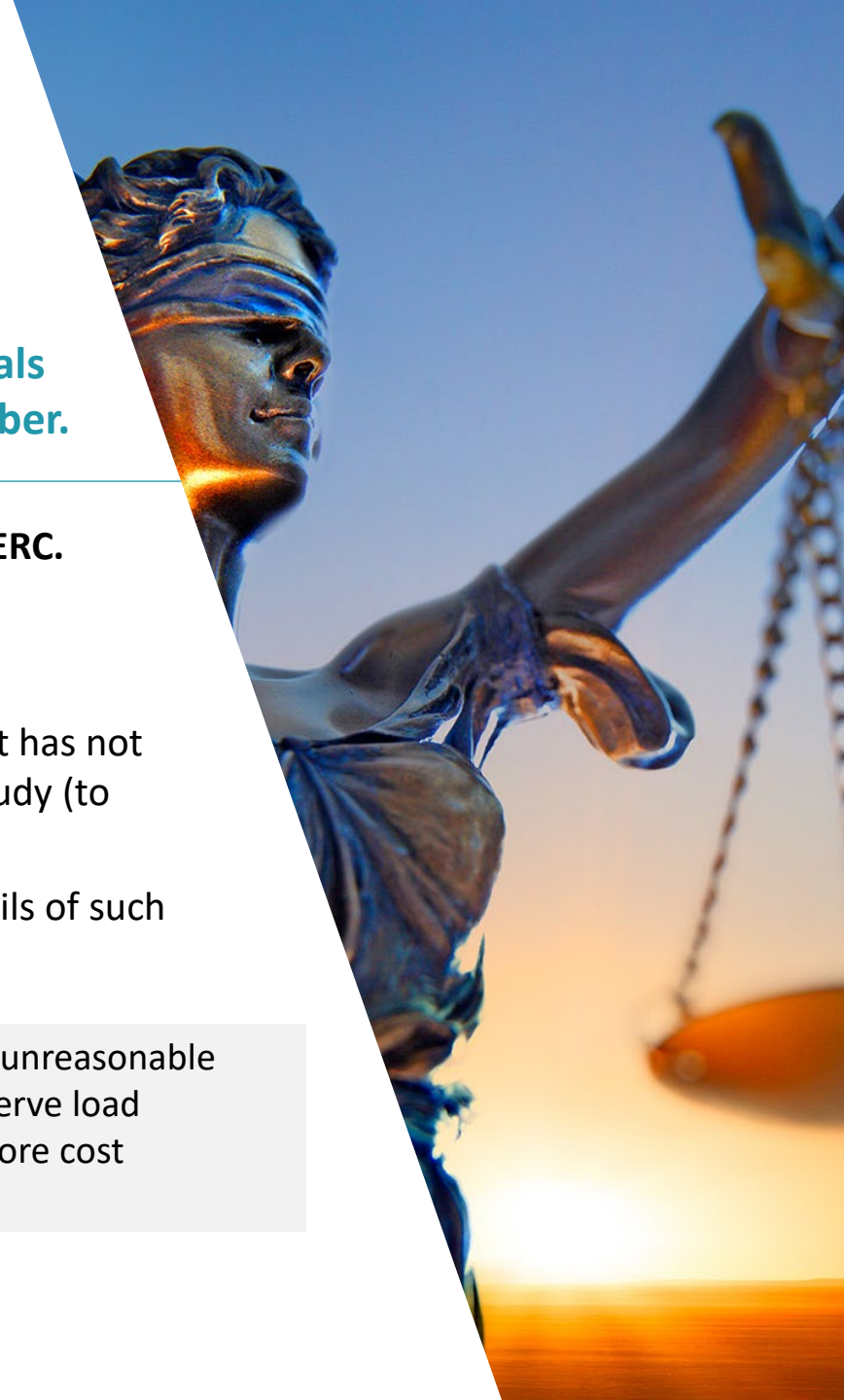
ISO-NE TCS Complaint

GI costs estimated in ISO-NE's TCS (published August 2026) appear to be extraordinarily high, surpassing the costs that historically resulted in withdrawals for many projects. At least seven projects have withdrawn as of end of September.

Five GI customers with 11 projects totaling 2.3 GW filed a complaint against ISO-NE at FERC.

- ✓ The study process has limited transparency.
- ✓ The process and assumptions applied in the study appear to be flawed.
- ✓ While ISO-NE has responded to feedback and concerns in response to the TCS results, it has not modified its cluster study methodology for the TCS and indicated it will not for the restudy (to account for the withdrawals) neither.
- ✓ ISO-NE has indicated that it will revisit its planning procedures for the next cluster, details of such revisions have not been shared.

In *Champion International v. ISO-NE*, FERC addressed an allegation that NEPOOL was imposing unreasonable assumptions in its system impact study that every interconnecting generator must be able to serve load anywhere in NEPOOL. The remedy required a study performed on reasonable assumptions before cost responsibility were attached to generators.



ISO-NE TCS Approach: Overview

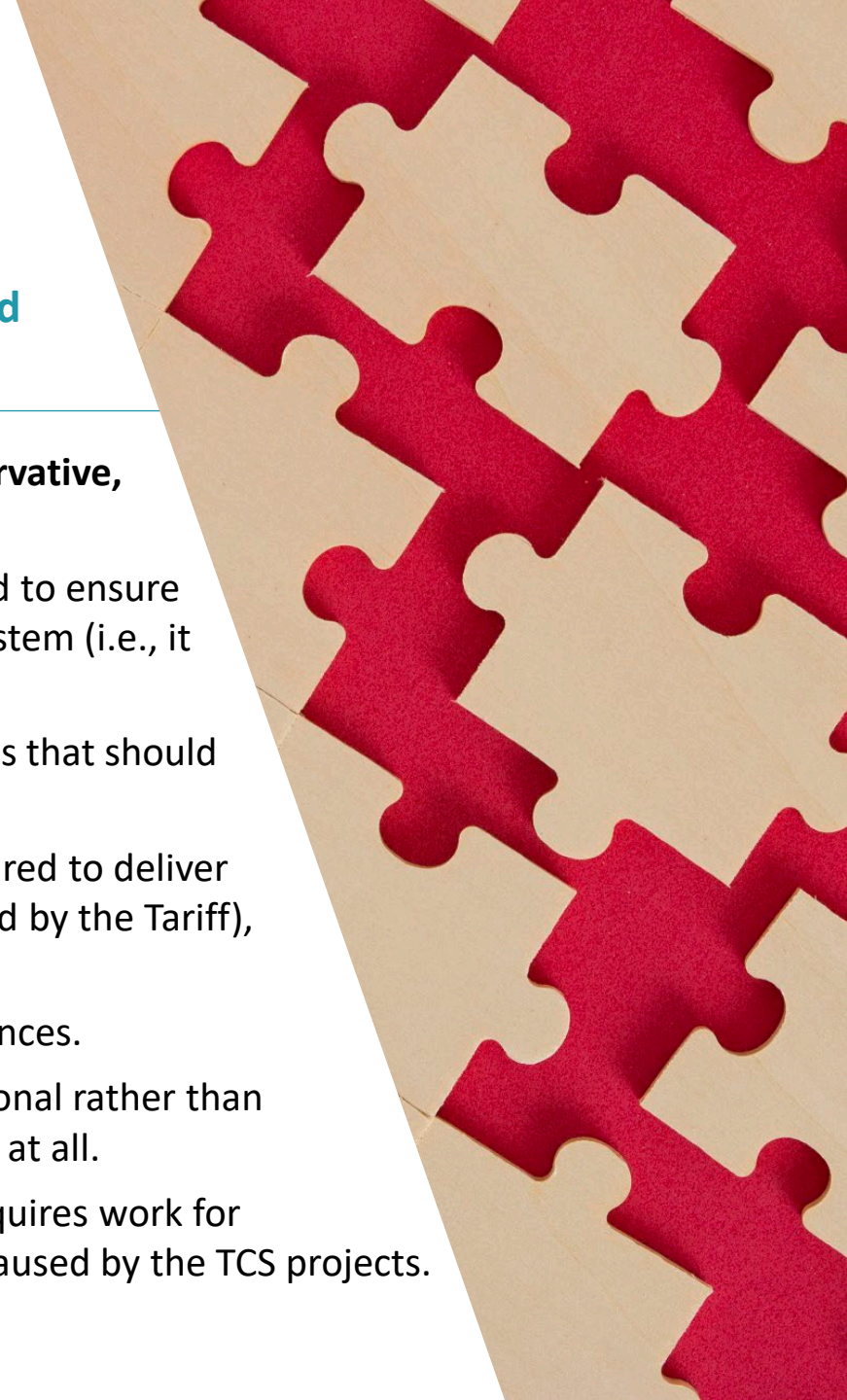
"ISO-NE applied modeling assumptions extend beyond merely conservative and across the line to unreasonable."

ISO-NE's approach and assumptions used in the cluster study appear to be overly conservative, and as a whole, lead to unrealistic results.

1. It assigned costs to interconnection customers, even where infrastructure was needed to ensure deliverability of existing resources, whether or not the new customers entered the system (i.e., it assigned costs that were not the "but for" consequence of new projects).
2. The method identified more constraints than necessary, triggering additional upgrades that should not have been identified.
3. Rather than assigning TCS interconnection customers only the costs of upgrades required to deliver their new projects to the capacity zone in which the projects were located (as required by the Tariff), ISO-NE assessed the costs of deliverability to the entire region.

These approaches/assumptions (see next slide and appendix) could lead to two consequences.

- ✓ Where the reference condition is more stressed than the CCIS requires, or tests inter-zonal rather than intra-zonal transfers, the resulting upgrade is not likely to be needed to provide service at all.
- ✓ Where the reference condition already contains the violation, or the facility already requires work for asset-condition reasons, the upgrade may well be needed. However, that need is not caused by the TCS projects.

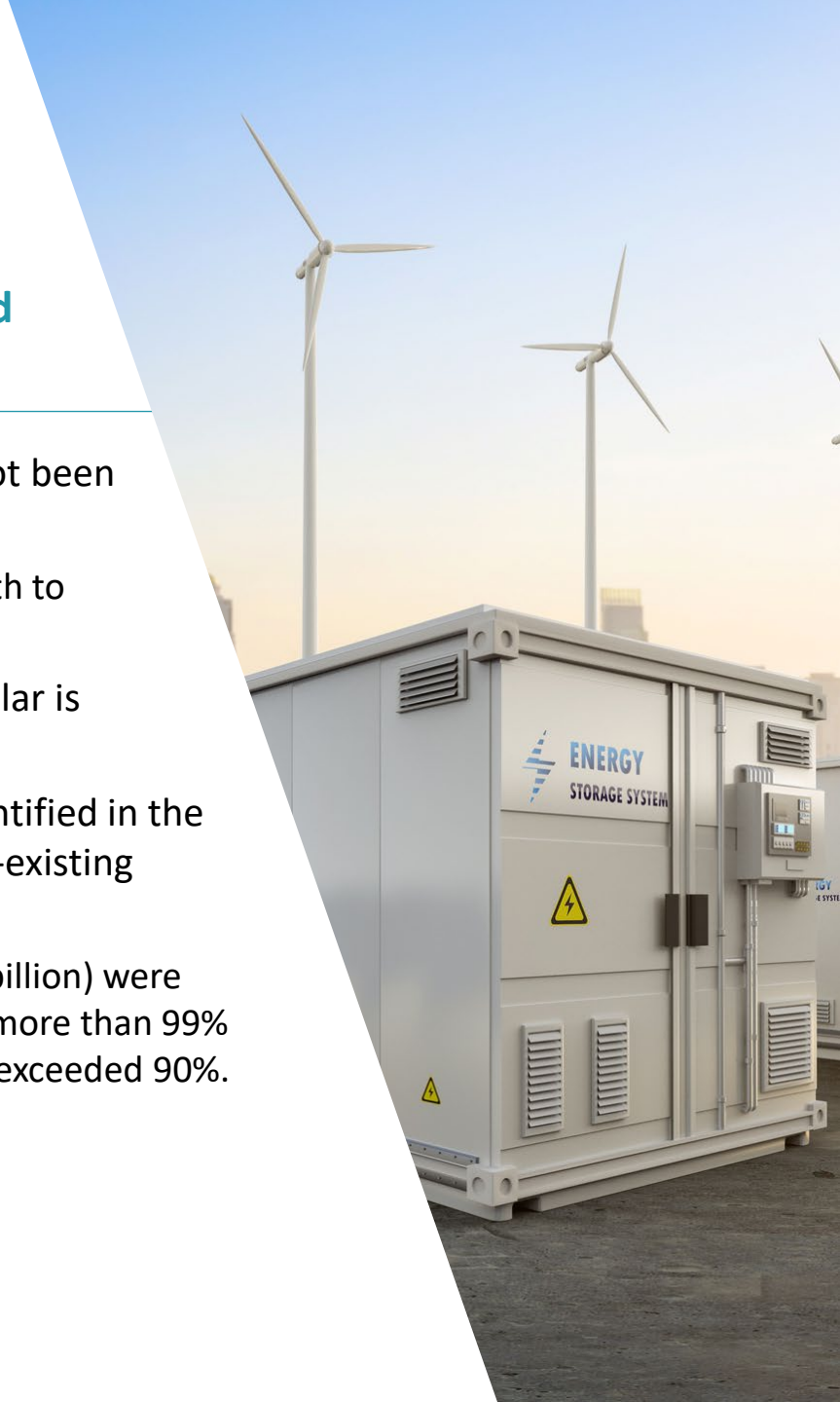


A Few Observations from the TCS

"ISO-NE applied modeling assumptions extend beyond merely conservative and across the line to unreasonable."

- ✓ GI costs for some battery energy storage in areas where transmission congestion has not been observed historically exceeded $1,000/kW ($1 million/MW).
  - By comparison, ISO-NE's recent forward capacity market cleared at around $2.5 /kW-month to 3.5/kW-month, or $30/kW-year to $40/kW-year.
- ✓ Dispatch modeled in the GI study for CCIS assumes battery storage discharging when solar is generating at its max.
- ✓ The initial reference case was already being overloaded, and a number of upgrades identified in the GI studies were already on the asset condition list (i.e., they were ISO-NE identified pre-existing requirements before the TCS.)
  - Out of the 44 upgrades identified that added to $3.2 billion, more than a third (over $1.1 billion) were associated with 12 upgrades needed to address infrastructure that was already loaded at more than 99% in ISO-NE's pre-project case. $1.8 billion arose from 26 upgrades where reference loading exceeded 90%.
- ✓ Tests inter-zonal rather than intra-zonal transfers.

Further details are discussed in the appendix.



Recommendations

1. Standardize a methodology well in advanced of GI analysis requirements.
   Encourage utility transparency in sharing the analyses, including detailed assumptions and rationale around methodology. This will be particularly important around new analyses like those triggered by Order 2023, or those associated with new technology.

2. Share various experiences across utilities. For example, use the TCS discussed in this presentation as a test bed for GI analysis evaluation but do not use the TCS customers as a guinea pig.
   Reflect on the findings to improve the process (which could include proactive planning), rather than stick to an approach.

3. Consider the eight Alternative Transmission Technologies (ATTs) discussed in Order 2023 in interconnection studies to reduce network upgrade costs, speed up queue processing, and improve grid efficiency. They can help support near term affordability and mitigate uncertainty.



Discussions



Appendix

- ISO-NE TCS Approach Details
- Alternatives Observed in NYISO
- Glossary



Appendix: ISO-NE TCS Approach: Overview

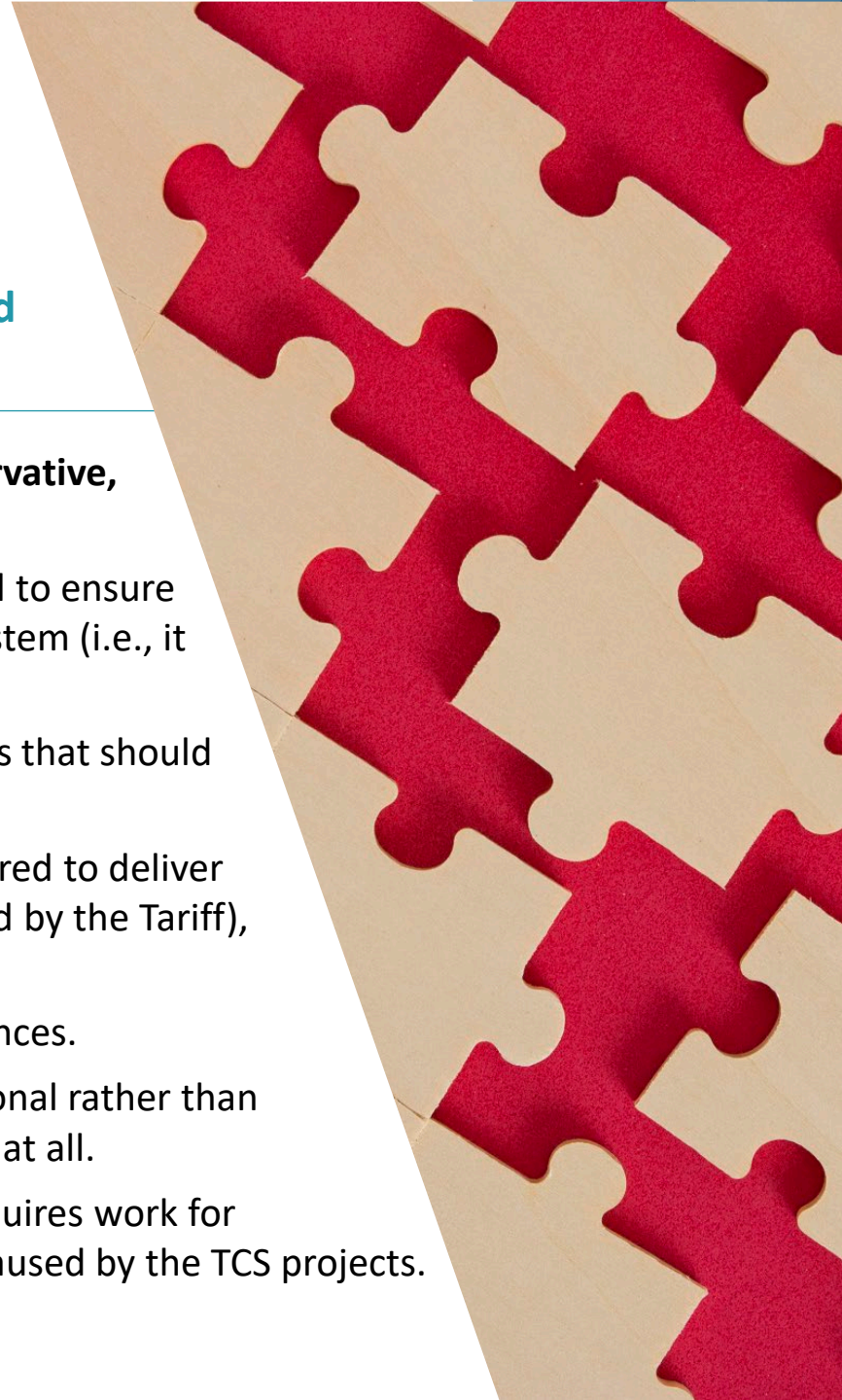
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Appendix: ISO-NE TCS Approach Details 1/3

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1. It assigned costs to interconnection customers, even where infrastructure was needed to ensure deliverability of existing resources, whether or not the new customers entered the system (i.e., it assigned costs that were not the "but for" consequence of new projects).
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   - ISO-NE's reference loading analysis relies in part on DC screening, while AC power flow can produce materially different loading results because it reflects reactive power, voltage, and losses. The complaint estimates that applying a 105% AC-to-DC factor would push 20 constraints totaling approximately $1.6 billion in estimated costs to exceed their ratings in the reference case.



Appendix: ISO-NE TCS Approach Details 2/3

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2. The method identified more constraints than necessary, triggering additional upgrades that should not have been identified.
   - For each stress flowgate, ISO-NE dispatched every harmer with a DFAX of 3% or greater (even if initially offline) to its full summer capacity until a monitored flowgate reached 100% of its rating. Those harmers could include other TCS projects not under study in that dispatch.
   - The method identified more constraints than necessary, triggering additional upgrades that should not have been identified. For example, the dispatch models battery storage discharging when solar is generating at its max.
   - For each stress flowgate, ISO-NE dispatched every harmer with a DFAX of 3% or greater (even if initially offline) to its full summer capacity until a monitored flowgate reached 100% of its rating. Those harmers could include other TCS projects not under study in that dispatch.
   - Many of the pre-loaded reference cases did not reflect either
     i) historical grid operating conditions, or
     ii) reasonably expected future operating conditions.



Appendix: ISO-NE TCS Approach Details 3/3

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3. Rather than assigning TCS interconnection customers only the costs of upgrades required to deliver their new projects to the capacity zone in which the projects were located (as required by the Tariff), ISO-NE assessed the costs of deliverability to the entire region.
   - ISO-NE's compliance filing for Order No. 2023 states that Capacity Network Resource Interconnection Service (CNRIS) offered Interconnection Customers the ability to interconnect their facilities for capacity under the intra-zonal deliverability standard, called the Capacity Capability Interconnection Standard (CCIS).
   - ISO-NE's planning document, PP5-6, confirms that a proposed facility "is not responsible for increasing the transfer capabilities of interfaces that form the boundaries between existing Load Zones."
   - The current approach applied to the TCS, which uses the ISO-NE load center as the reference bus, rather than the zone load center, effectively asks for inter-zonal deliverability that requires increasing transfer capability across an interface that forms a Load Zone boundary. ISO-NE's own division of responsibility places the cost of regional transmission service needed to deliver output to load, rather than the Interconnection Customer.
   - The complaint assumes over a quarter of the $3.2 billion of upgrade costs (over $800 million) are from interfaces that form the boundaries between existing Load Zones.

Appendix: Alternatives Observed in NYISO

NYISO recently revised its deliverability methodology after its first cluster analysis and demonstrated that assumptions used to construct its deliverability analysis materially affected the transmission upgrades identified.

The revised NYISO approach (accepted by FERC) addressed an analytical issue of whether the transfer assumed in a capacity deliverability study reflects transmission capability that is actually required to provide the requested capacity service.

- ✓ While the mechanics of the NYISO and ISO-NE methodologies differ, both use constructed dispatch conditions to determine whether new capacity can be accommodated while preserving the deliverability rights of existing resources.
- ✓ NYISO asked whether the modeled transfer represents transmission capability that the new capacity actually requires, rather than additional capability created by the assumptions used to construct the study case.
- ✓ When NYISO performs the upstream and downstream deliverability test, an overload is identified based on the lesser of the upstream excess generation or the downstream load plus load forecast uncertainty.

For example, if 1,000 MW of excess generation is available upstream but only 400 MW of load must be served downstream, a study that requires the transmission system to accommodate the full 1,000 MW evaluates a transfer greater than the transfer necessary to serve the downstream load. An overload created by the assumed 1,000 MW transfer establishes that the system cannot accommodate that modeled transfer, but it does not establish that the same transmission capability is necessary to provide the requested capacity service.

- ✓ After NYISO revised its deliverability methodology, only three of the 24 upgrades identified previously were expected to remain necessary. FERC Commissioner Rosner estimated that this reduction would avoid more than $1 billion in unnecessary upgrade costs.

APPENDIX

Glossary

- ATT — Alternative Transmission Technologies
- CNR — Capacity Network Resource
- CNRIS — Capacity Network Resource Interconnection Service
- CCIS — Capacity Capability Interconnection Standard
- DFAX — Distribution Factor
- FERC — Federal Energy Regulatory Commission
- GI — Generation Interconnection
- ISO — Independent System Operator
- ISO-NE — ISO New England
- JTIQ — Joint Targeted Interconnection Queue
- MISO — Midcontinent ISO
- NCIS — Network Capability Interconnection Standard
- NRIS — Network Resource Interconnection Service
- NYISO — New York ISO
- PJM — PJM Interconnection
- RTO — Regional Transmission Organization
- SPP — Southwest Power Pool
- TCS — Transitional Cluster Study

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Mr. T. Bruce Tsuchida is a Principal of The Brattle Group with over thirty years of experience in domestic and international power generation development, utility operation, and power market analysis. He specializes in bridging technology, economics, and regulatory policy, particularly in assessing the impact of new technologies and regulatory changes. This includes modeling of evolving wholesale and retail electricity markets, impact of renewables, storage, and other new technologies' on system operations, utility business, and various valuations (including the engineering and technical capabilities) of transmission, generation, and distribution assets, deliverability, and contracts.

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