ESIG LLTF
MISO Large Load Forecasting
(Focus on Data Centers)

May 6th, 2025

Executive Summary

Purpose: To provide an overview of MISO's large load research and load forecasting process

- **Process:** MISO has developed a compendium approach to determining large load growth and associated power consumption
- **Results:** Significant new load growth is anticipated for MISO's system driven by industry and technological changes.
- **Next Steps:** Refine the needs for data exchanges with MISO partners and external communications

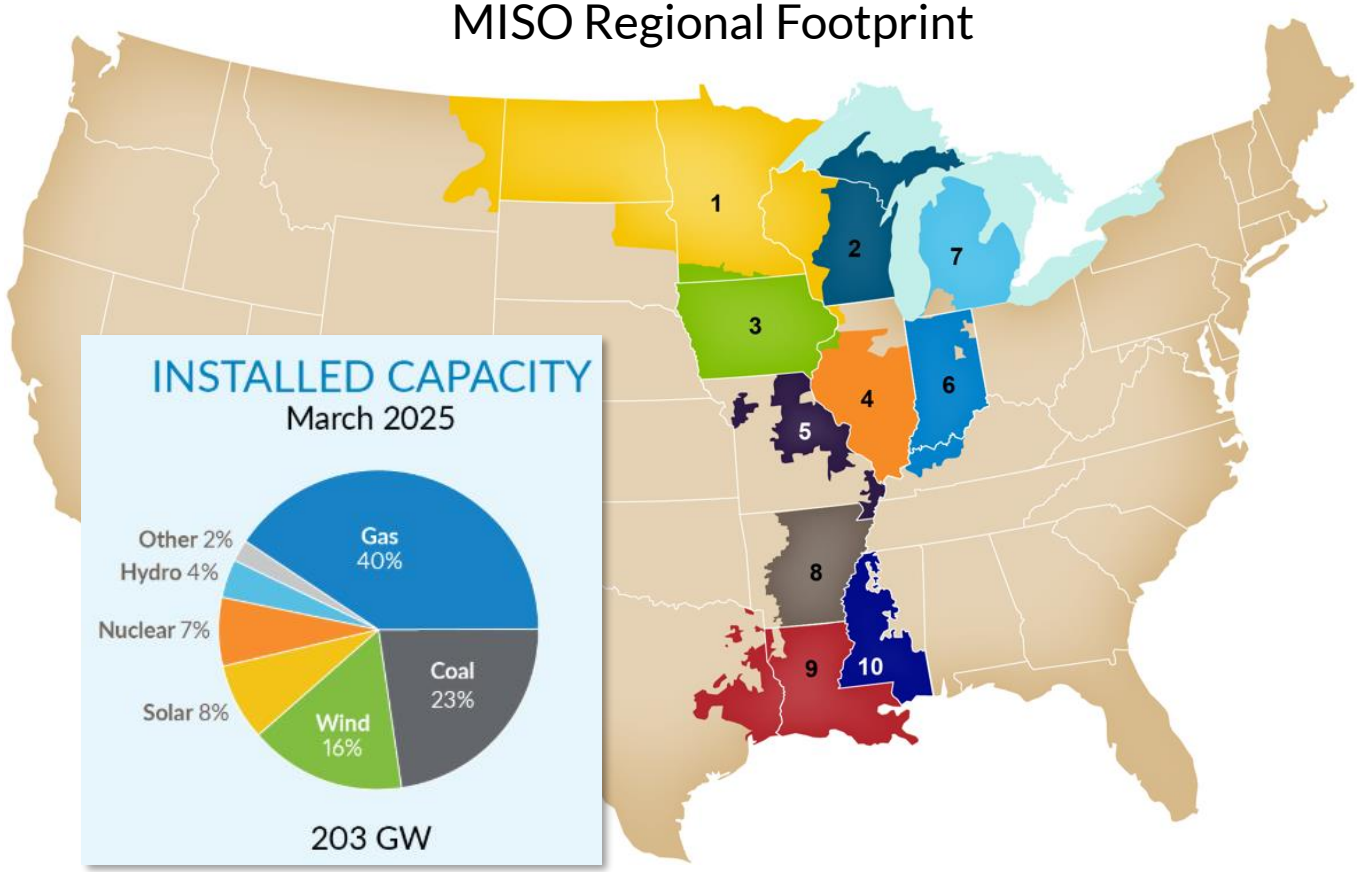
MISO—Midcontinent Independent System Operator

- Headquartered in Carmel, IN with additional control rooms in Eagan, MN and Little Rock, AR
- MISO manages market operations and conducts transmission planning across 15-state footprint

KEY FACTS

Area Served	15 U.S. States and Manitoba, Canada
Population Served	45 Million
Transmission Line	77,000 Miles
Generating Units (Commercial Model)	1,460
Record Demand	127.1 GW 7/20/2011
Wind Peak	25.6 GW 1/12/2024
Solar Peak	11.5 GW 2/21/2025
Members	55 Transmission Owners
	168 Non-transmission Owners
Market Participants	>550
Carbon Reduction	Approximately 32% since 2014

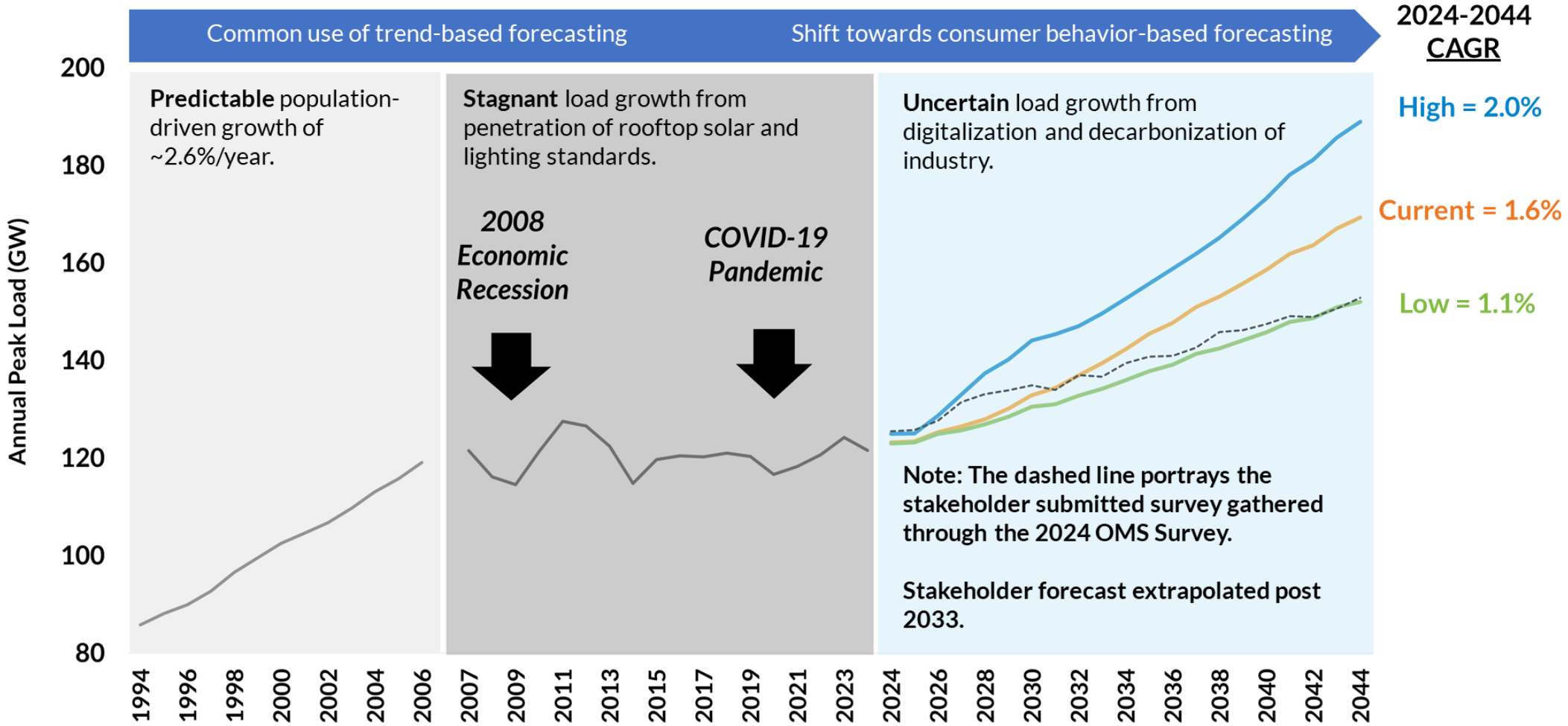
MISO Regional Footprint



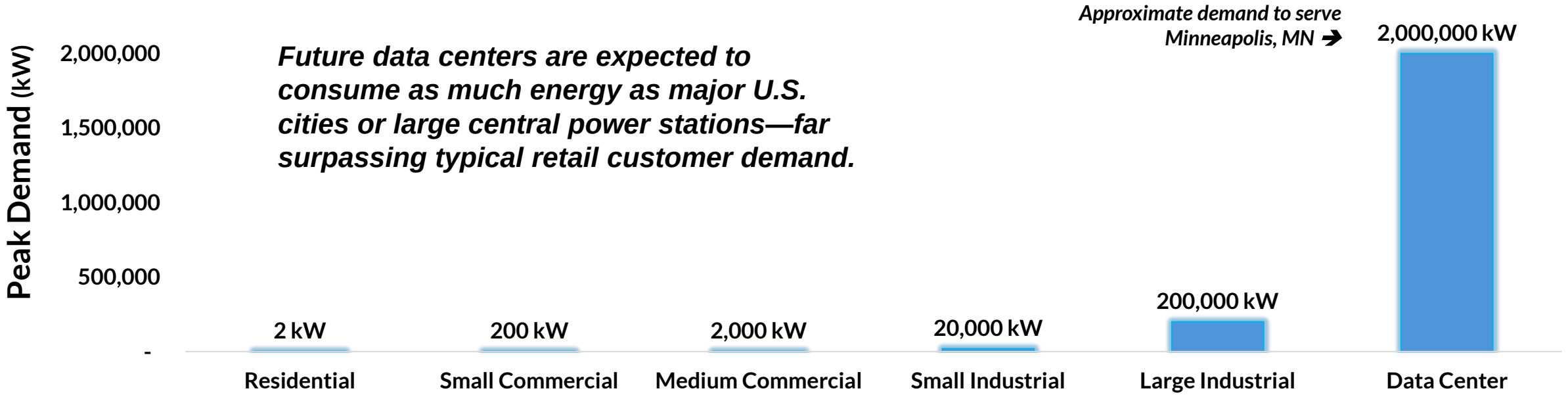
Long-term load forecasting is vital for planning and must account for increasing uncertainties amid industry changes.

- 20-year planning horizon for long-term load forecasting
- MISO's load forecast supports a variety of planning studies including:
  - **Planning** including Resource Adequacy Outlooks, MISO Futures, and Long-Range Transmission Planning.
  - **Compliance Efforts** such as Tariffs and regulatory filings.
  - **Corporate Planning Studies**, such as the MISO Value Proposition.

MISO's electric load growth is expected to climb as industry and consumers shift toward electrification.



The demand of typical retail loads is dramatically smaller than expected data center loads.



Known announcements will be documented and added to forecast updates

AI's promise is transformative, but investment and tech hurdles may slow scalable deployment—tempering data center growth and energy demand.

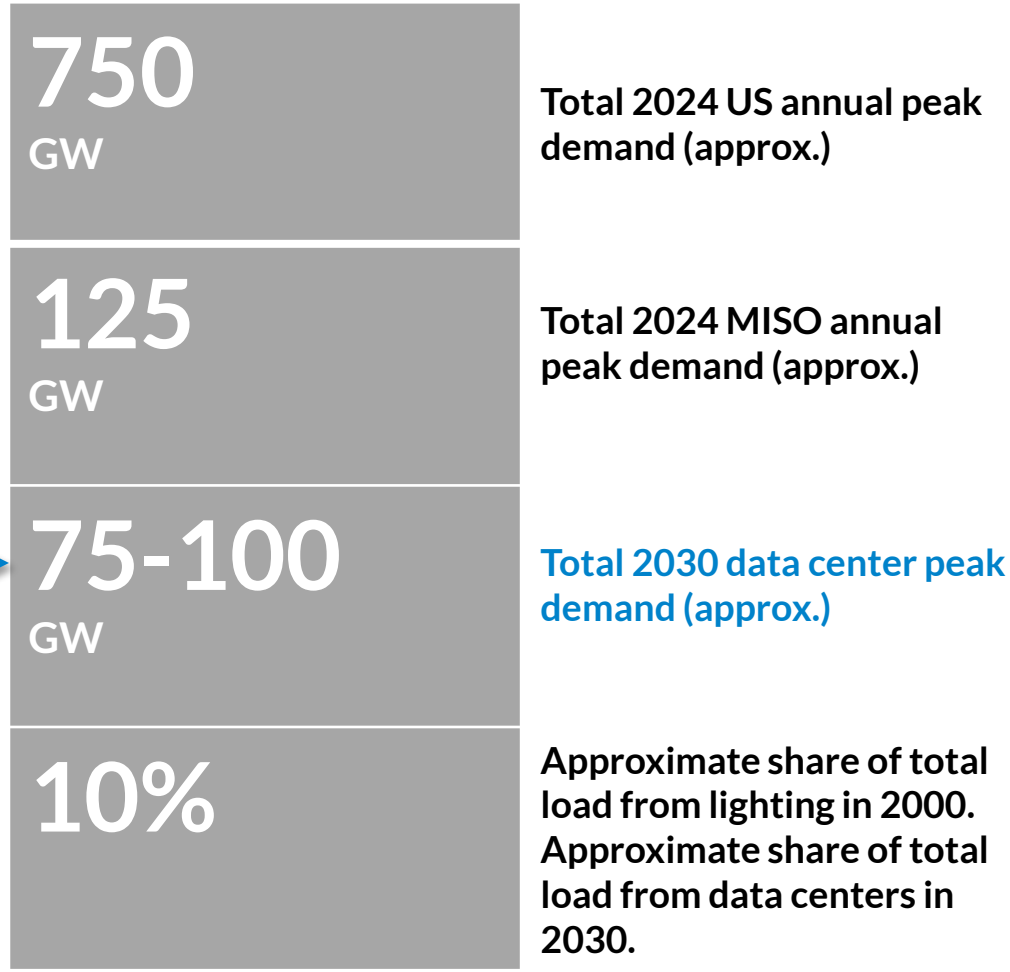
Dependency on AI Monetization
Data center energy demand hinges on successful AI monetization, with load growth uncertain due to the unpredictable pace of AI innovation.

Uncertain Realization of Projected Demand
Data centers could reach 10-12% of U.S. energy loads by 2030, but this depends on profitable AI applications; otherwise, demand may fall short.

Bulk Power Needs
Data centers require stable, high load factors, offering predictable demand to energy providers, contingent on continued expansion.

Reserve Power Needs
Data centers' demand stability benefits energy providers but relies on their continued growth.

Data Center Operators' Role in Energy Policy
Data centers are taking a quasi-utility role by investing in carbon-free generation and energy planning to manage their footprint and regulatory risks.

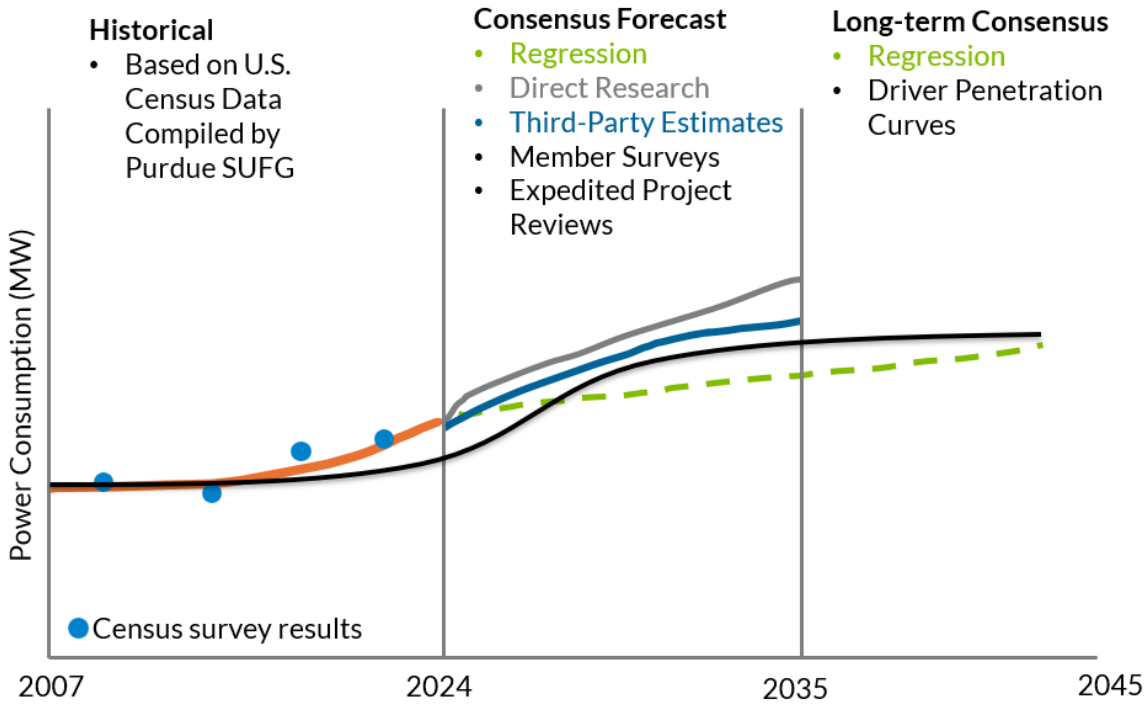


MISO's uses a compendium approach for forecasting its critical variables.

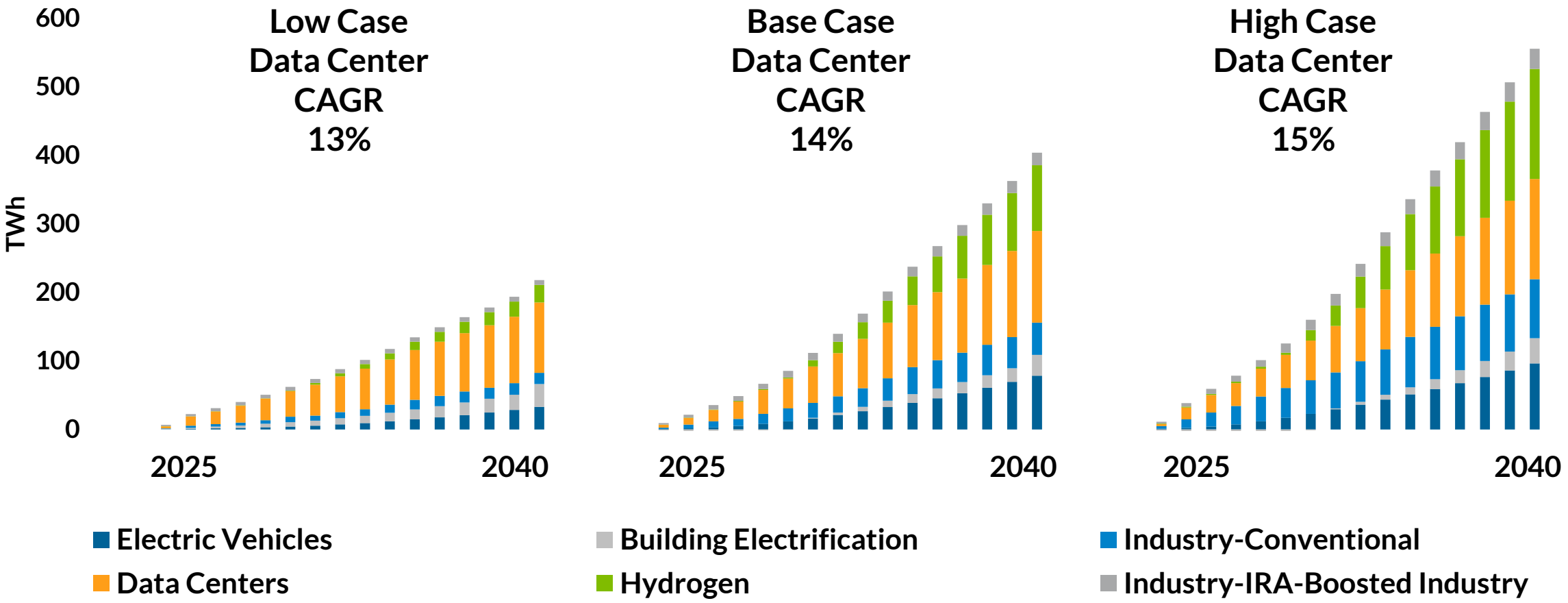
For the C&I sector, MISO uses a NAICS-based approach, distinguishing between standard and 'spotlight' drivers.

NAICS	Spotlight Industries	Data Sources
33-4413	**Semiconductors**	Semiconductor Industry Association
33-4413	**Solar**	Solar Energy Industries Association
32-4110	**Oil Refineries**	EPA
32-5193	**Ethanol**	EPA
33-1110	**Steel Mills**	EPA
32-6000	**Plastics and Rubber**	Public Announcements
33-1314	**Aluminum Smelting**	Public Announcements
33-5200	**Appliances**	Public Announcements
33-6110	**Electric Vehicles**	Public Announcements
33-6400	**Aerospace**	Public Announcements
51-8210	**Data Centers**	Public Announcements
54-1990	**3D Printing**	Public Announcements
33-5910	**Batteries**	NREL, Publ. Ann.

MISO consolidates data into a structured compendium, enabling trend analysis, development of consensus forecasts, and data-driven planning decisions.

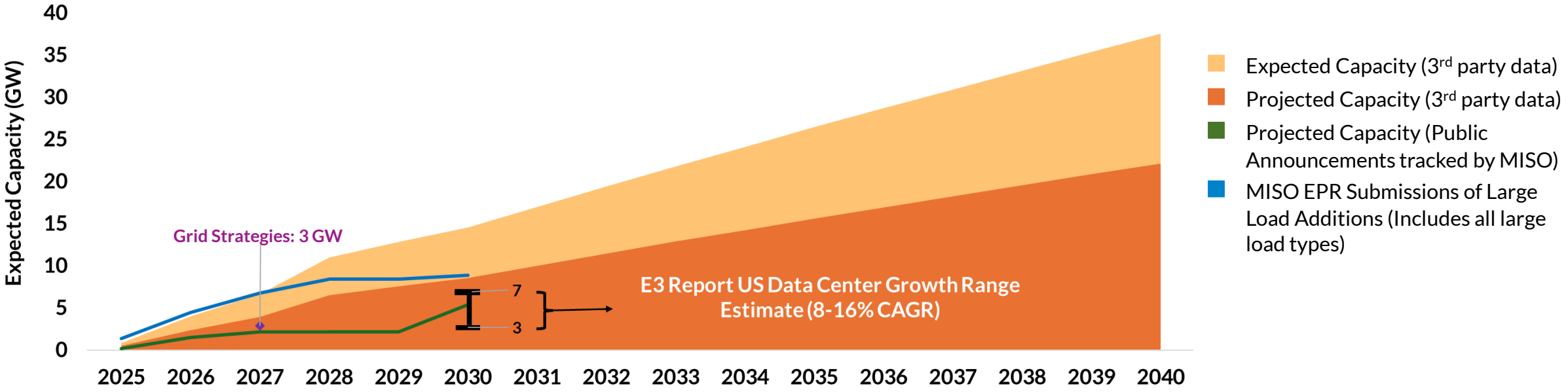


Data centers are poised to drive significant growth within MISO's footprint over the forecast horizon.



Data centers are becoming an increasingly significant portion of overall electric load due to rapid growth in AI and cloud computing, with demand forecasted to be 23-37 GW by 2044

- MISO's projections are based on announced project capacities, with growth distributed across ISOs and states
- Key uncertainties affecting AI-related load growth include challenges in site selection, supply chain bottlenecks for critical equipment, and construction delays due to labor shortages.

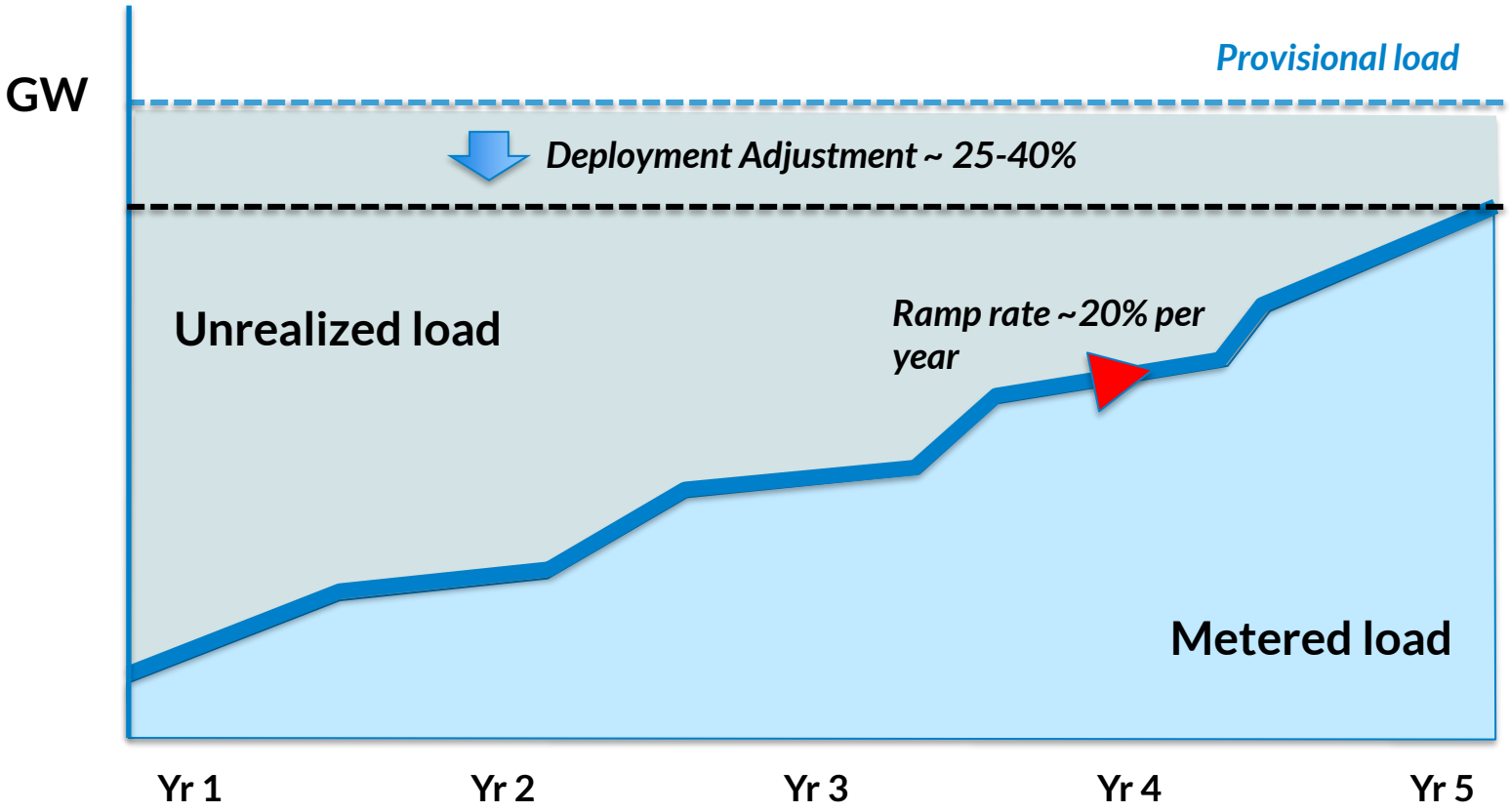


Notes: *Grid Strategies: The Era of Flat Power Demand is Over, 2023*

Basic Math Expected Total Demand = Online Date Acreage or Square Footage x Electrical Conversion Factors x % Realization and Phase-In Rate x Load Factor

Publicly stated data center plans require moderation of forecast assumptions to reflect phased deployment and observed industry realization rates.

Project adjustments for data center forecasts



Provisional Load The total projected capacity of new data center projects as initially announced, either publicly or through interconnection requests.

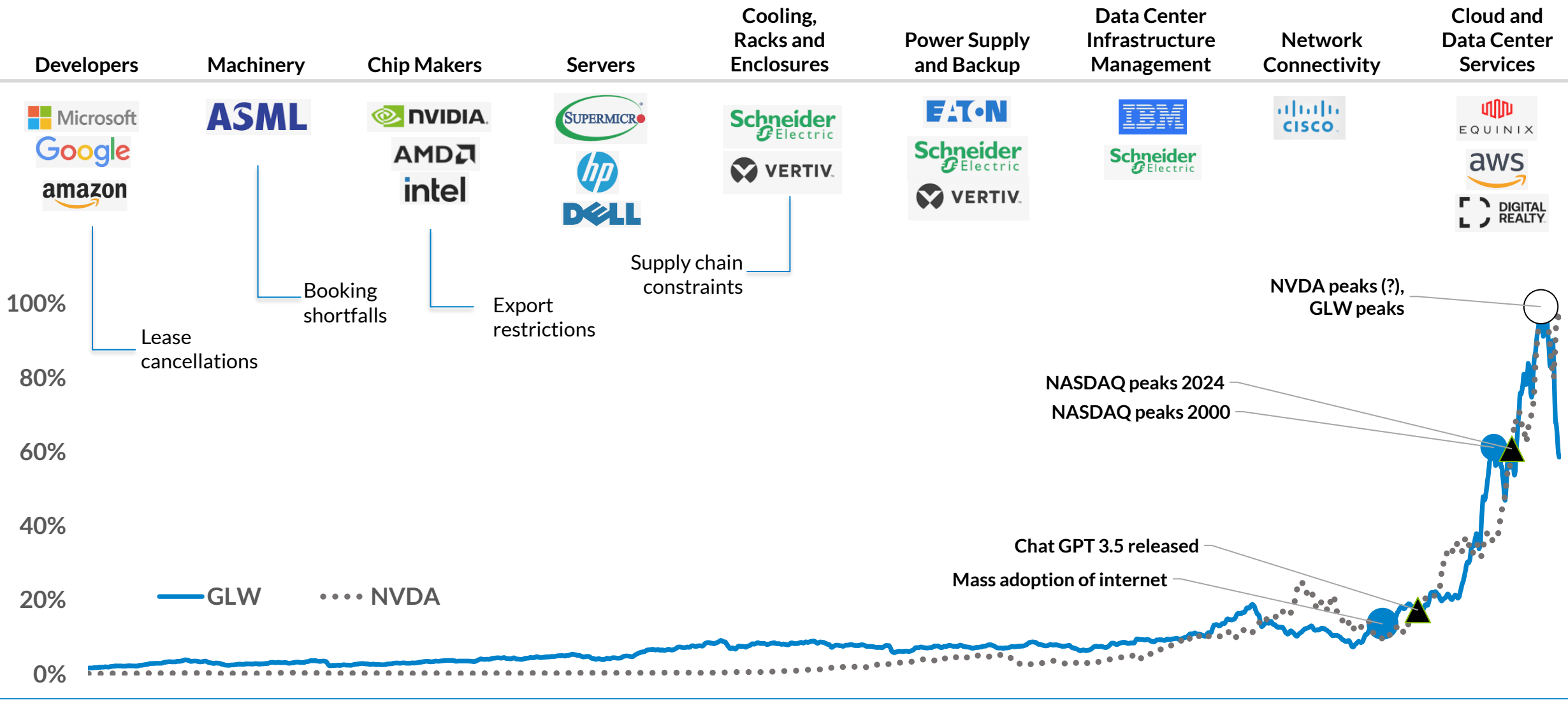
Deployment Adjustment Reflects the extent to which stated capacities are deployed in practice.

Ramp Rates Projects are expected to phase-in over time, at an expected rate of approximately 20% annually.

Unrealized Load The portion of the adjusted provisional load that has not yet materialized on the grid, accounting for uncertainty in project timelines, execution, or actual usage behavior.

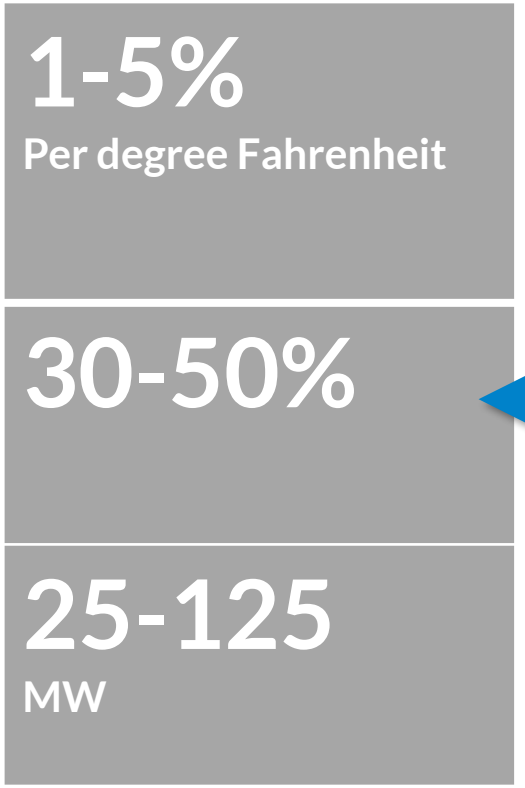
Metered Load The real, measured electricity consumption from operating data centers—used to validate assumptions and refine forecasting models.

The rapid rise of AI is starting to reveal its growing pains, reminiscent of the dot-com boom of the late 1990s.



Data centers' power demand can shift significantly with ambient temperature due to high cooling requirements.

ILLUSTRATIVE



Elasticity range of residential electric demand

Range of ramp needs for a 1,000 MW data center

- Data centers typically measure efficiency using the Power Usage Effectiveness (PUE) ratio, where PUE = Total Facility Energy / IT Equipment Energy.
- An ideal data center would have a PUE = 1.0, meaning all energy goes directly to computing, with no additional cooling or auxiliary power needs.
- Cooling requirements can account for a significant portion of a data center's energy load, often ranging from 30% to 50%.
- Advanced data centers, such as those operated by hyperscale providers (e.g., Google, Amazon, Facebook), have been able to reduce cooling loads significantly.
- In hotter climates or during warm seasons, cooling demands can spike, leading cooling to consume closer to 50% of total power. in cooler climates or with effective use of free cooling, this can drop below 20%.
- Techniques like immersion cooling, liquid cooling, and AI-based cooling management are gradually reducing the energy load attributed to cooling, aiming to bring PUEs even closer to the ideal 1.0.

MISO examines large loads using a variety of external-facing methods.

Public Announcements

Public announcements give early, real-time insights into new data center projects and expansions, helping MISO stay updated on upcoming demand.

Stakeholder Coordination

Coordinating with stakeholders, including MISO members, data center operators, and local government allows MISO to gather accurate demand projections and align on infrastructure needs.

Contracted Third Parties

External consultants and data providers offer specialized expertise and industry data, adding depth and validation to MISO's forecasts.

Member Survey

- Annually, MISO gathers ten years of aggregate forecast data for each market participant through the OMS survey.

Expedited Project Review (EPR)

- Transmission owners may request an expedited review when urgent system conditions require timely infrastructure enhancements.
- Often used for large load additions like data centers.
- A decision is typically provided to the transmission owner within thirty days of the project's submission to MISO.

Next Steps

- **Ongoing Methodology Enhancements:** With input from stakeholders, MISO will continue to refine end-use forecast methodologies for large loads that highlight rapidly evolving industry trends.
- **Process Automation:** MISO will enhance methods for exploring automating data exchanges with third-party entities, including stakeholders and load-serving entities (LSEs), to improve our large load forecast.