MISO 2024 Load Forecast and Process Enhancements Workshop

December 18, 2024

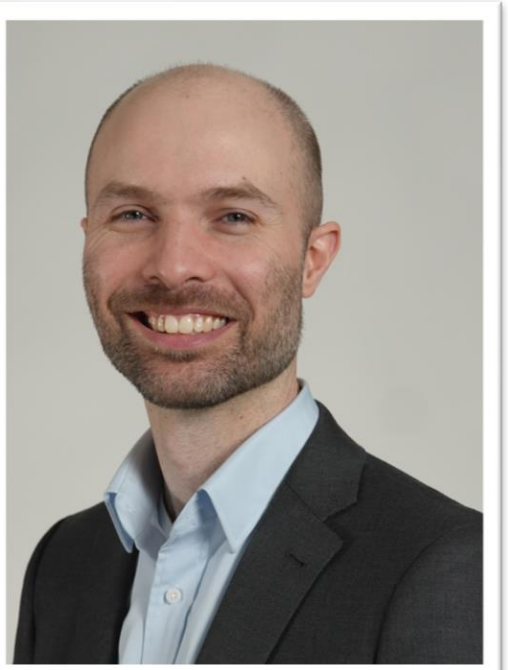
Updated: corrected Low scenario CAGR value on slide 9.

This workshop will be recorded.

Agenda

1.	Welcome and Introduction	DL Oates & Laura Rauch	1:00 p.m. (EST)
2.	Process	Brad Decker	1:25 p.m.
3.	Results	Brad Decker	2:05 p.m.
4.	Next Steps	Dominique Davis	2:45 p.m.
5.	Adjournment		3:00 p.m.

Executive Introduction



DL Oates

Executive Director
Market and Grid
Research

Laura Rauch

Executive Director
Transmission Planning

Why are we updating our load forecasts and Futures?

- **New drivers of load growth:** Data centers, industrial, and transportation drivers are materially increasing the outlook for load growth over the coming years
- **Growing uncertainty:** There is substantial uncertainty in the magnitude of growth from these new load drivers, as well as in the timing and magnitude of resources needed to meet the load
- **Increasing importance of data:** Tightening reserve margins, a shifting resource mix, and increasing complexity are increasing the importance of MISO-provided outlooks to support Members and States in making planning decisions
- **Focus on long lead-time planning:** Transmission planning and Member generation planning require high-quality, scenario-based, multi-year outlooks

MISO Futures update high-level schedule

- Load forecasting (Q4-2024)
- Member plans and forecasts survey (Q1-2025)
- Futures scenario framing (Q1-2025)
- Generation expansion
- System (Resource and Energy) adequacy
- Siting and scenario finalization

Schedule under development

Executive Summary

Purpose: To inform stakeholders about MISO's work to update the long-term load forecast process and results

- **Process:** MISO is working toward the transition from an externally-developed forecast to an internally-developed forecast.
- **Results:** Significant new load growth is anticipated for MISO's system driven by industry and technological changes. Today we will discuss 2024 results.
- **Next Steps:** Include refining the needs for data exchanges with MISO partners and external communications.

Questions?

- Please raise your hand. There will be a question-and-answer period at the end of each slide.
- MISO is opening a feedback request through January 15, 2025, on the material presented today

Long-term load forecasting is essential for planning resources to ensure a reliable generation system. With ongoing industry changes, it is increasingly important to assess the uncertainties surrounding these forecasts.

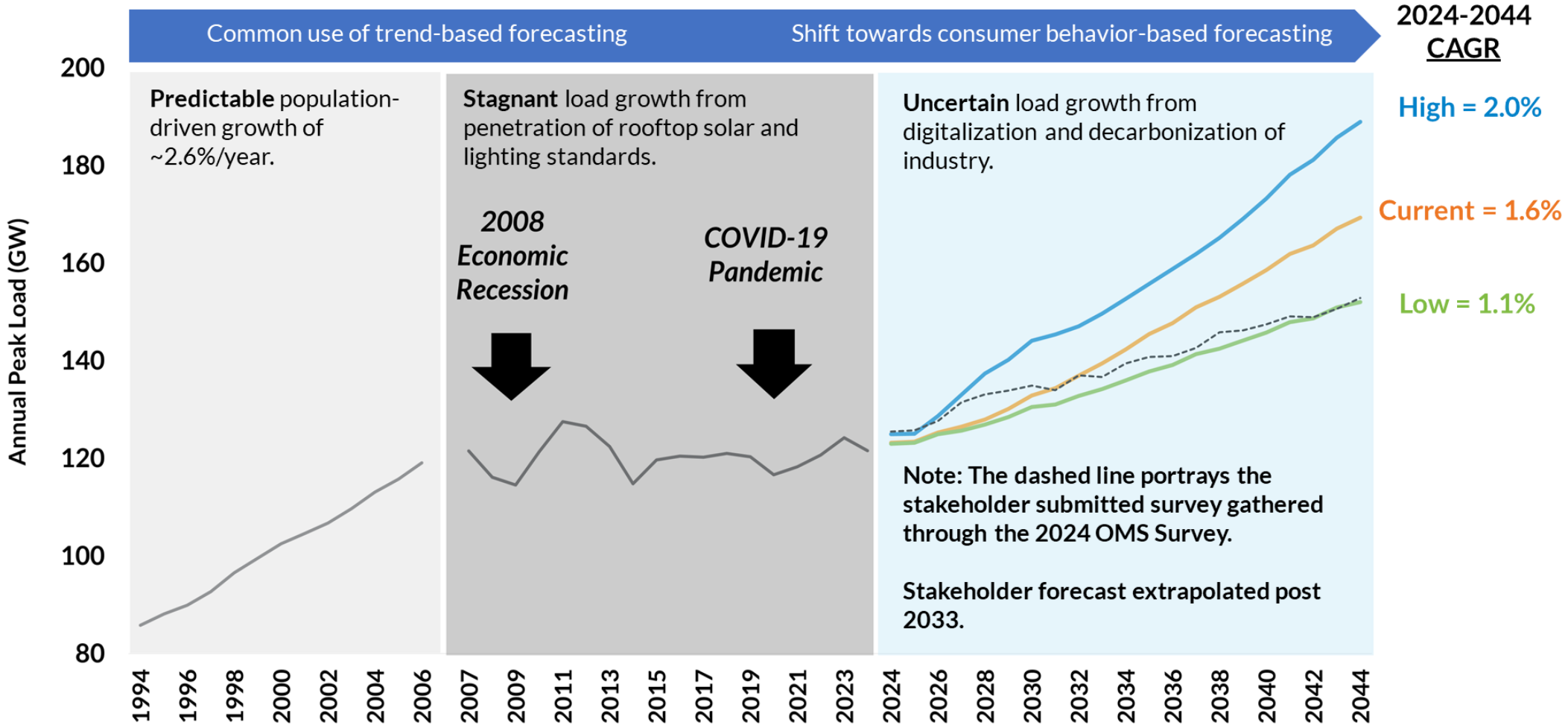
MISO serves 45 million people across 15 states and the Canadian province of Manitoba

- Estimating system load has gained increasing importance due to growing uncertainties and evolving dynamics in the energy industry.

MISO's load forecast supports a variety of planning studies including:

- **Planning** including Resource Adequacy Outlooks, Futures, and Long-Range Transmission Planning.
- **Compliance Efforts** such as Tariffs and regulatory filings.
- **Corporate Planning studies**, such as the Value Proposition.

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

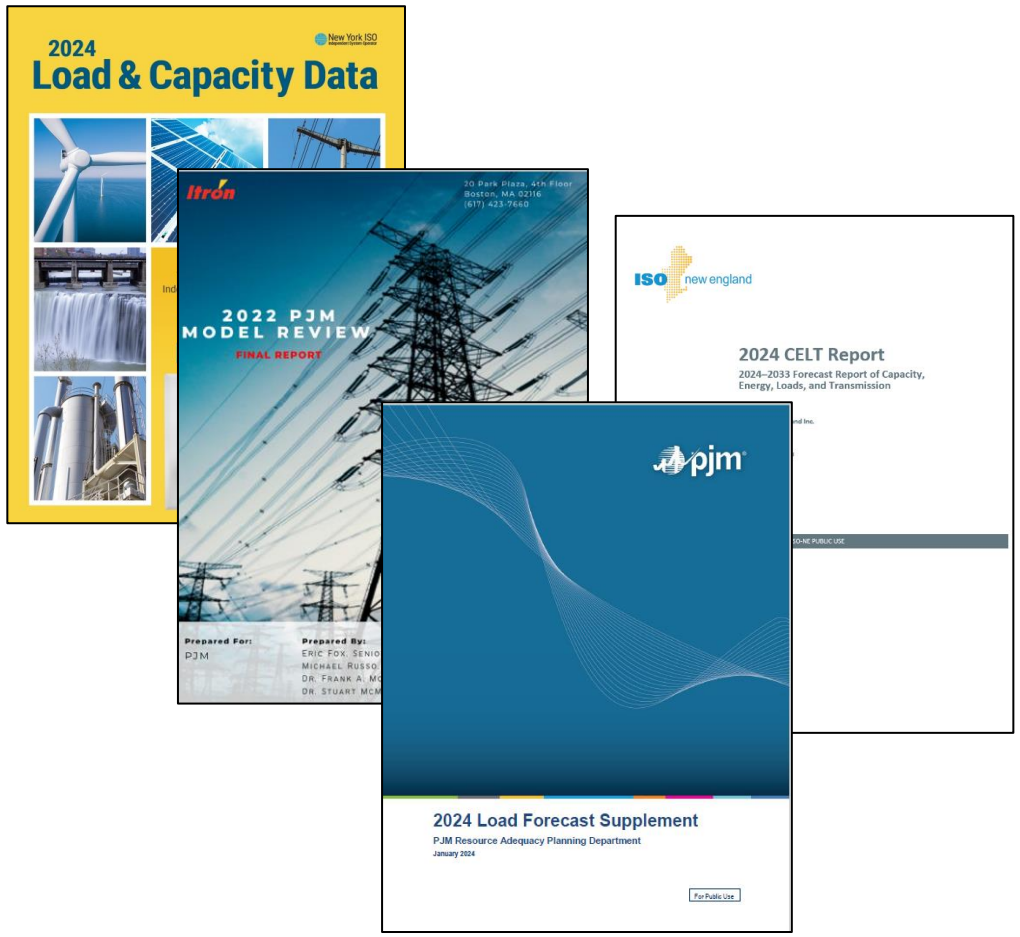


Most U.S. ISOs and RTOs have programmatic, long-term load forecasting initiatives

Programmatic Forecasting: Each ISO/RTO uses structured methodologies and forecasting processes, incorporating economic, demographic and technological data.

Long-Term Planning: Forecasts typically span 10+ years, with annual updates to adjust for new trends, policy changes and stakeholder feedback.

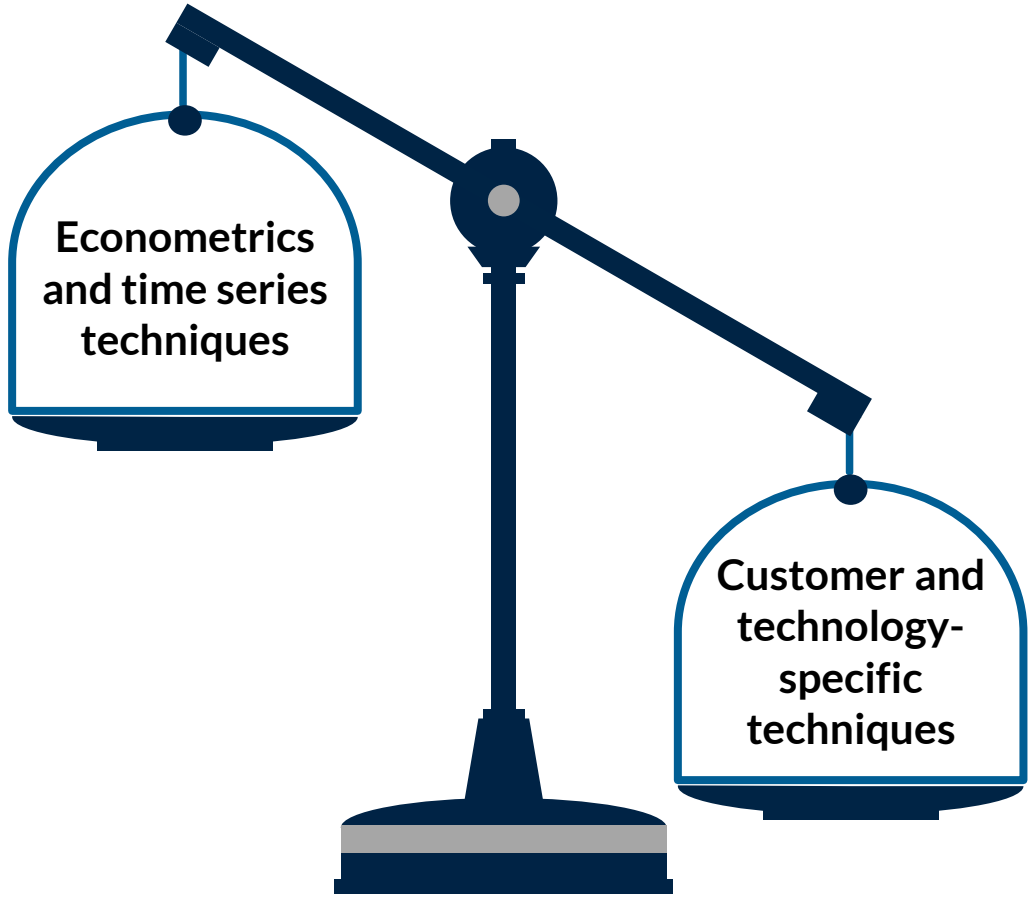
Stakeholder Coordination: Strong engagement is maintained through stakeholder input, public reporting and consultation processes to ensure transparency and alignment with regional needs.



The balance between forecasting methods will shift toward hourly, weather-driven end-use techniques to accommodate policy-driven industry changes

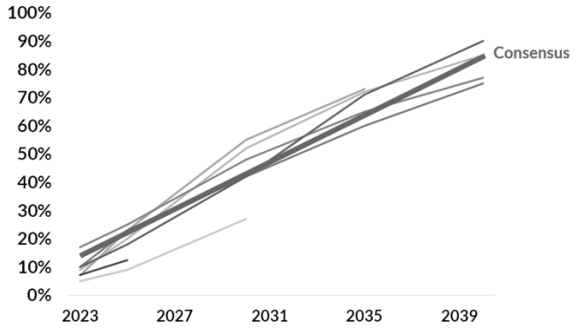
Forecasting method components:

- Hourly customer demand and weather
- Customer segmentation
- Extensively researched end-use components ("Customers x Use-per-customer" format)
- Modified econometric models
- Evolution toward turning-point models to replace recent load reconstitution methods
- Weather normalization, simulation and climate impact assessments

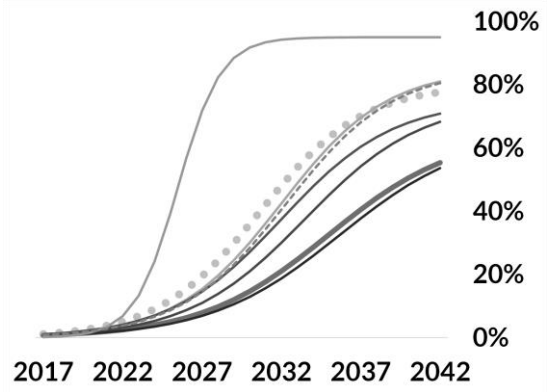


MISO's forecast anatomy for expected growth segments includes six essential levels

1 Driver Data Source Compendium



2 Technology Penetration Models



3 Volume Determinants

322 — Watt-hours per mile driven for the average EV

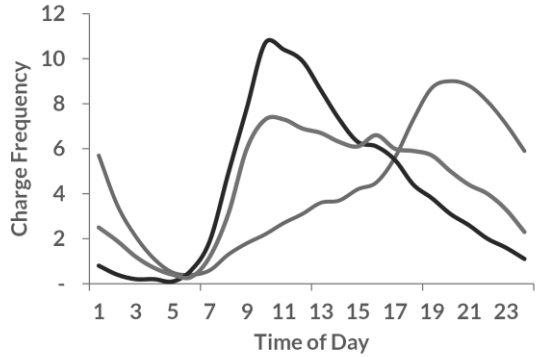
X

10,000 to 12,000 — Miles driven per year by the average EV car-owner

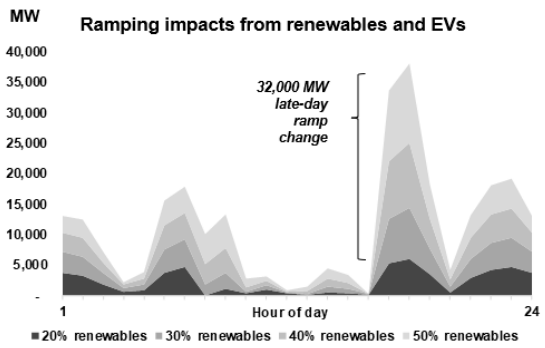
=

3,581 — Annual number of kWh per year used by the average EV owner

4 Usage Profiles



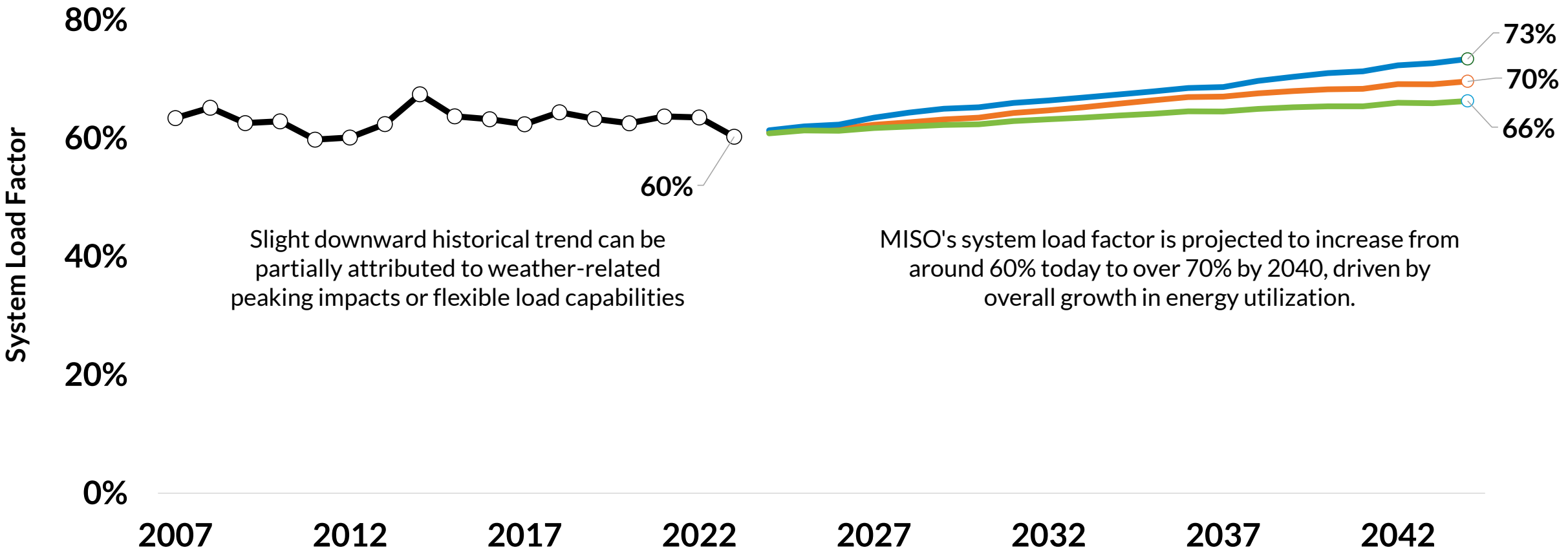
5 Evolutionary Demand Behavior



6 Data Allocation

ILLUSTRATIVE—For discussion purposes only

MISO uses system load factor and coincidence factor as control variables in its hourly forecast process



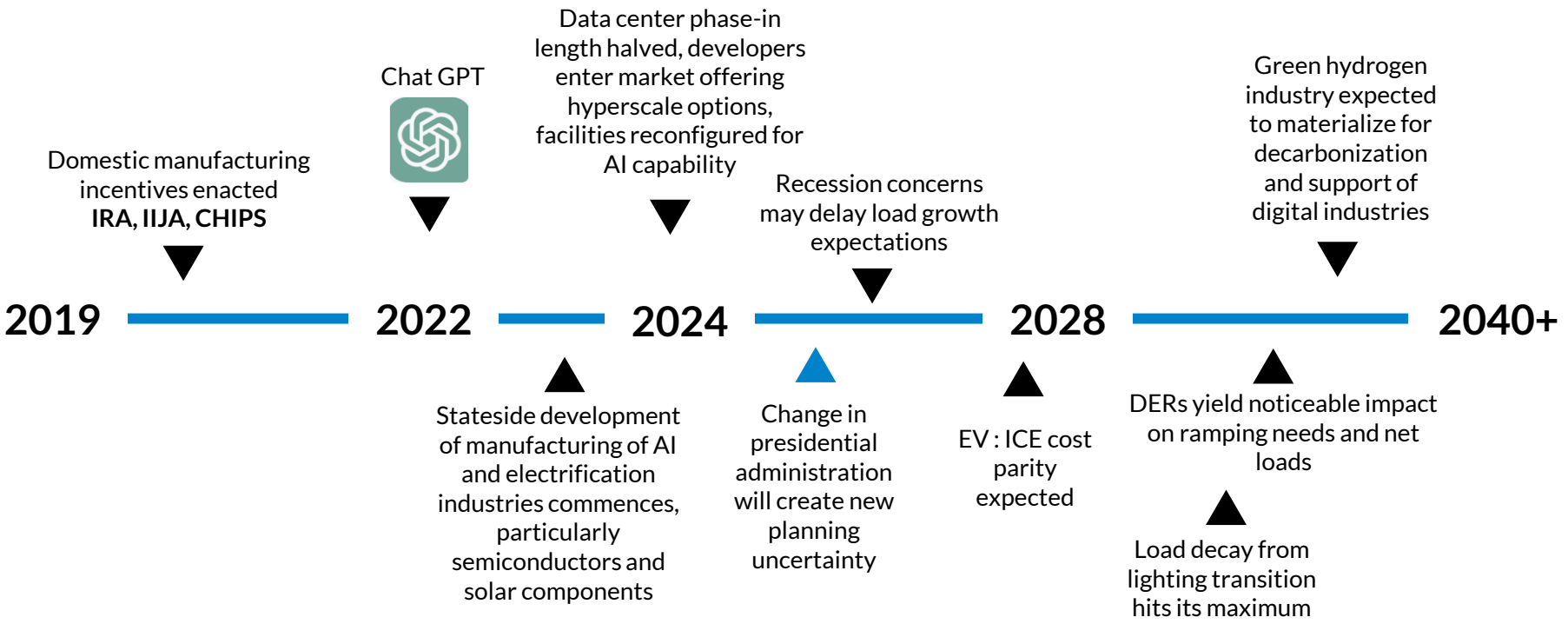
Notes: System load factor measures how efficiently electricity is used over time by comparing the average load to the peak load. Coincidence factor (not shown) compares the peak demand of individual systems to the overall system's peak demand.

The pace of change in MISO's system demand will largely depend on the AI and green energy revolutions and federal incentives to support those efforts

1 **AI Revolution**
The CHIPS Act enhances semiconductor manufacturing essential for AI, expanding high-tech capabilities.

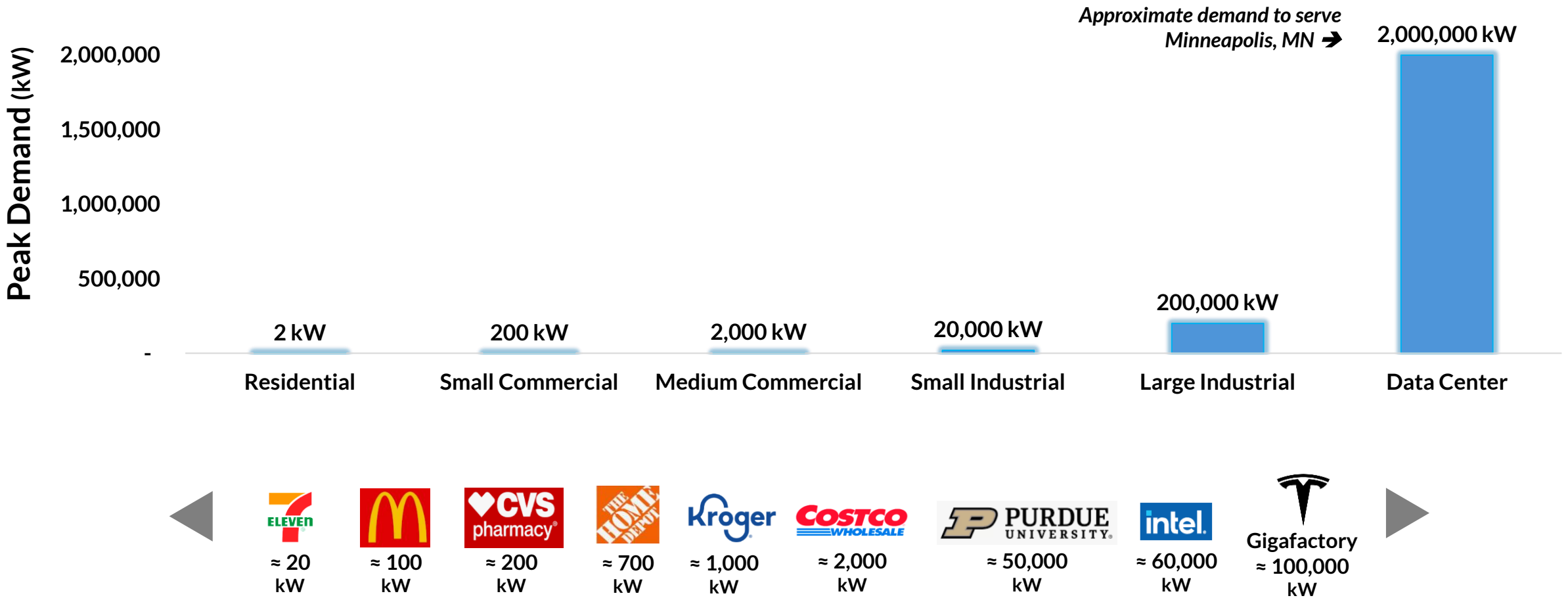
2 **Decarbonization Objectives**
The IRA promotes renewable energy and efficiency, driving demand for green technologies that rely on advanced manufacturing processes.

3 **Reindustrialization Goals**
The IIJA improves infrastructure supporting the modern manufacturing sector, complemented by technological investments from the CHIPS Act.



IRA: *Inflation Reduction Act* ***IIJA:*** *Infrastructure Investment and Jobs Act* ***CHIPS:*** *Creating Helpful Incentives to Produce Semiconductors*

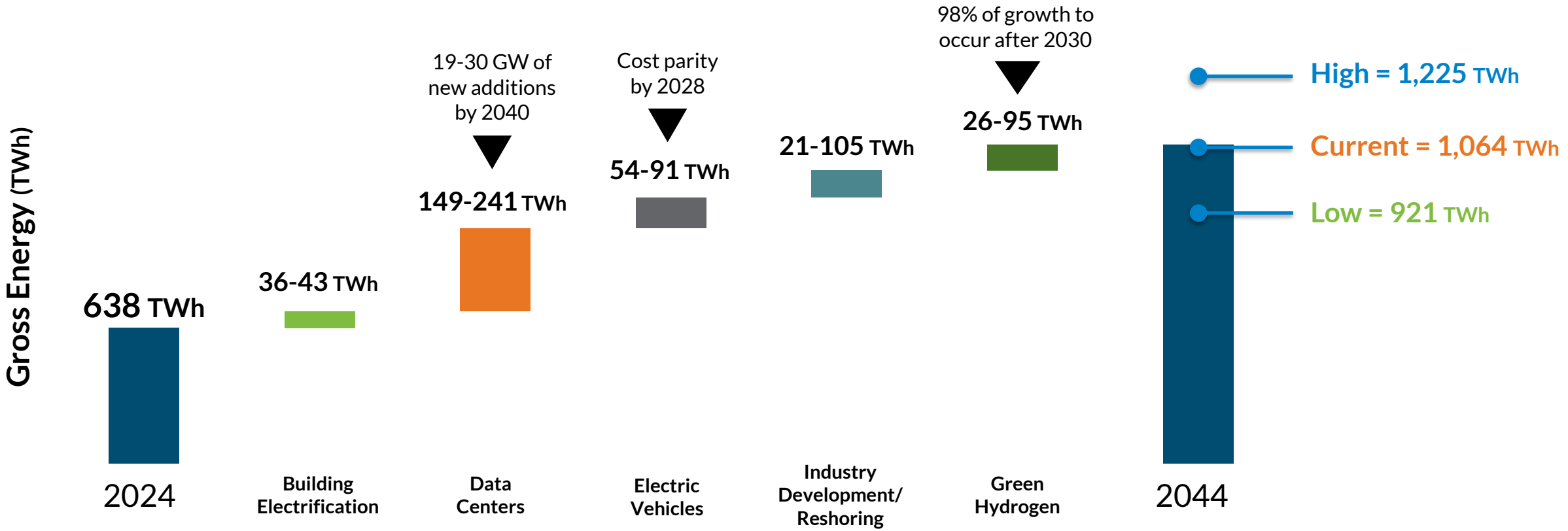
The scale of proposed data centers greatly exceeds that of retail electric customer classes, with future data centers expected to match the energy demand of major U.S. cities.



Known announcements will be documented and added to forecast updates

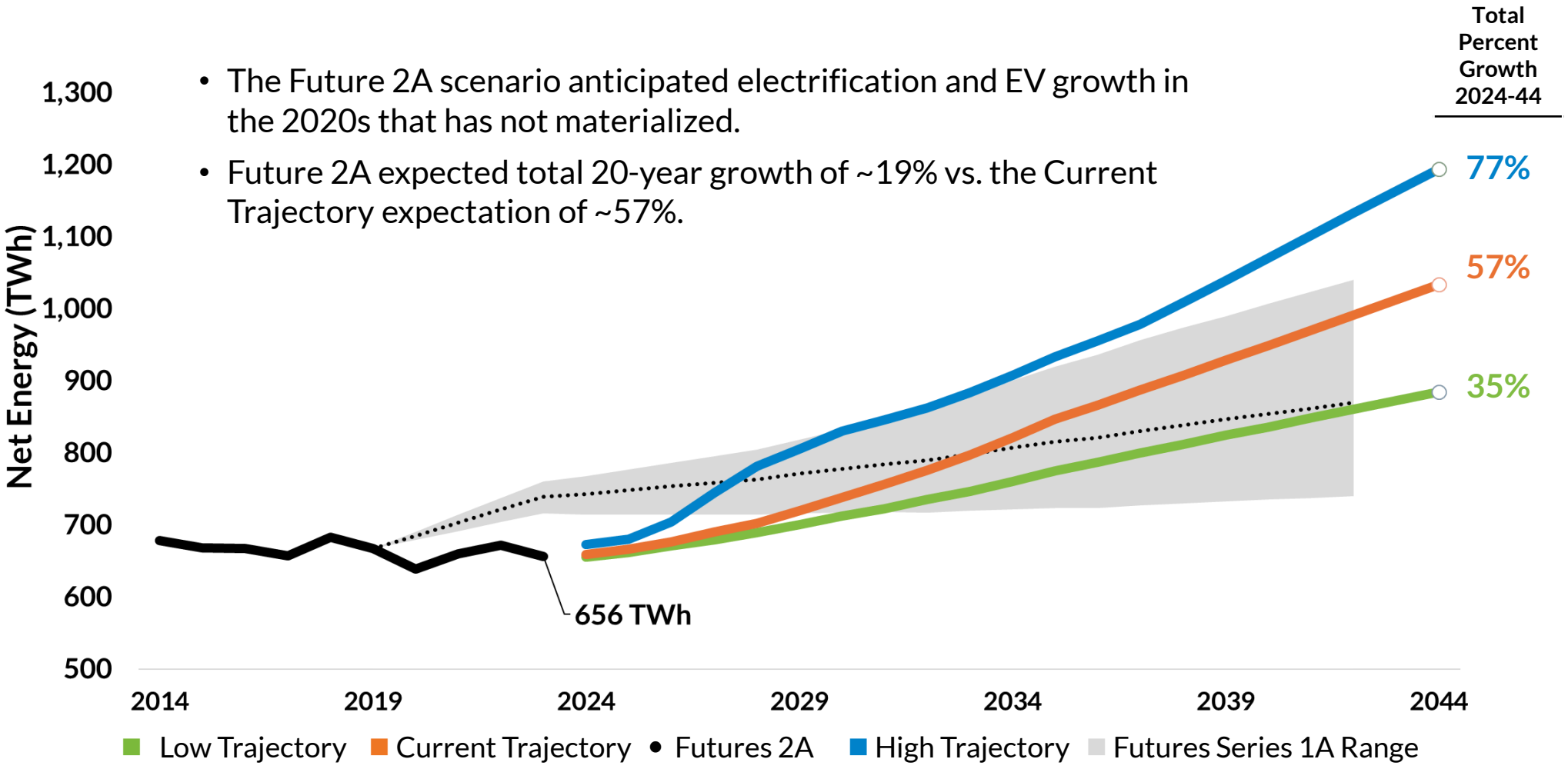
Data centers, electric vehicles and green hydrogen are expected to be the primary drivers of peak and energy growth through 2044

- **MISO's growth drivers are expected to be more energy-intensive than those of most existing end-users, with large data centers and other industries anticipated to operate at high load factors.**
- **Through 2044, MISO's gross energy is expected to increase by 1.9% to 3.3% annually.**



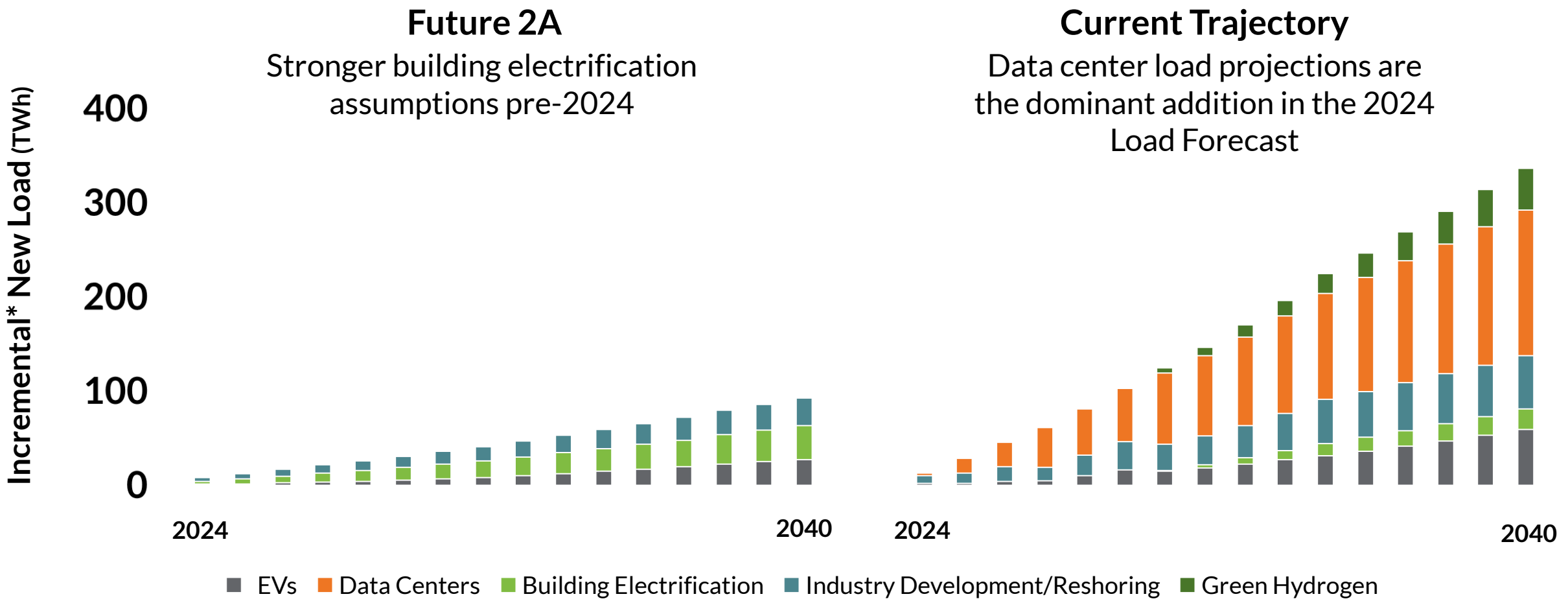
Updated industry, macroeconomic, and policy assumptions have resulted in new load growth trajectories since MISO's Futures Series 1A report

- The Future 2A scenario anticipated electrification and EV growth in the 2020s that has not materialized.
- Future 2A expected total 20-year growth of ~19% vs. the Current Trajectory expectation of ~57%.



Note: Futures Series 1A Report can be found at https://cdn.misoenergy.org/Series1A_Futures_Report630735.pdf

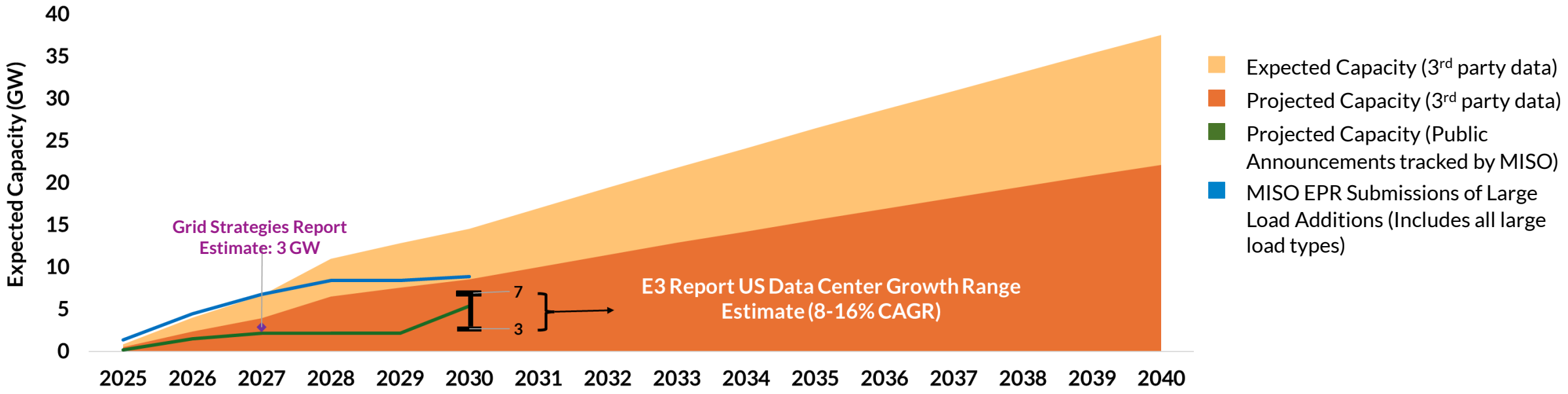
Projected load growth from all forms of electrification within MISO's footprint is expected to be approximately three times higher than previously forecast



Incremental values are relative to different baselines i.e. Future 2A(F2A) uses 2023 F2A values and Current Trajectory uses 2023 Current Trajectory values*

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 (149-241 TWh) by 2044

- **MISO's projections are based on announced project capacities, with growth distributed across ISOs and states to reflect emerging markets.**
- **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.**

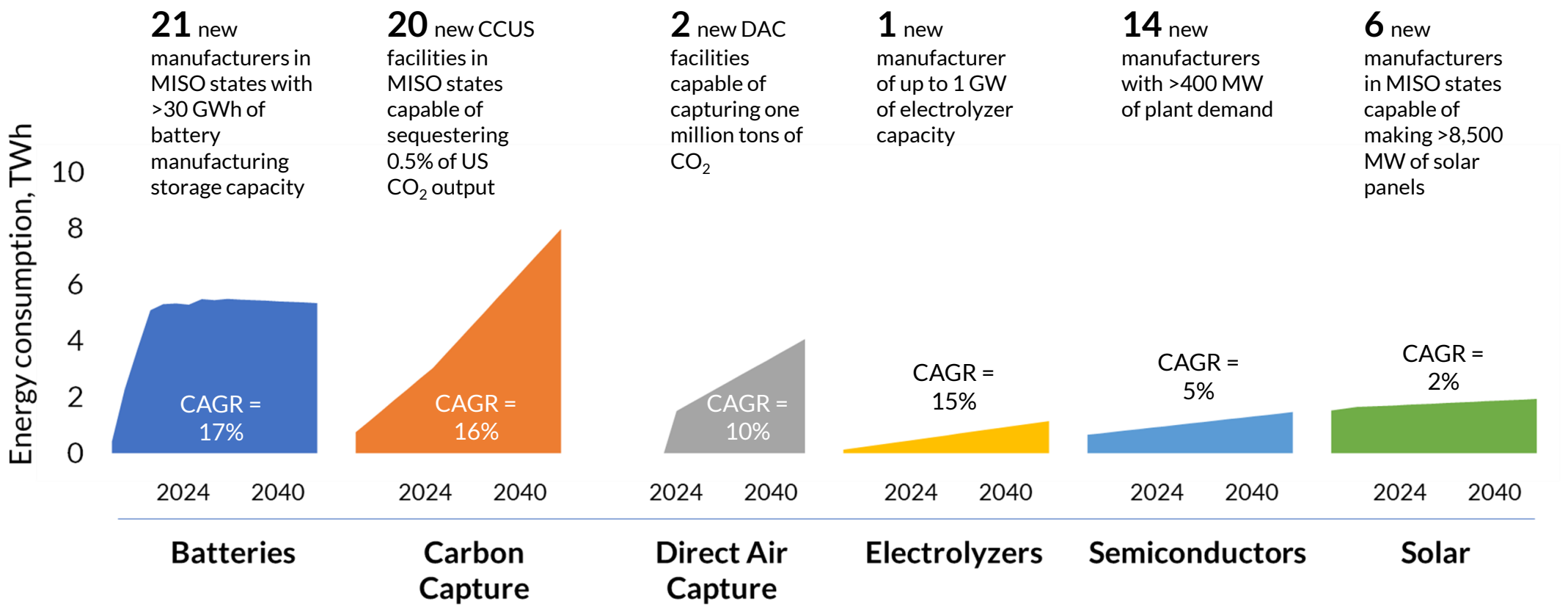


Notes: *Known announcements will be documented and added to forecast updates*
Grid Strategies: The Era of Flat Power Demand is Over, 2023

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

Federal laws like the Infrastructure Investment and Jobs Act, CHIPS Act, and Inflation Reduction Act are driving growth in manufacturing and industry within the MISO region.

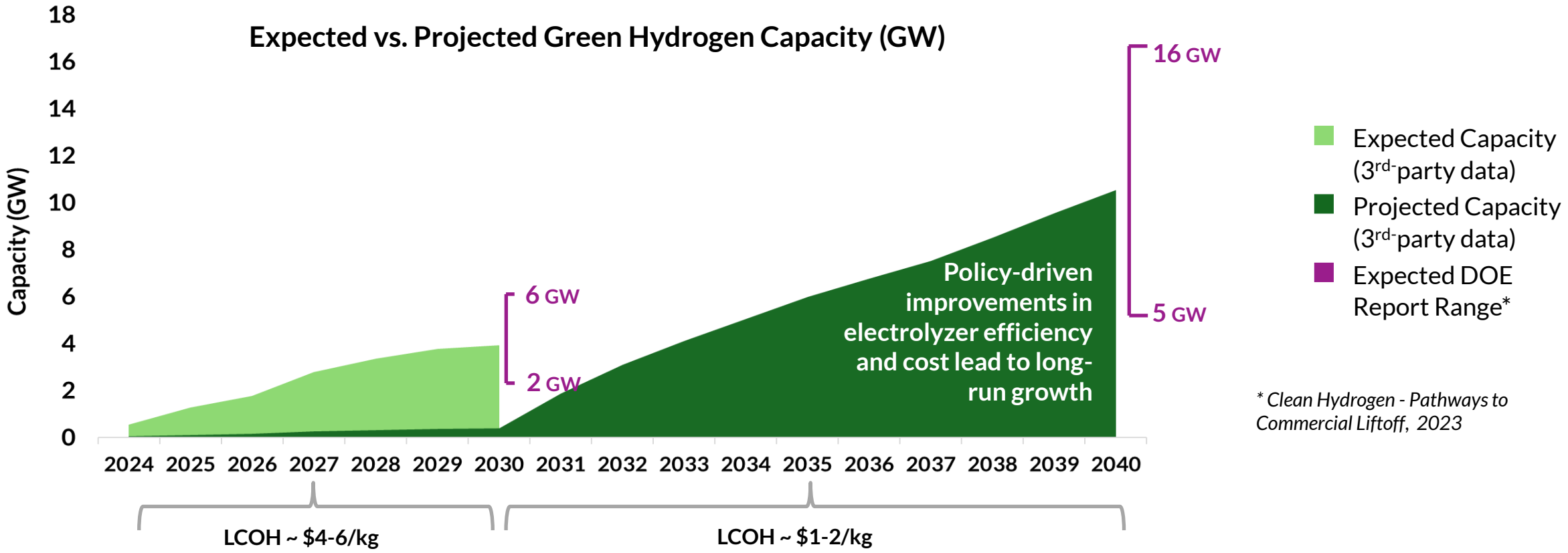
- **Most growth in manufacturing and industry will take place post-2030 but is highly-contingent on continued policy support.**
- **MISO's forecast strategy segments data by Local Balancing Authority (LBA) and focuses on targeted growth industries under NAICS Code 33.**



Basic Math Expected Total Demand = New Manufacturers by Segment x Average Demand by Unit x Capacity Utilization Rate x Phase-In Factor / Public Policy Determinants

Green hydrogen production is expected to be a major driver of load growth after 2030, fueled by federal policies like the IRA and the Department of Energy's Hydrogen Shot, which aim to expand its use in hard-to-decarbonize sectors.

- MISO's load forecast anticipates slow growth in hydrogen-related energy demand through 2030, but a surge of 26-95 TWh by 2044.
- Nearly half of this growth is projected to occur in LRZ 09, driven by its strong export potential.

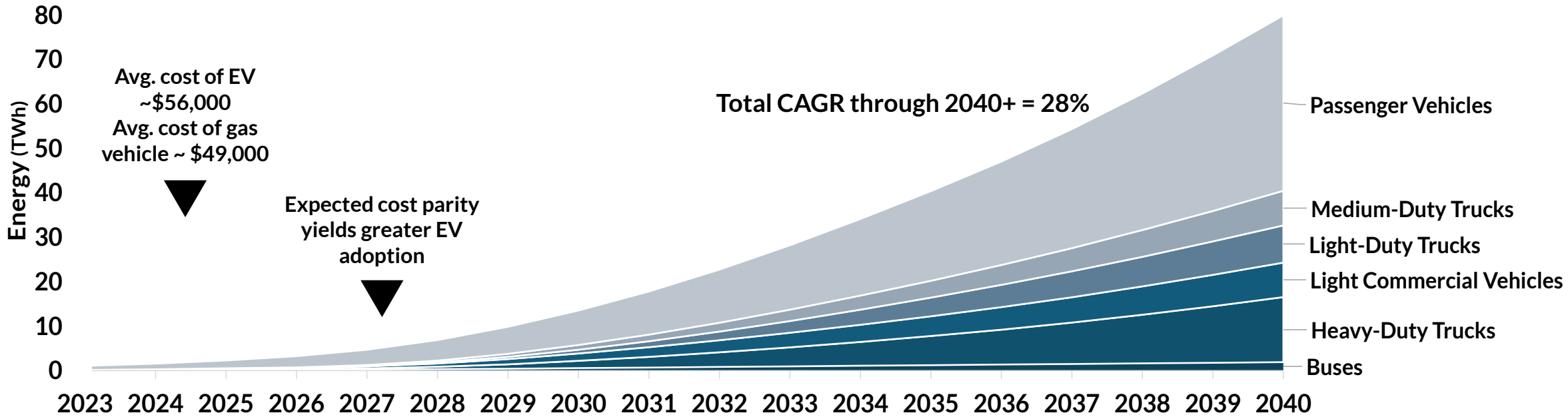


* *Clean Hydrogen - Pathways to Commercial Liftoff, 2023*

Basic Math Expected Total Demand = Number of Customers x (Use-per-customer X Levelized Cost of Hydrogen) / Efficiency Factor x Capacity Factor x Phase-In Rate

The current U.S. electric vehicle (EV) market is steadily growing and gaining market share, with EVs now accounting for nearly 9% of light-duty vehicle sales.

- MISO's EV demand forecast integrates data from public and private sources and projects EV penetration using state-level registration data with a logistic regression/Sigmoid S-curve model.
- Forecasts are refined at the LRZ and LBA levels using historical ratios.
- Key factors such as miles driven are sourced from the U.S. DOE, with hourly charging profiles generated by NREL's EVI-Pro model.



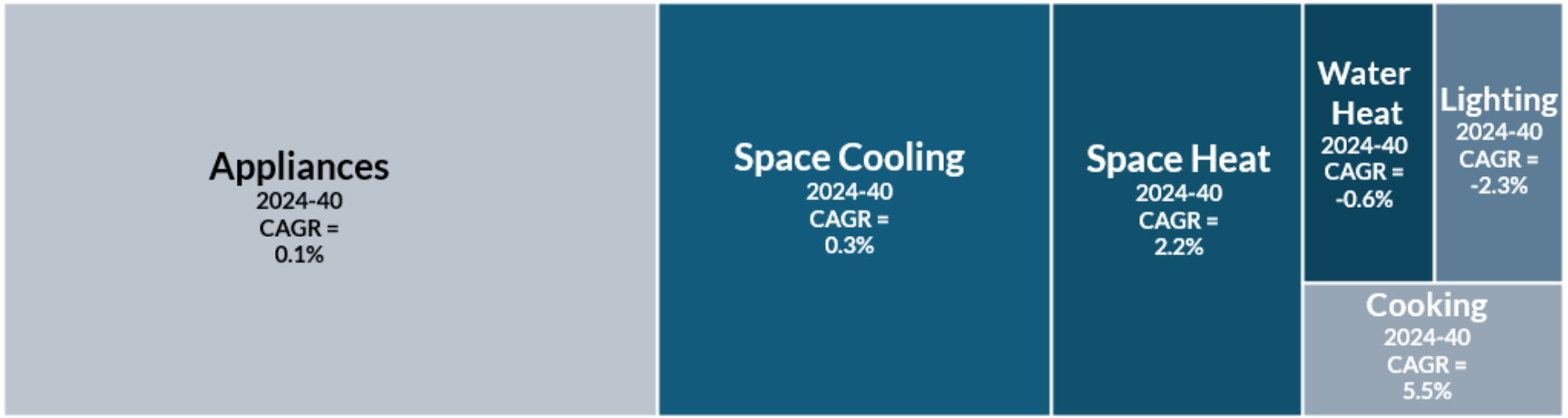
Basic Math

Expected Total Demand = Number of Vehicles x Vehicle Usage and Efficiency x Hourly Charging Profiles by Segment x Load Factor Progression

Building electrification, driven by higher penetration expectations for heat pumps and electric appliances, will lead to higher load growth in MISO, supported by federal rebates and state policies.

- **MISO works directly with third parties and gathers information from publicly-available sources to develop forecasts for the future electrification of its service area.**
- **MISO anticipates that building electrification will contribute 30 - 37 incremental TWh by 2040.**

Share of 2040 MISO Load by End-Use



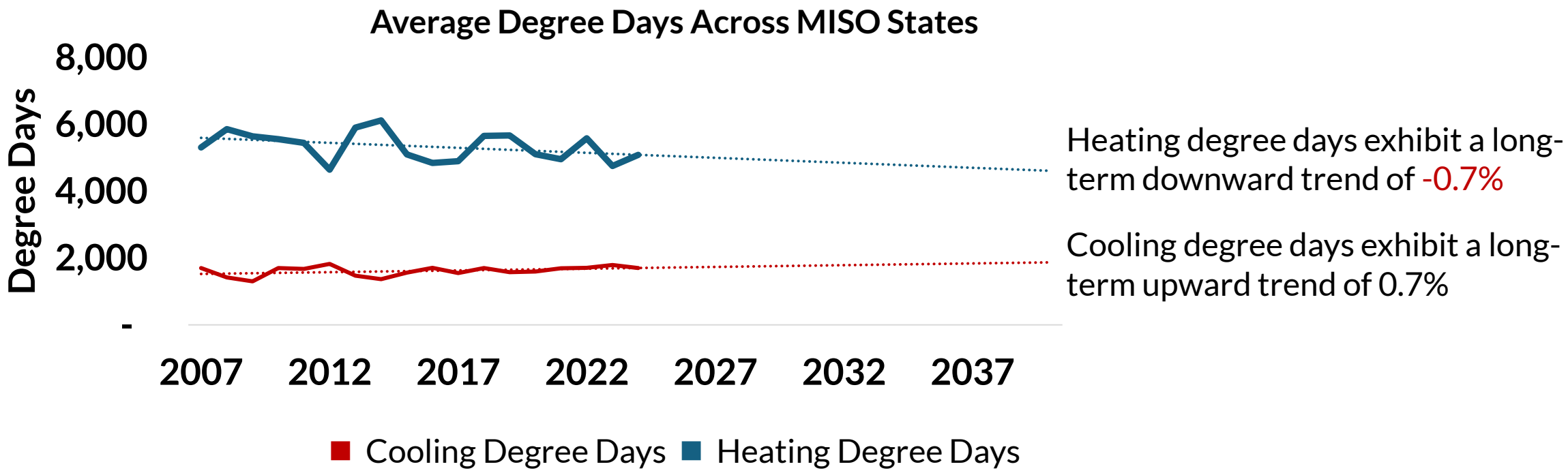
Gas space heating is expected to give way to electric sources over time, particularly in MISO's northern states

Lighting as a share of total electricity consumption has fallen from ~10% in 2000 to less than 5% today

Basic Math

Expected Total Demand	=	Persons/Household or Number of Units per Household	x	Temperature-Affected Average Power Consumed by Unit	x	Usage duration by Time of Day	x	Changes in Efficiency from Regulation or Technological Improvements

Warming trends are implied in MISO's weather-sensitive loads such as residential space cooling and heating, and small commercial loads, while data centers will be a future focus.



Notes: Degree days calculated using a 65° base across all States and MISO LRZs
LRZ- and LBA-specific trends are calculated using regionally assigned weather stations

Basic Math Expected Degree Days = f (Linear regression function of long-term historical degree days)

Next Steps

- **Ongoing Methodology Enhancements:** With input from stakeholders, MISO will continue to refine end-use forecast methodologies by incorporating up-to-date macroeconomic assumptions and specialized analyses that highlight rapidly evolving industry trends.
- **Process Automation:** MISO will enhance methods for gathering historical enterprise data and explore automating data exchanges with third-party entities, including stakeholders and load-serving entities (LSEs).
- **Boost DER Monitoring:** MISO will intensify its research into behind-the-meter assets, such as demand response, distributed generation, and storage.

Stakeholder Feedback Request

- MISO is requesting feedback on the Load Forecast presented in the white paper and at the workshop by January 15. We request that feedback focus on suggestions that have a material impact on aggregate volumetric or peak load. MISO will consider whether feedback should be reflected in our upcoming Futures update or a subsequent load forecast update.
- Feedback requests and responses are managed through the Feedback Tool on the MISO website: https://www.misoenergy.org/engage/stakeholder-feedback/