Western Interstate Energy Board

Electrification in the Western Interconnection

Planning for Load Growth, Flexibility, and Reliability

Eric Baran · Aaron Beard · Marissa Moers · Christopher Zawora · Western Interstate Energy Board · 2026

Webinar Agenda

Western Interstate Energy Board

Welcome & Opening Remarks

Maren Mahoney, Chair, WIEB

Part 1: Paper Overview

Eric Baran & Marissa Moers, WIEB

Part 2: Forecasting Electrification Impacts

Trieu Mai, ESIG

Part 3: Regional Reliability & Adequacy

Katie Rogers, WECC

Part 4: State Policy & Forecast Alignment

Quentin Gee, California Energy Commission

Part 5: Facilitated Discussion / Q&A

Moderated by WIEB Staff

Closing & Next Steps

WIEB Staff

Webinar Logistics

Western Interstate Energy Board

Access the Paper

The full paper is available on the WIEB website.

Full Report

Or contact Eric Baran for a direct link:
ebaran@westernenergyboard.org

Webinar Recording

This webinar is being recorded.

Materials

The recording and slide deck will be posted to WIEB's website.

Questions during the webinar? Use the Chat box or raise your hand. A facilitated Q&A session will follow the presentations.

Welcome:
Opening Remarks

Maren Mahoney, Chair, Western Interstate Energy Board

PART 1

Paper Overview

Electrification in the Western Interconnection: Planning for Load Growth, Flexibility, and Reliability

Presenters: Eric Baran & Marissa Moers, WIEB

About This Paper

Purpose

Developed by WIEB staff as part of the **Reserve Expenditure Plan (REP)** to build a shared, region-wide understanding of how transportation and building electrification affect electric system planning across the West.

Reviewed:
28 IRPs published 2021–2025 across 14 U.S. states and 2 Canadian provinces.

Goal:
Identify opportunities for improved transparency, data alignment, and planning consistency for building and transportation electrification.

The Western Interconnection

14 States + 2 Provinces	U.S. + Canadian jurisdictions served
90M+	People across the interconnection
150,000+	Miles of transmission lines
160 GW	Regional peak load capacity
942 TWh	Annual demand baseline (2025)

Scope & Limitations

Electrification ≠ Large Loads

Both increase demand, but they create different reliability risks, modeling needs, and policy responses. *This paper focuses on electrification while acknowledging large loads as a parallel challenge.*

Electrification

- Distributed across millions of customers
- Policy & technology-driven (EVs, heat pumps)
- Gradual growth over time
- Changes when and how the system peaks
- Raises flexibility & seasonal adequacy questions

Large Loads

- Concentrated, transmission-scale additions
- Market-driven (data centers, hydrogen)
- Step-change demand growth
- Raises siting, interconnection & transmission challenges
- Often uncertain timing and magnitude

ABOUT THIS PAPER

1. **Snapshot of IRPs**
   2021–2025 · approaches vary across utilities
2. **Evaluates Modeling**
   Not a forecast validation study
3. **Regional Lens Only**
   Not local policy or utility constraints
4. **Policies Evolving**
   Planning assumptions may lag

Key Findings

01 Electrification is the largest driver of sustained load growth

Led by transportation and building heating. Western demand forecast to grow 20.4% by 2034 — more than double the 9.6% projected in 2022 resource plans.

02 Not just how much — but when and where

Seasonal peaks are shifting. Evening ramps are steepening. Winter reliability risks are intensifying across the region, especially in northern and hydro-dominant areas.

03 Planning tools are evolving, but unevenly

More utilities are adopting probabilistic and hourly frameworks, but approaches and assumptions vary widely. This inconsistency obscures where reliability risks are emerging.

04 Policy ambition is outpacing planning assumptions

Without better alignment, shared data, and common modeling frameworks, capacity and flexibility needs will be systematically understated — creating procurement and investment risk.

Electrification Drivers Across the Western Interconnection

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Incremental / Resource-Diversity

States & Provinces

MT · WY · AB

- Limited statutory electrification mandates
- Focus on affordability, reliability, fuel diversity
- Targeted EV or infrastructure programs
- Electrification primarily market- & technology-driven

Electrification primarily market- and technology-driven

Emerging / Transitional Policy

States & Provinces

NV · UT · AZ · ID

- Clean energy goals or GHG reduction plans
- EV incentives and infrastructure programs
- Limited or evolving building electrification policies
- Electrification accelerating economically

Policy-influenced but economically accelerating

Aggressive Policy States

States & Provinces

CA · WA · OR · CO · NM · BC

- 100% clean energy / net-zero targets
- ZEV sales mandates (100% by 2035 in many cases)
- Clean heat or zero-emission building policies
- Active utility coordination & forecasting integration

Electrification is strongly policy-driven and embedded in planning

The Scale of Change

Western demand trajectory has fundamentally shifted with electrification now embedded in long-term plans

Historical Growth

4.5%

Historical growth rate (2013–2022)

Predominately summer peaking

Current Forecast

20.4%

Projected demand growth by 2034

vs. 9.6% forecast in 2022 plans

Load Shape

is also changing

Emerging winter risks and steeper evening ramps

Annual demand: 942 TWh (2025) → 1,134 TWh (2034)

Changing Load Shape:
When and Where the Grid Is Most Stressed

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❄ Pacific Northwest & Hydro-Dominant Areas

Winter peaks intensifying

Heat pump adoption and declining natural gas end-use are making the system sharply sensitive to cold weather. A few degrees below normal can add **hundreds of megawatts** of incremental demand.

Extended cold snaps

Extreme winter weather coinciding with low hydro conditions **create tail-risk scenarios** that traditional summer-peak planning frameworks were not designed to handle.

☀ Southwest & California

Evening ramp risk (6–10 PM)

High solar penetration has flattened mid-afternoon peaks. The critical window is now the **late evening** when solar output drops and EV charging begins.

Managed vs. unmanaged EV charging

Can shift several thousand megawatts within hours — behavioral assumptions are now a key reliability variable.

California is also experiencing **emerging winter peak pressure** from increased electric heating and shorter solar days.

A Region Planning in Different Directions

28 IRPs reviewed · Published 2021–2025 · Forecast horizons of 10–23 years

0.8% – 3.7%

Annual energy growth range across reviewed Western IRPs

1 in 3

IRPs include a high-electrification or high-flexibility scenario

Static vs. Dynamic

No shared methodology across the Interconnection

Why This Variance Is a Policy Problem

When utilities serving the same interconnection operate from incompatible forecasts, **it means states and regional bodies cannot get a coherent picture of Western reliability.**

Understated capacity needs today become potential procurement shortfalls, emergency measures, and rate impacts tomorrow.

Where Plans Diverge Most

EV and building load assumptions

Some utilities model high adoption aligned to state mandates; others assume far slower uptake — producing vastly different peak timing and magnitude.

Weather and winter risk treatment

Some plans embed stochastic cold-weather scenarios; others use fixed degree-day adjustments that miss tail-risk events.

Flexibility as a resource

Fewer than 1 in 3 IRPs treat EV charging or demand response as controllable capacity. Most still model electrification as static, inflexible load.

Recommendations

For Utilities

- Adopt standardized electrification forecasting frameworks
- Model flexibility explicitly — treat EV charging, thermostats, and demand response as controllable capacity
- Plan for winter and shoulder-season reliability, not just summer peaks
- Integrate electrification and large load forecasting into shared transmission and generation plans
- Publish electrification assumptions, adoption scenarios, and flexibility contributions within IRPs
- Invest in metering granularity and open data standards for EV and building loads

For Regulators & Policymakers

- Require high-electrification and high-flexibility scenarios in IRP filings
- Promote regional coordination for consistent probabilistic adequacy frameworks
- Advance time-of-use and dynamic rate design to align customer behavior with system needs
- Streamline permitting for grid upgrades tied to electrification (distribution, interconnection, storage)
- Establish minimum standards for electrification modeling — data sources, time resolution, documentation
- Facilitate joint state-utility technical working groups to exchange methods and review results

PART 2

Expert Spotlight: Forecasting Electrification Impacts

Trieu Mai · ESIG

Grid Planning for Electrification

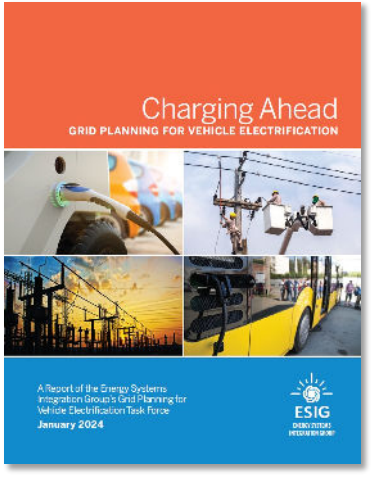
Insights from ESIG's Task Forces and NREL's Electrification Futures Study

Trieu Mai

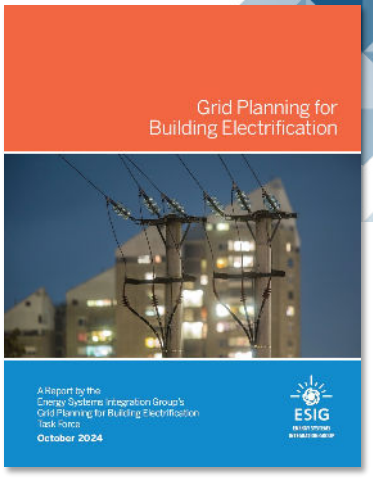
March 4, 2026
WIEB Webinar: Electrification in the West

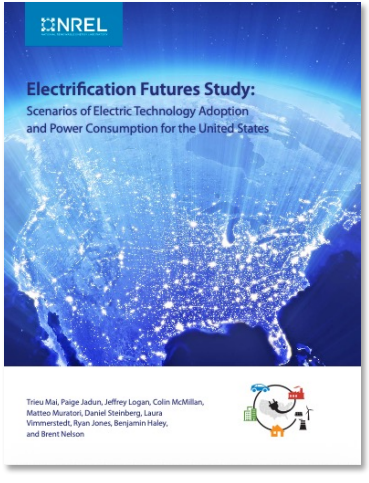
Energy Systems Integration Group

- ESIG is a member-driven organization that addresses technical challenges for transforming energy systems. We do this through collaboration, education and knowledge sharing.
- >300 members worldwide broadly focused on power systems transformation and integration of energy systems
- Workshops, webinars, reports available freely on our website (https://www.esig.energy/) and on YouTube (@EnergySystemsIntegrationGroup). Join our mailing list!
- We create task forces to address topics such as multi-value transmission benefits or grid-forming technology or electrification and these task forces do analysis, run simulations, synthesize best practices, etc.



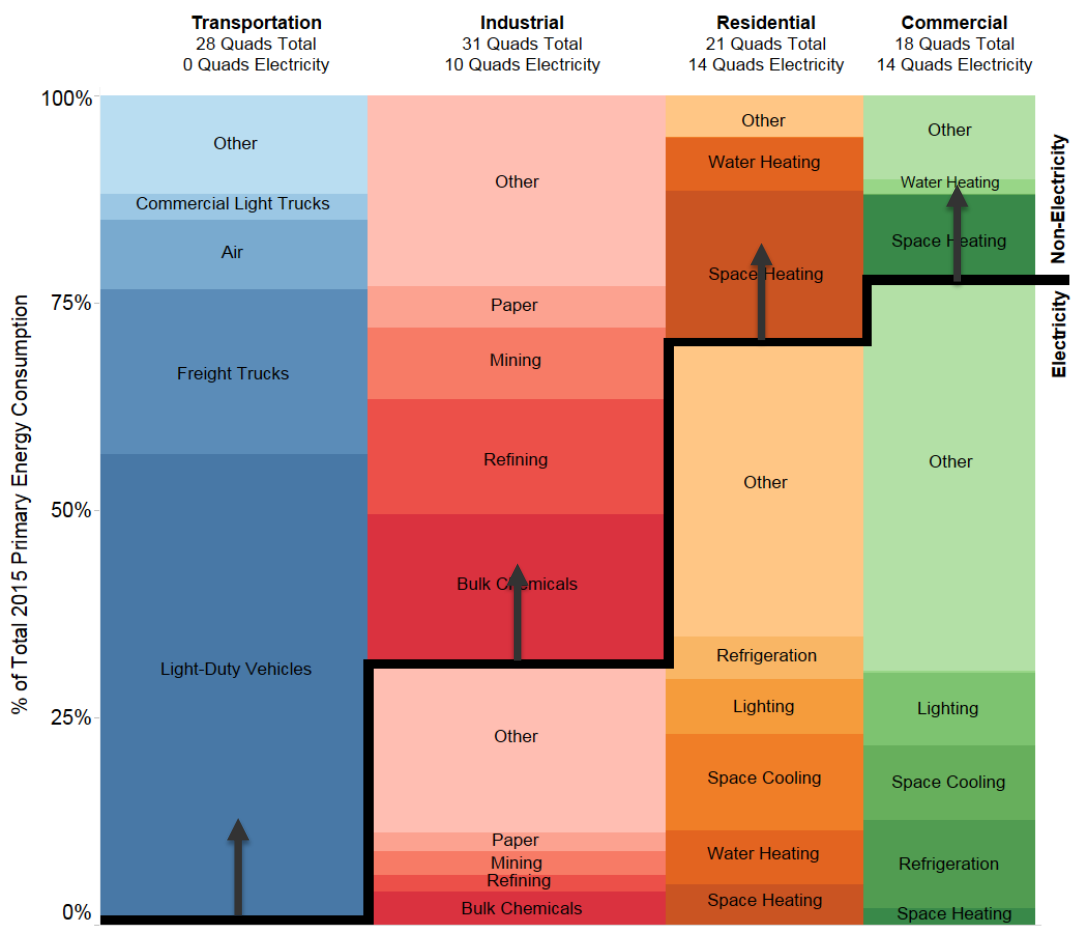
Join us March 16-19 in Tucson for ESIG's Spring Technical Workshop





How do we define electrification?

- **Electrification**: the shift from any non-electric source of energy to electricity at the point of final consumption
  - Mainly vehicles and space/water heating in buildings
  - Industrial electrification is also occurring (e.g., oil & gas) but not discussed today
  - Access to electricity or growth in new sources of electricity demand (e.g., data centers) are not included in this definition



What is Building Electrification?

Building Electrification can affect all regions

Different regions across the country are at different levels of electrification. Transitioning the non-electric energy consumption to electricity could have dramatic effects on the electricity sector.

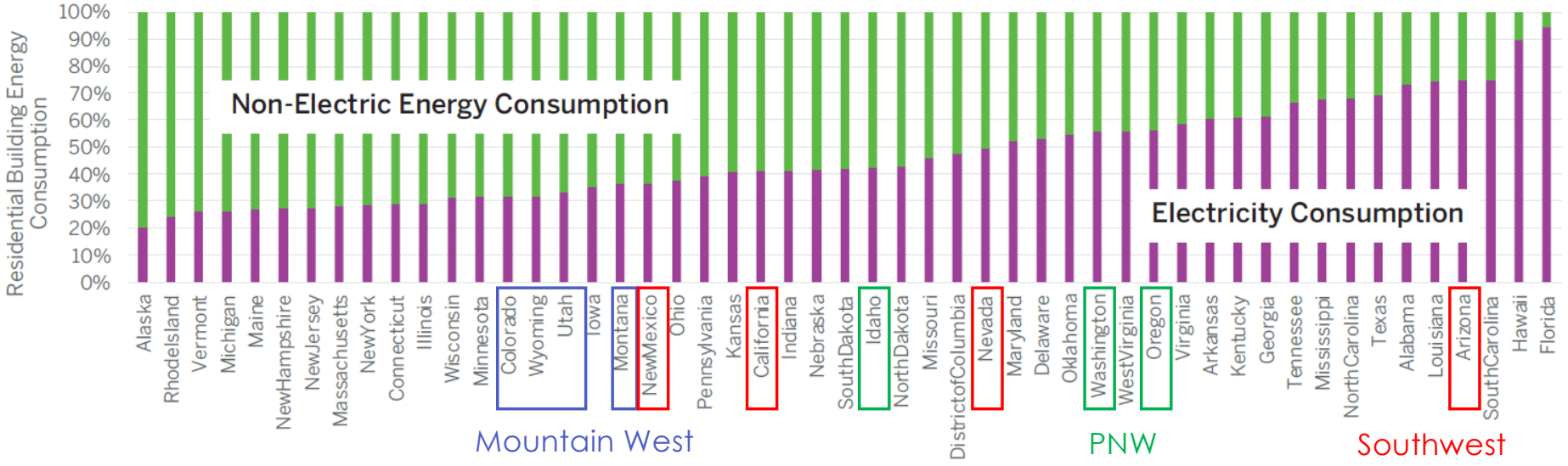
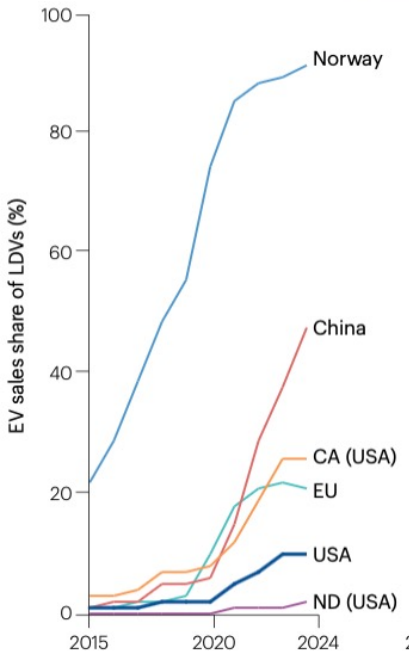


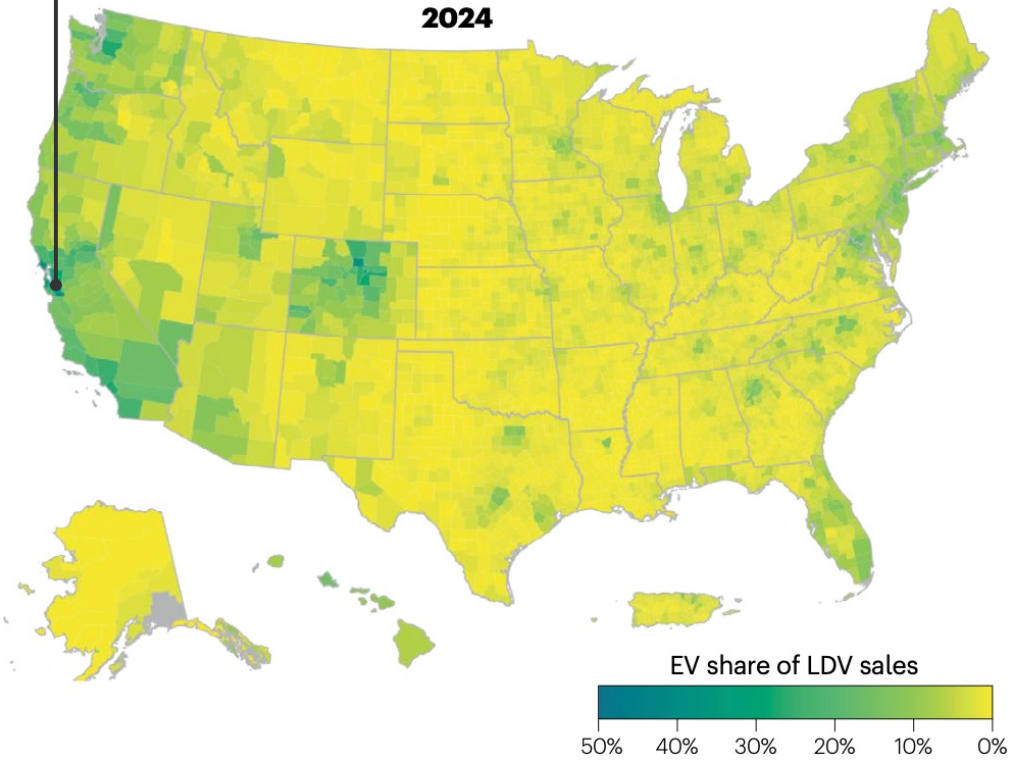
Image source: ESIG, Data via EIA

Vehicle electrification is growing (non-uniformly)

Global: 22% LDV sales were EVs in 2024



Santa Clara County, CA: 43% sales, 12% stock



Source: https://doi.org/10.1038/s44359-025-00108-3
Muratori et al. 2025. "Trends and 2025 insights on the rise of electric vehicles in the USA." *Nature Reviews Clean Technology.* Vol. 1, pp. 827-845.

The Electrification Futures Study explored 5 questions

Load

How might electrification impact electricity **demand** and **use patterns**?

Infrastructure

How would the electricity system need to **transform** to meet changes in demand?

Operations

How would the system operate, with high levels of electrification, to meet **reliability** needs in 2050?

Flexibility

What role might **demand-side flexibility** play to support reliable operations?

Impacts

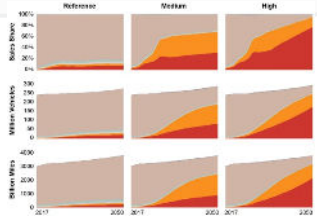
What are the potential **costs, benefits, and impacts** of widespread electrification?

Modeling Methods

End-Use Technology Adoption:

Demand-Side Scenarios

- EnergyPATHWAYS stock turnover and energy accounting model
- ADOPT vehicle choice model



today – 2050 demand

Power System Evolution:

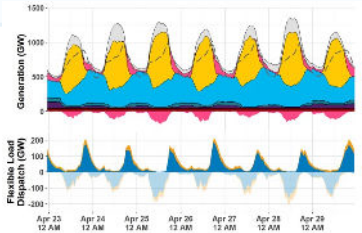
Supply-Side Scenarios

- ReEDS capacity expansion model
- dGen rooftop photovoltaic adoption model

2050 capacity

2050 Grid Operation Analysis

- PLEXOS production cost model



View reports at www.nrel.gov/efs

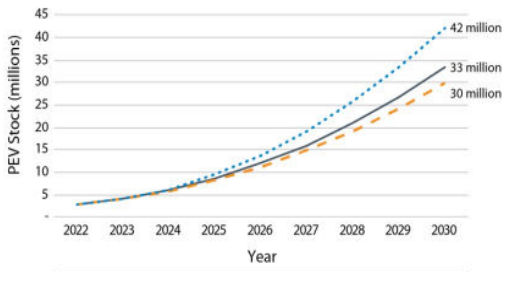
Uncertainty Abounds

ESIG

Adoption Rates?

How many vehicles are expected by when?

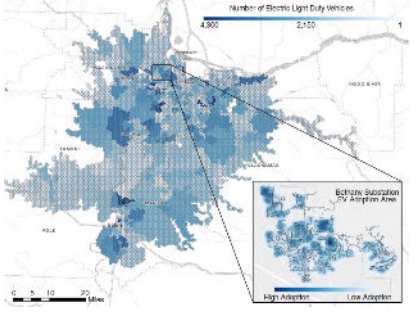
- Type of vehicles (SUV, trucks)
- Technology Change (efficiency & battery technology)
- Use Cases (LDV, MDV, fleets)



Location of Charging?

Where will charging take place?

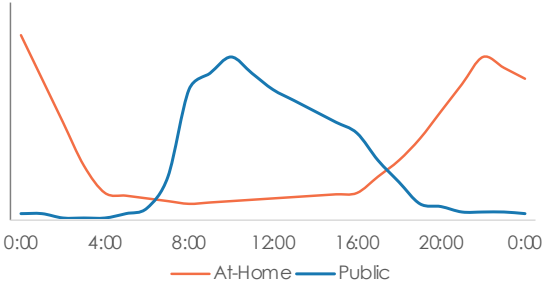
- Home vs. workplace charging?
- Which communities will see adoption first?
- Where do people drive?



Timing of Charging?

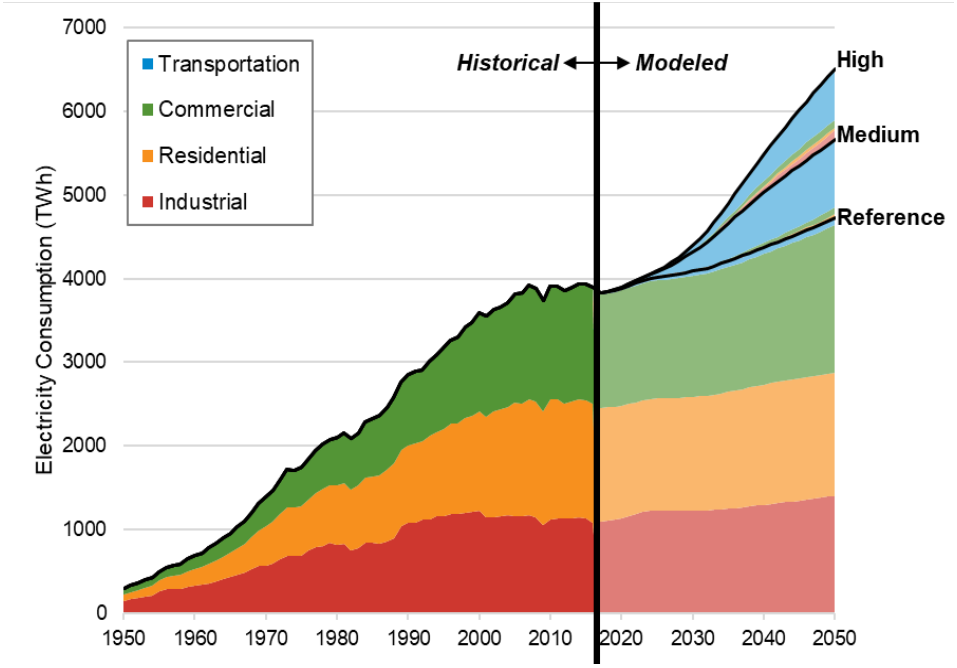
When will vehicle owners charge?

- Hourly charging profiles
- Event-based planning (holidays, storms, etc.)
- Rate design and incentives



The answer to each of these questions has significant implications for power system planning and cost, particularly for distribution networks.

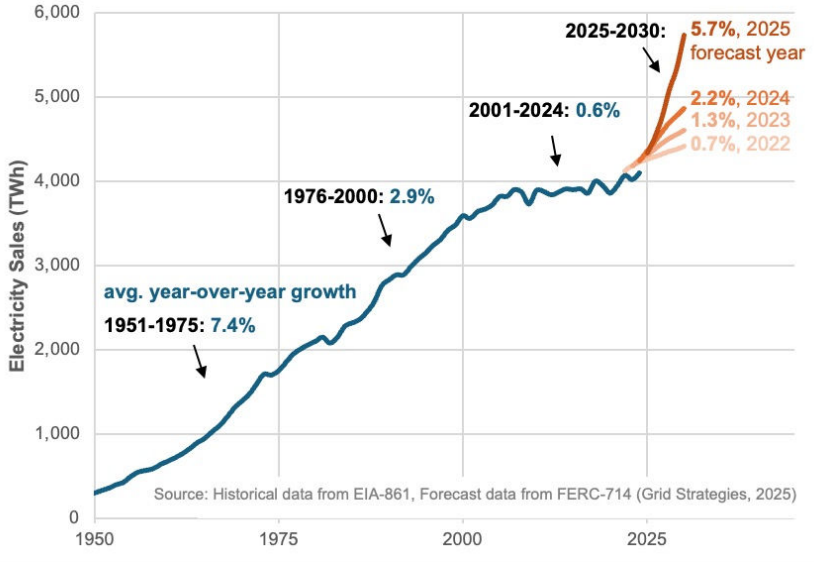
Vehicle electrification dominates incremental growth in *annual* electricity demand



Electrification scenarios from ~2018

Source: NREL EFS

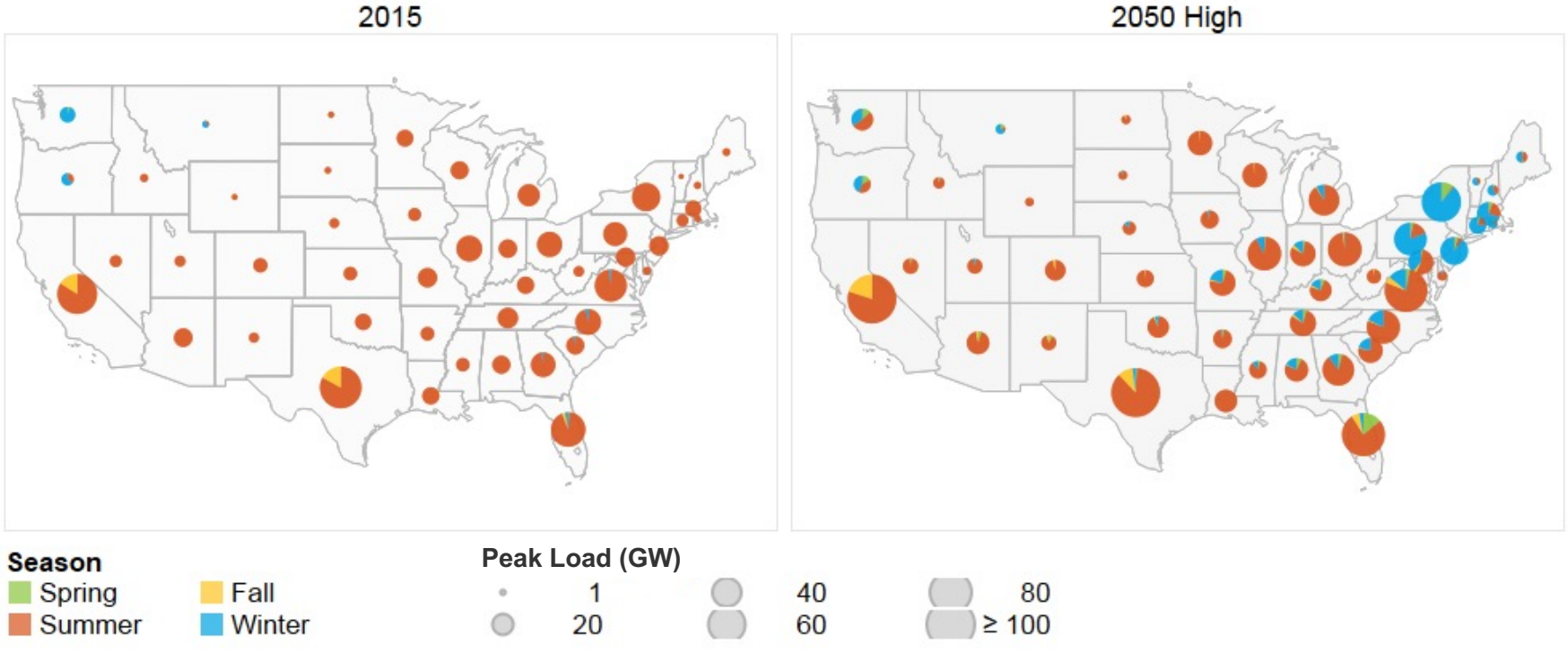
~55% forecasted peak demand growth (2025-2030) are from **data centers**



Utility- and regional-forecasts from ~2025

Source: Grid Strategies (2025), FERC and EIA data

Electric space heating can impact the timing and magnitude of peak demand



Note: Summer = June-August, Fall = September-November, Winter = December-February, Spring = March-May

Source: NREL EFS

Increasing Weather Dependence

Winter events often last longer, changing the stress profile on grid equipment

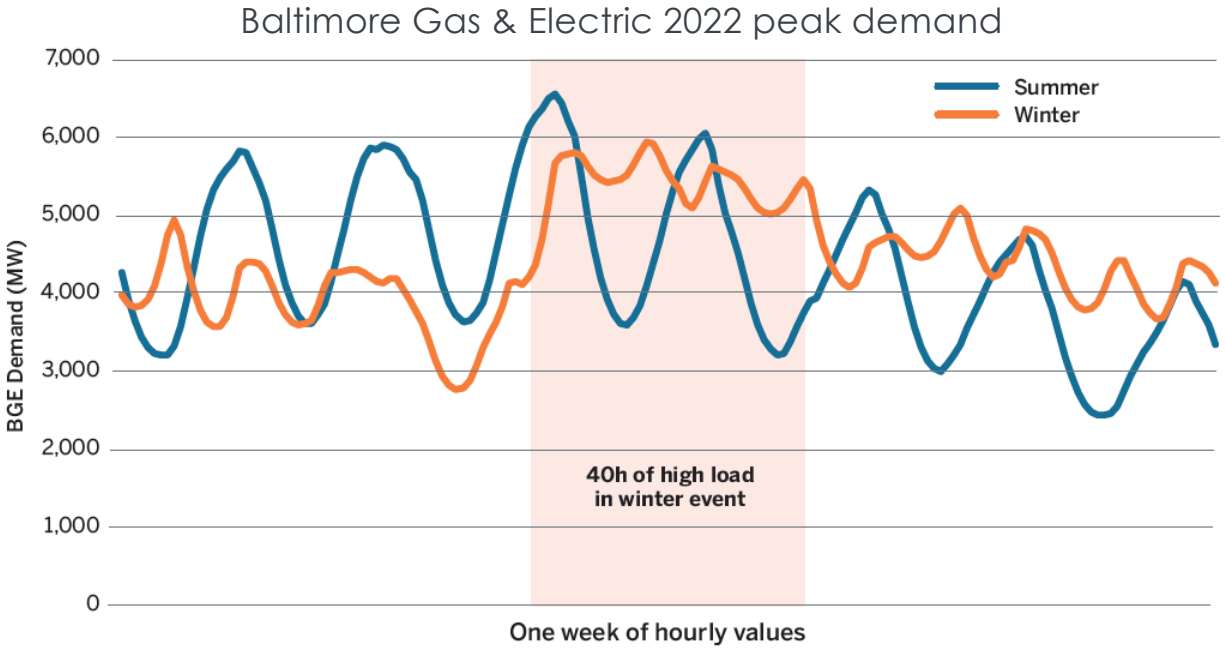
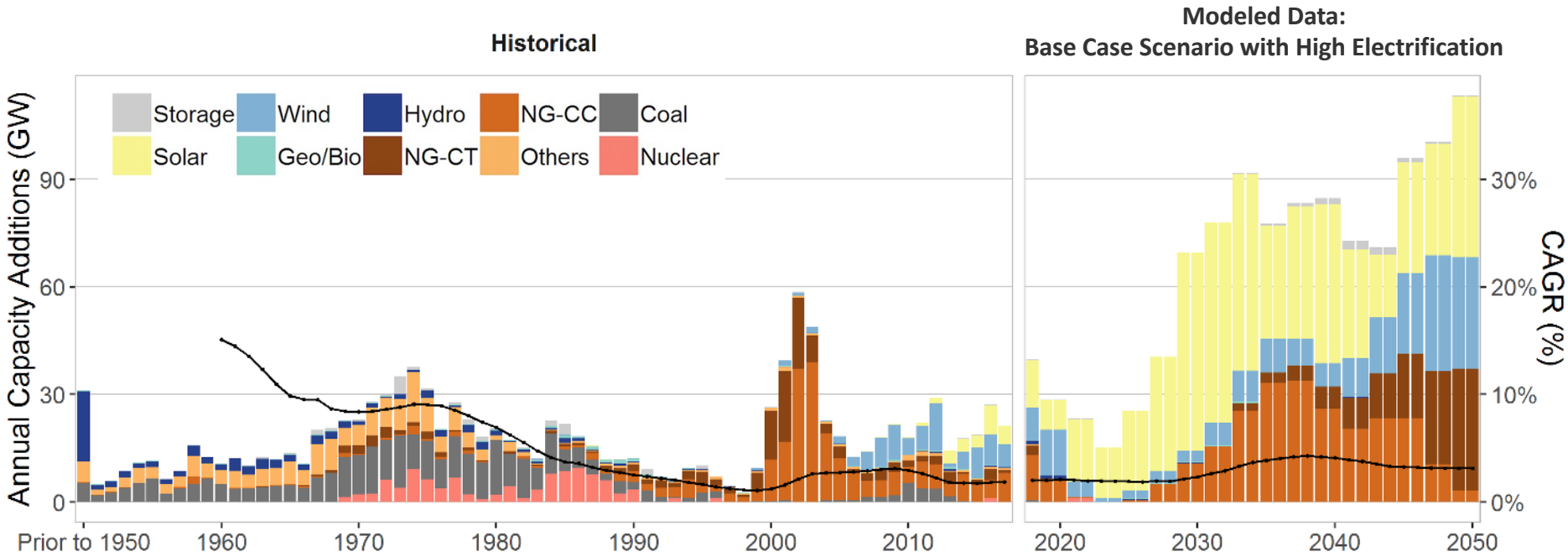


Image source: ESIG, Data via EIA930

Electrification (coupled with retirements) can drive tremendous need for new infrastructure



EIA: 53 GW of new utility-scale generation capacity went online in 2025

Source: NREL EFS

Solutions:

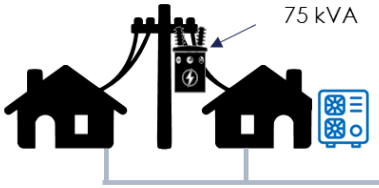
Touch the Grid Once

Two kinds of grid upgrades:

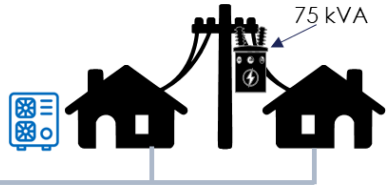
1. "Future-ready" the grid with opportunistic upgrades:
   - Updated planning criteria
   - Reconsider design standards
     New load factors = different stress on the system
2. Discrete projects requiring upgrades

Options for Upgrade Strategies

A) Customers on this electric service transformer, which has already been upgraded opt to convert to electric heating.

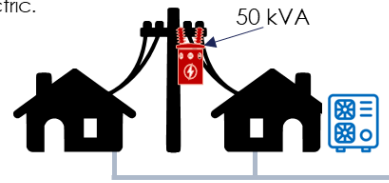


B) Customers on this electric service transformer, which has already been upgraded, are slow to adopt electric heating.

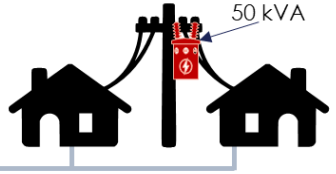


Gas network continues to support all customers

C) Customers on this electric service transformer, which has not been upgraded, can overload grid equipment when they choose to convert to electric.

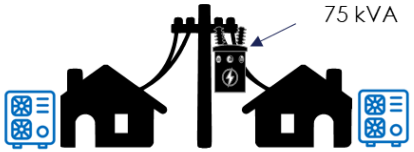


D) Customers on this electric service transformer, which has not been upgraded, are slow to adopt electric heating.



Gas network continues to support all customers

This region has targeted electrification, outfitting every home with new heat pumps and performing all necessary grid upgrades upon conversion, including any upstream upgrades, such as at the substation. In order to achieve this level of electrification, all customers must be willing to abandon their gas supply.



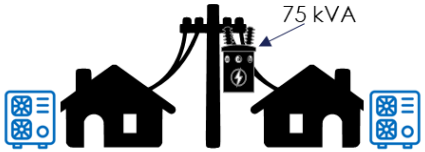
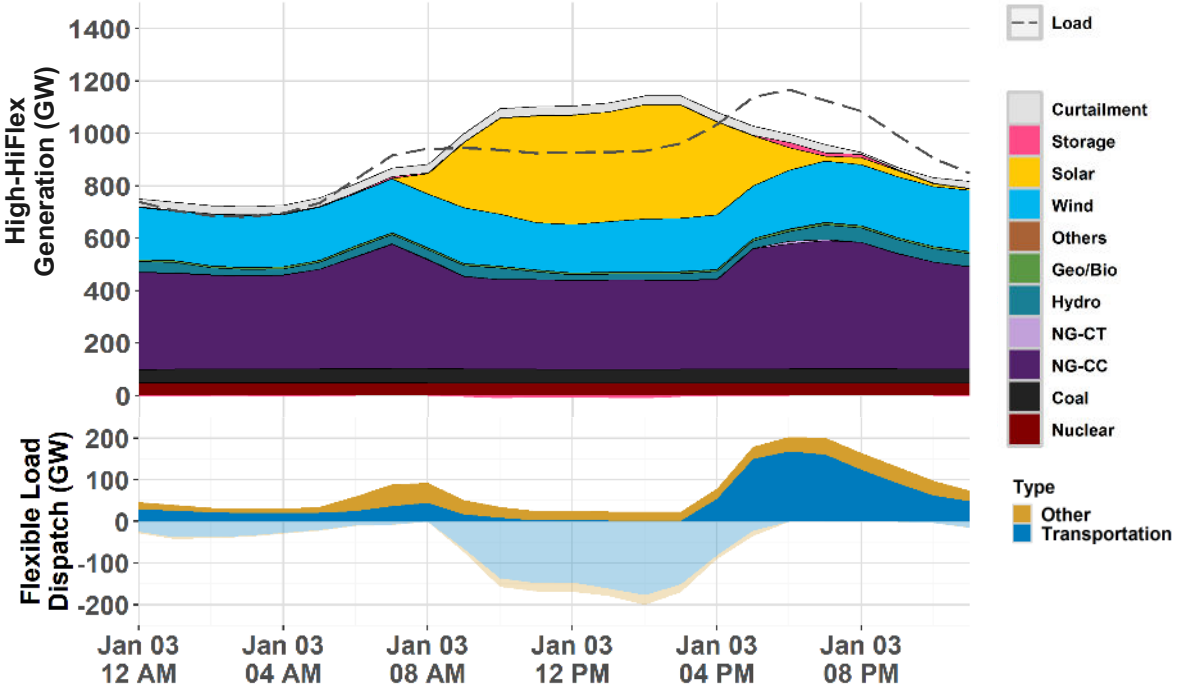


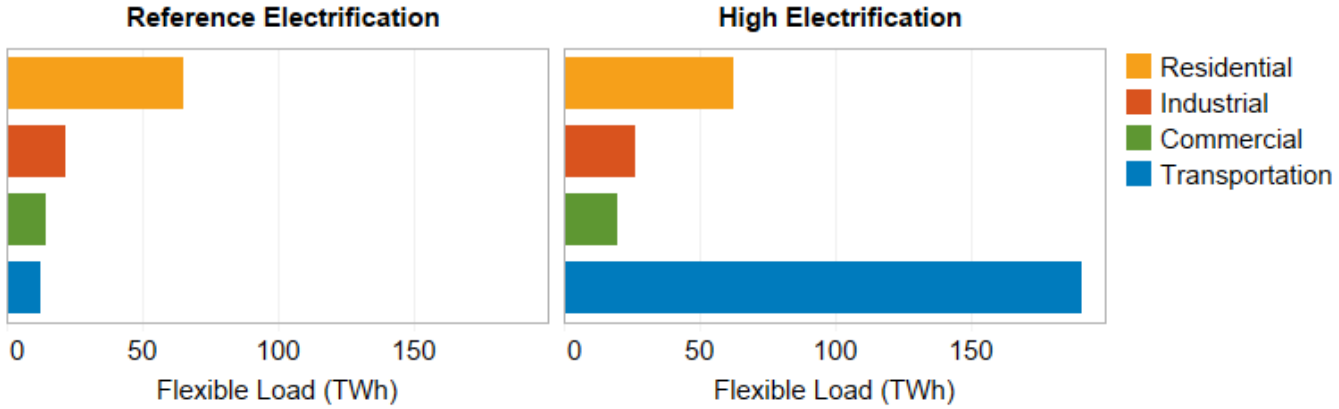
Image sources: ESIG

Operations: Modeled portfolios are resource adequate



The system serves **more than 99.99% of the load and 99.96% of the operating reserves** in hourly simulations of all 2050 scenarios

Electrification expands opportunities for demand-side flexibility

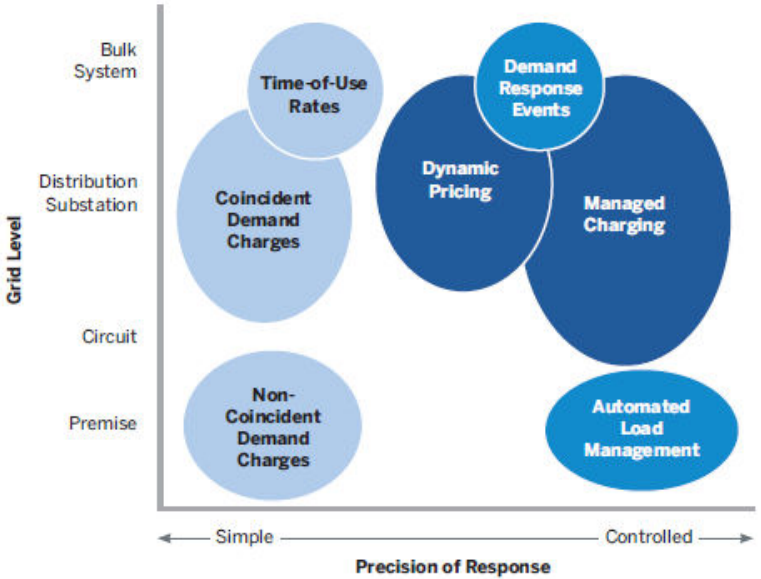


Demand-side flexibility reduces (1) VRE curtailment, (2) thermal plant ramping and cycling, (3) increases utilization of more-efficient generators and transmission, and (4) reduces the need for new infrastructure

And that flexibility has high potential value: **$4-16/MW-h Available, $8-22/MWh Shifted**

Embrace Smart Charging:

Many Flavors of Smart Charging – pricing, control, preset, and dynamic



Mitigation Measure	Classification		Suitability to Address Challenges at Multiple Levels				Ease of Implementation	Cost
	Signal	Timing	Site	Distribution	Transmission	Generation		
Demand charge	Pricing	Preset						
Time-of-use rate	Pricing	Preset						
Dynamic price signal	Pricing	Dynamic						
Consumer response to event-based demand response	Control	Dynamic						
Dynamic managed charging	Control	Dynamic						
Automated load management	Control	Preset						

More to less suitable ▶ ▶ ▶ Less to more complex ▶ ▶ ▶

Cost and ease to implement smart charging measures are characterized relative to each other and should be evaluated against alternatives, such as infrastructure improvements.

Image Sources. Energy Systems Integration Group. 1. Cutter et al., 2021. 2. Badtke-Berkow et al., 2015. 3. Octopus Energy, 2019.

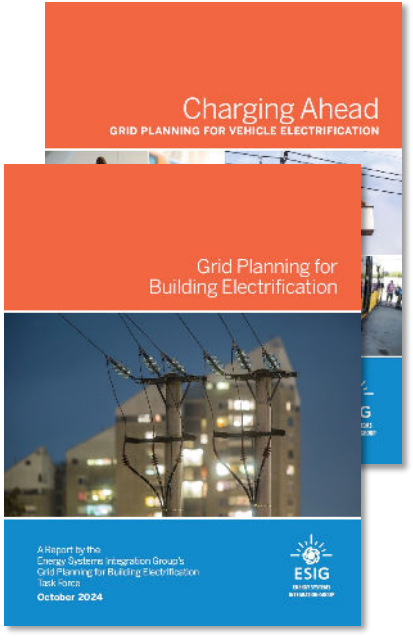
Priorities for effectively integrating electrification into grid planning

1. **Improve forecasting** by increasing granularity (e.g., vehicle types, weather, charging infrastructure, building envelopes). Use of scenarios to capture the uncertainty of locational and temporal grid impacts.

2. **Embrace demand flexibility and demand management** including smart charging and energy efficiency

3. **Modernize planning approaches** by expanding beyond single peak-load hour, evaluating equipment standards, use multiple scenarios.

4. **Promote proactive upgrades** that incorporate future-ready and upsize equipment identified through a multi-stakeholder group.

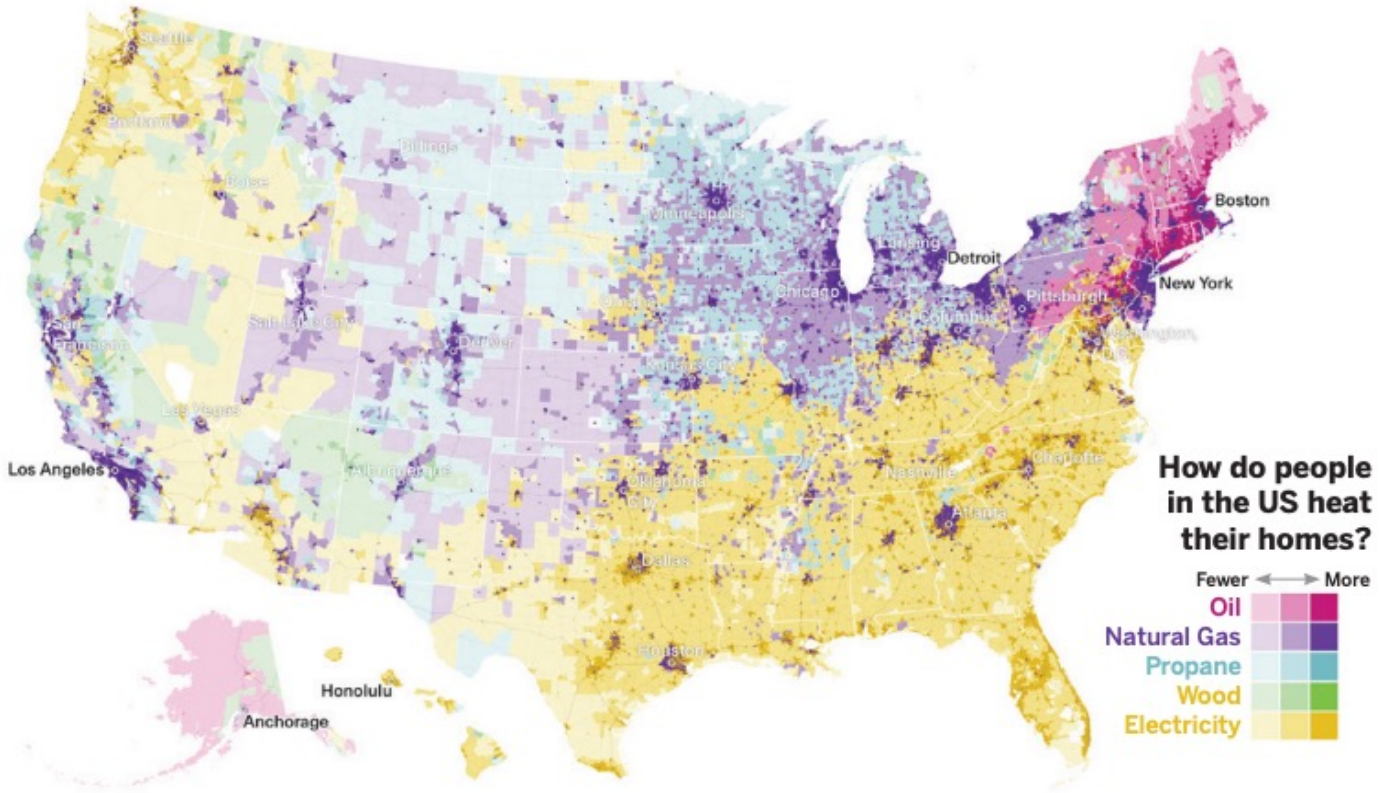


Thank You!

trieu@esig.energy

Acknowledgments:
ESIG Grid Planning for Vehicle Electrification and Building Electrification Task Forces, especially Sean Morash (Telos)
NREL Electrification Futures Study team, especially Caitlin Murphy (NREL)

ESIG
ENERGY SYSTEMS INTEGRATION GROUP



Source: Stevens (2023), ESIG (2024)

PART 3

Expert Spotlight: Regional Reliability & Adequacy

Katie Rogers · WECC

WECC

Western Reliability and Adequacy Implications of Electrification

Katie Rogers
Manager, Reliability Assessments

Electric Reliability
& Security for the West

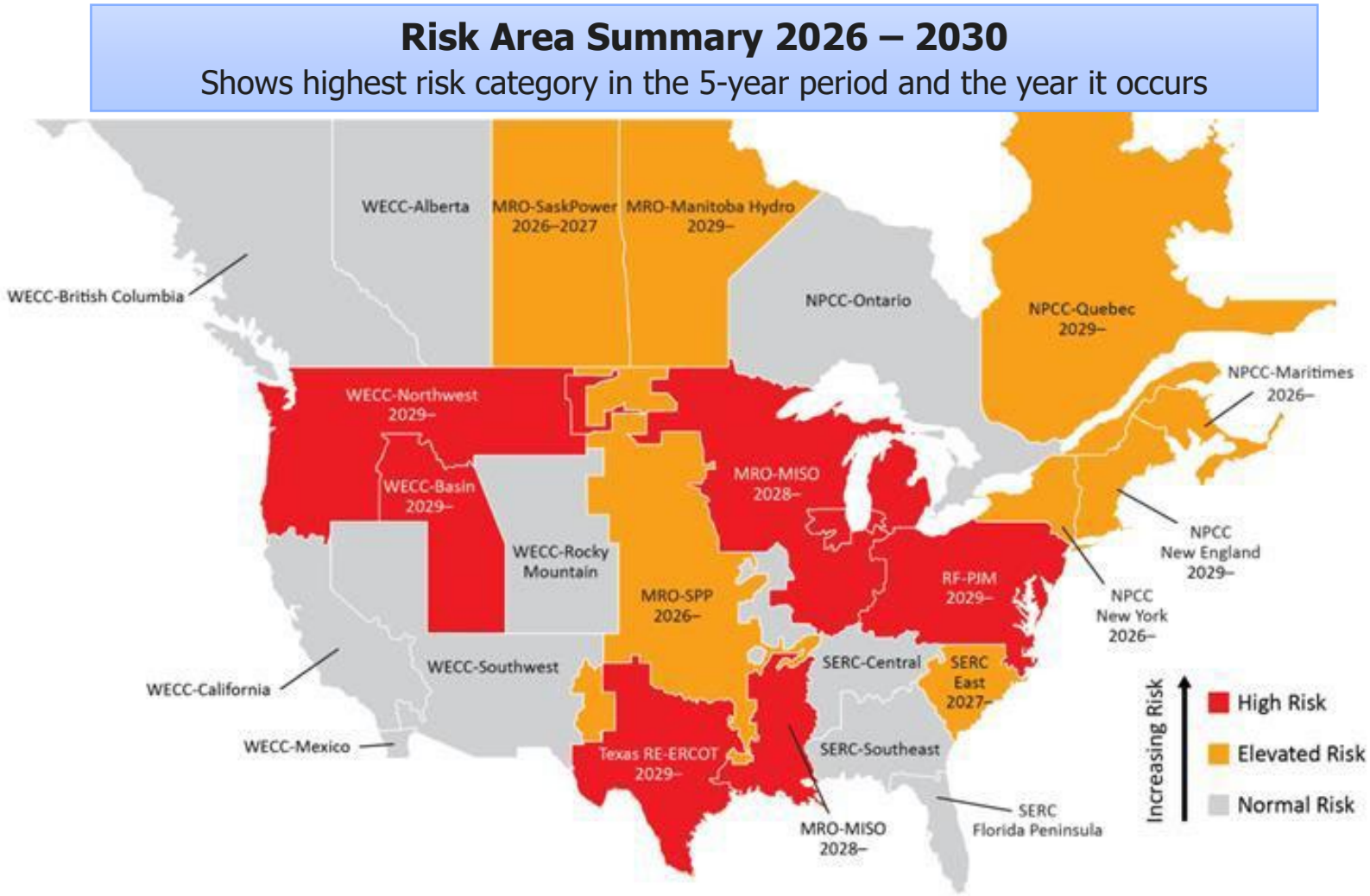
March 4, 2026

Western Electricity Coordinating Council

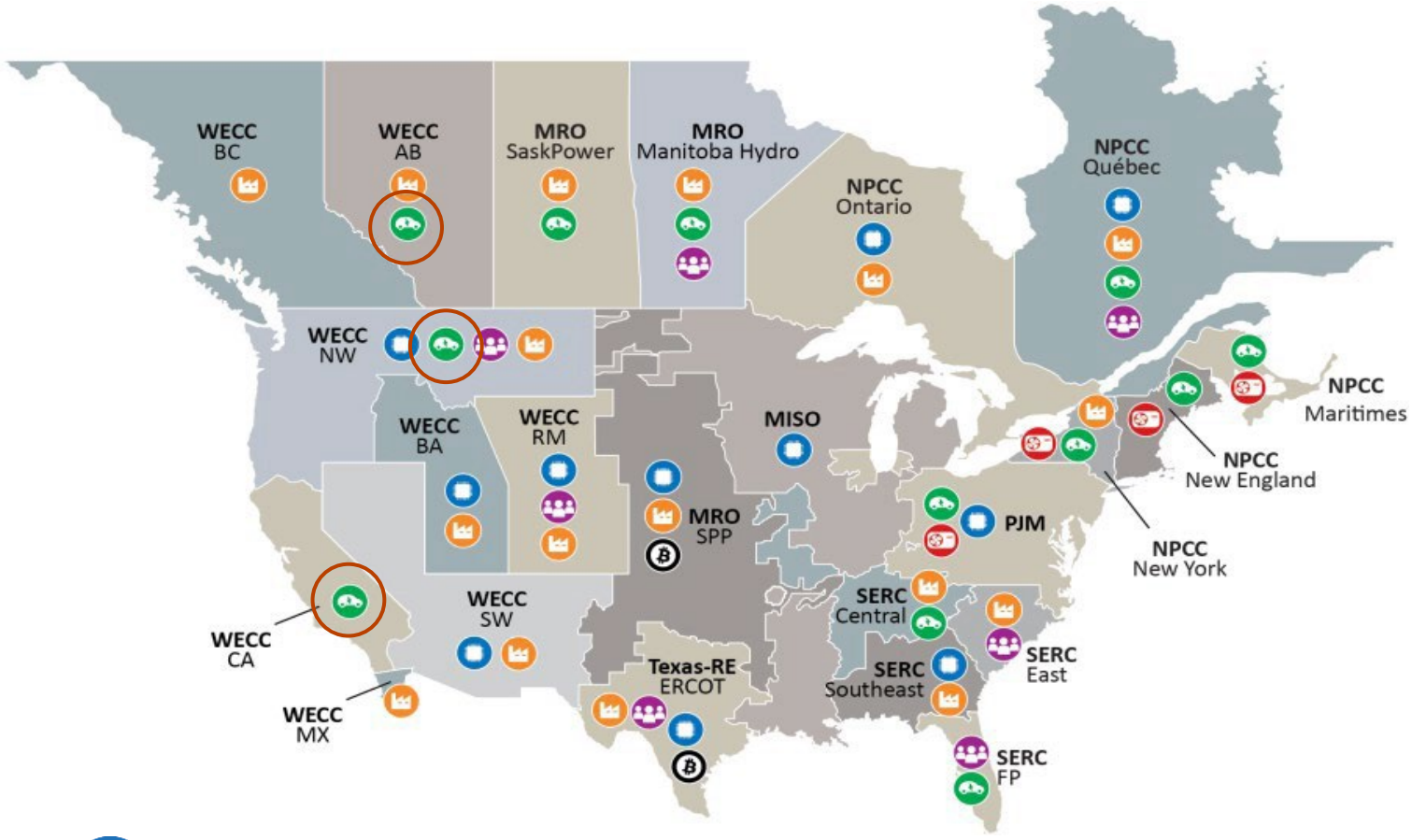
- Designated as the Regional Entity for the Western Interconnection
- Delegated authority from North American Electric Reliability Corporation (NERC)
- Largest of six Regional Entities
- Help create, monitor, enforce reliability standards and promote activity that ensures reliability and security
- Service territory
  - Eight subregions
    - All or parts of 14 western states
    - Alberta and British Columbia
    - Northern Baja California, Mexico

Current Resource Adequacy Outlook

- 2025 NERC Long-term Reliability Assessment (LTRA)
- High Risk in the West beginning in 2029:
  - Basin
  - Northwest



Where is the Electrification?



Electrification Data and Assumptions

Western Interconnection: Top Load Types Incorporated in Demand Forecasts			
Member Inclusion*	Maximum Contribution to Demand Forecast	Average Contribution to Demand Forecast	Factor
72%	-10%	-4%	Behind the Meter (BTM) Adoption
72%	25%	4%	Electrification - Transportation
72%	-15%	-3%	Energy Efficiency - Residential
69%	-10%	-2%	Energy Efficiency - Commercial
63%	40%	10%	Electrification - Residential
59%	40%	10%	Data Centers
59%	45%	13%	Electrification - Commercial
56%	-4%	-1%	Energy Efficiency - Industrial/Manufacturing
56%	10%	4%	Irrigation Load
47%	-10%	-3%	Demand Side Management (DSM)/Demand Response (DR)
44%	5%	2%	Electrification - Industrial/Manufacturing
34%	45%	8%	Mining
25%	5%	3%	Cryptomining
25%	10%	5%	Incremental Load for Extreme Heat Event(s)
22%	10%	5%	Oil extraction and/or Refining
* Total participation included 32 BAs/LSEs			

2025 Loads & Resources (L&R) data collection, as of 12/31/24

Challenges

- Inconsistencies in assumptions and data across Balancing Authorities (BA)
- Variable load profiles
- Large loads vs. electrification
  - Aggregation of smaller loads could be equivalent to a “large load”
  - May not be subject to large loads registration/standards

ELECTRIC RELIABILITY & SECURITY FOR THE WEST

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155 N 400 W, Salt Lake City, Utah 84103, USA

PART 4

Expert Spotlight: State Policy & Forecast Alignment

Quentin Gee · California Energy Commission

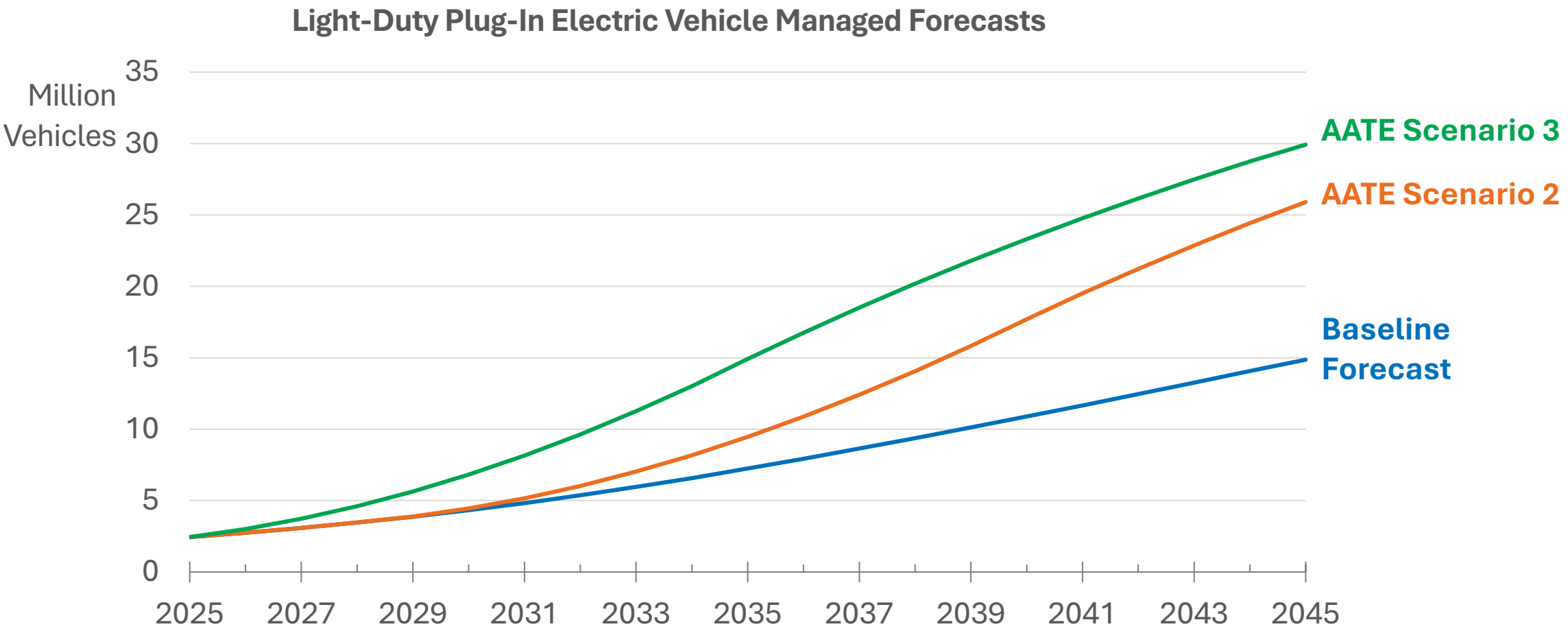
Load Growth, Electric Vehicles, and Building Electrification in California

Quentin Gee, Ph.D.
Energy Assessments Division
WIEB Electrification Webinar
March 4, 2026

Forecasting Electricity Demand for Electric Vehicles

- Additional Achievable Transportation Electrification (AATE) Framework
  - Load modifiers that go above the baseline but are reasonably expected to occur
- Light-Duty EVs
  - Existing Data and Trends
  - Vehicle choice model informed by the California Vehicle Survey
    - Personal
    - Commercial
  - AATE: Post-Process alignment with market transformation potential or policy drivers
  - Travel Model: Assigns miles driven and energy demand
- Medium- and Heavy-Duty EVs
  - Freight movement demand
  - Truck use survey inputs and truck choice model
  - AATE: Post-Process alignment with market transformation potential or policy drivers

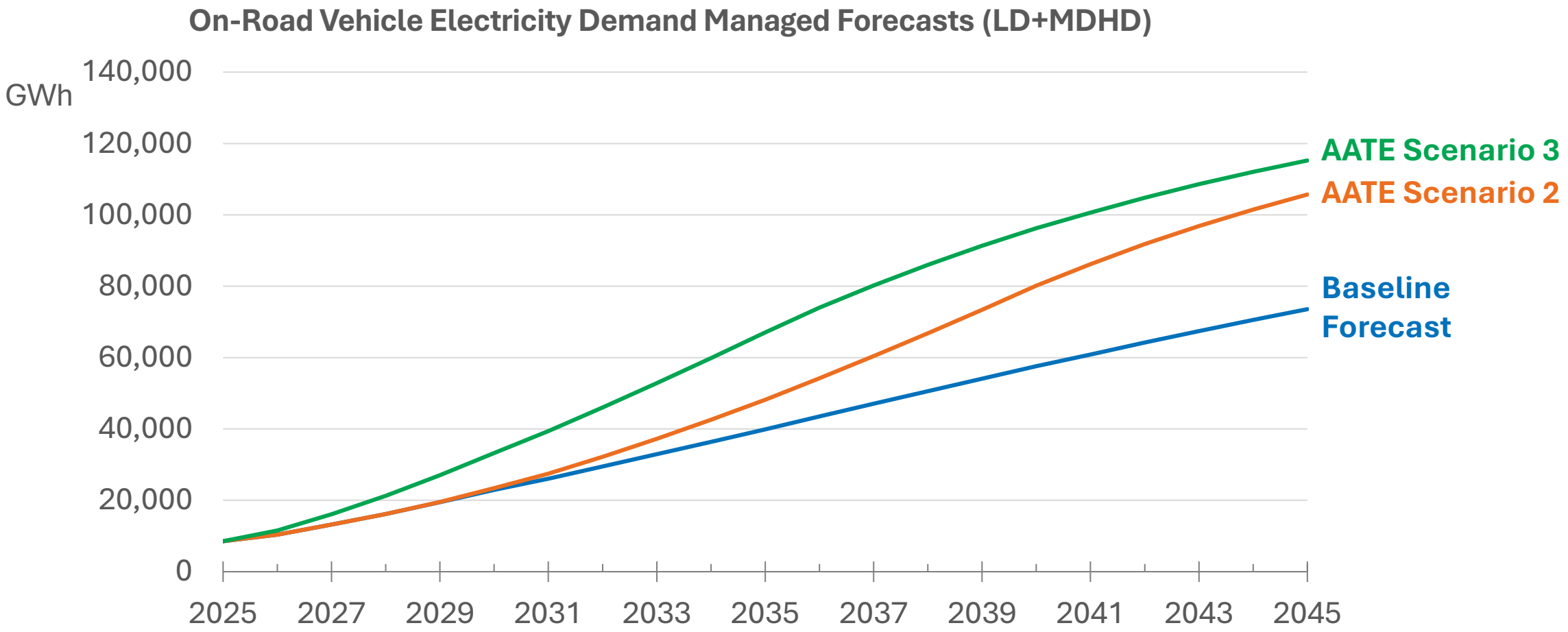
EV Population



Source: CEC Staff

AATE – Additional Achievable Transportation Electrification

EV Electricity Demand



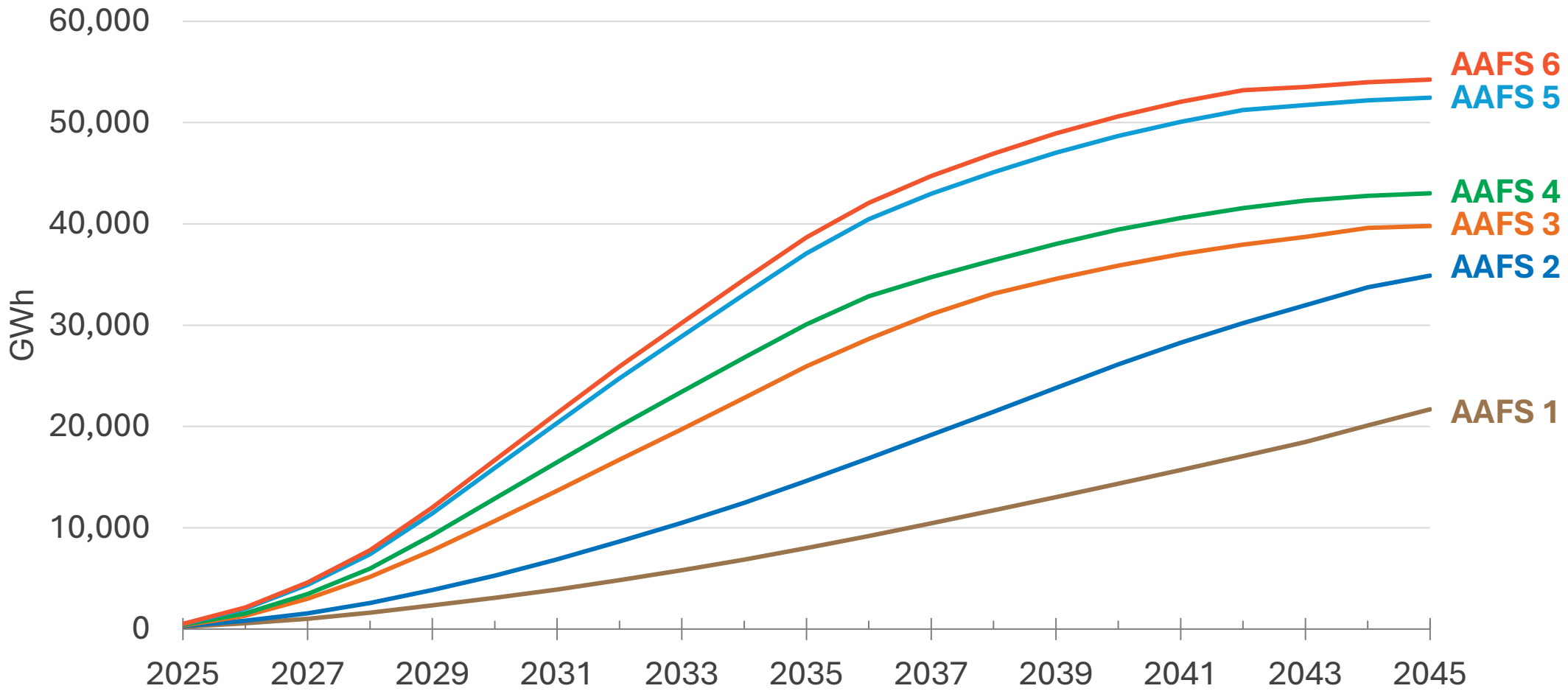
Source: CEC Staff

AATE – Additional Achievable Transportation Electrification

Forecasting Demand for Building Electrification

- Existing models for residential and commercial sectors incorporate existing regulations, codes, and standards
- Additional Achievable Fuel Substitution is a Load Modifier with 6 scenarios deemed within the range of reasonably expected to occur
- Framework
  - Programs and Incremental Codes and Standards (PiCS)
  - Zero-Emission Fuel Substitution from CEC's Fuel Substitution Scenario Analysis Tool (FSSAT)
    - Enhanced ZE regulations
    - Additional ZE market transformation potential

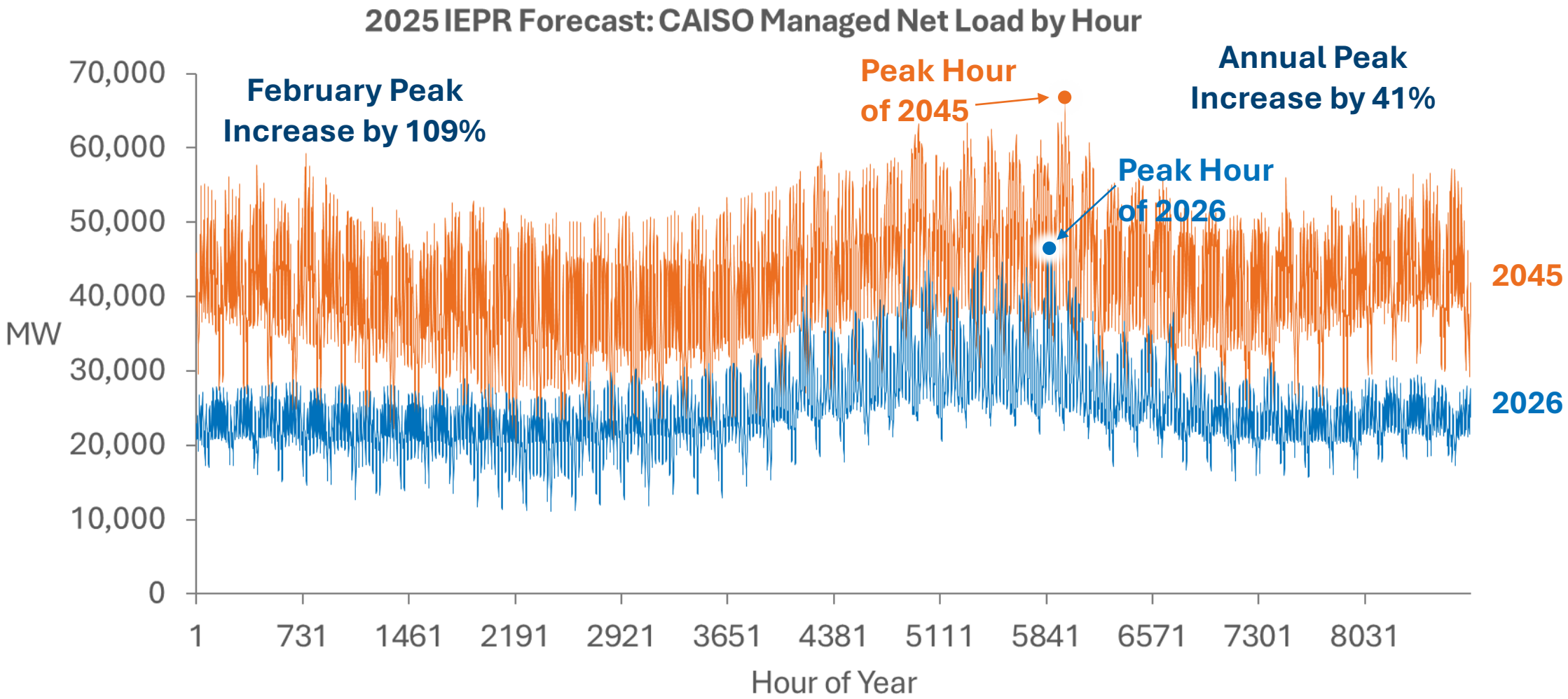
Building Electrification AAFS Forecast



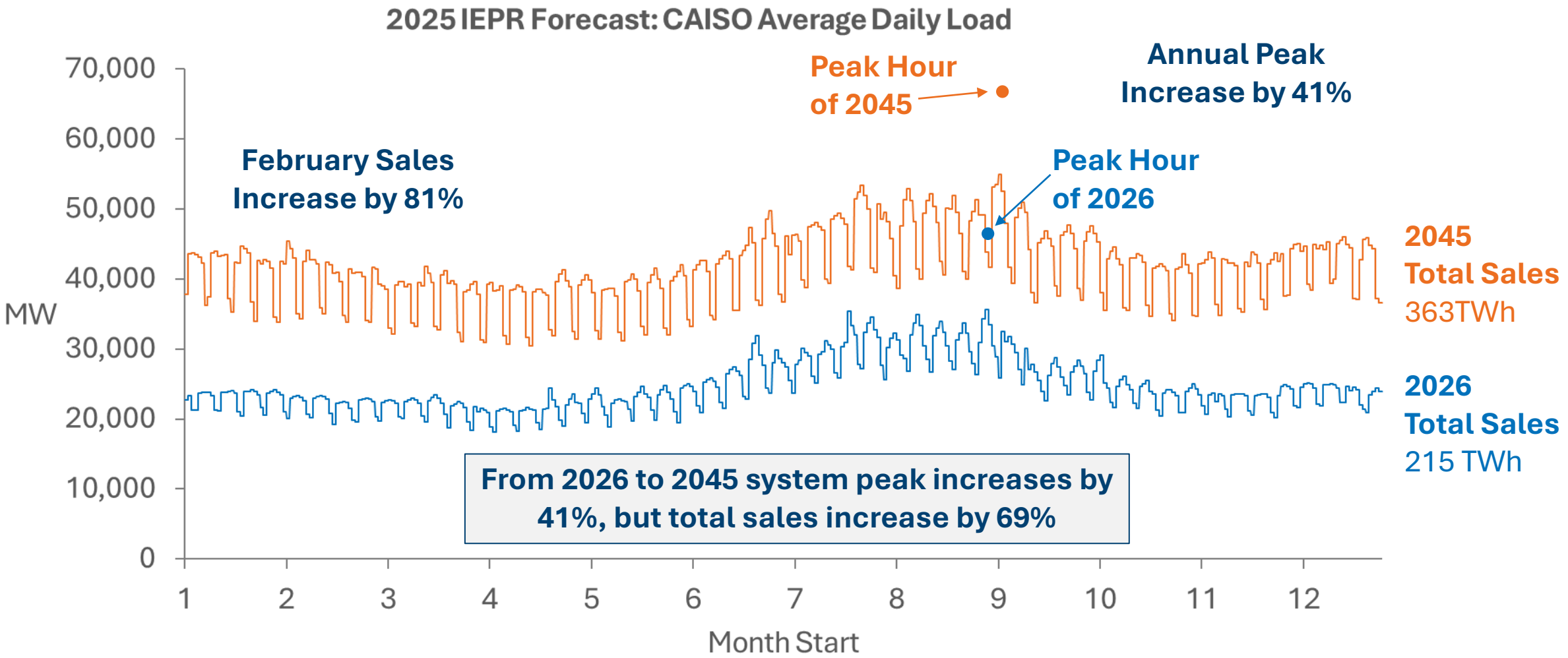
Source: CEC Staff

All Load Growth in Context

8760 Hourly Analysis of System Load

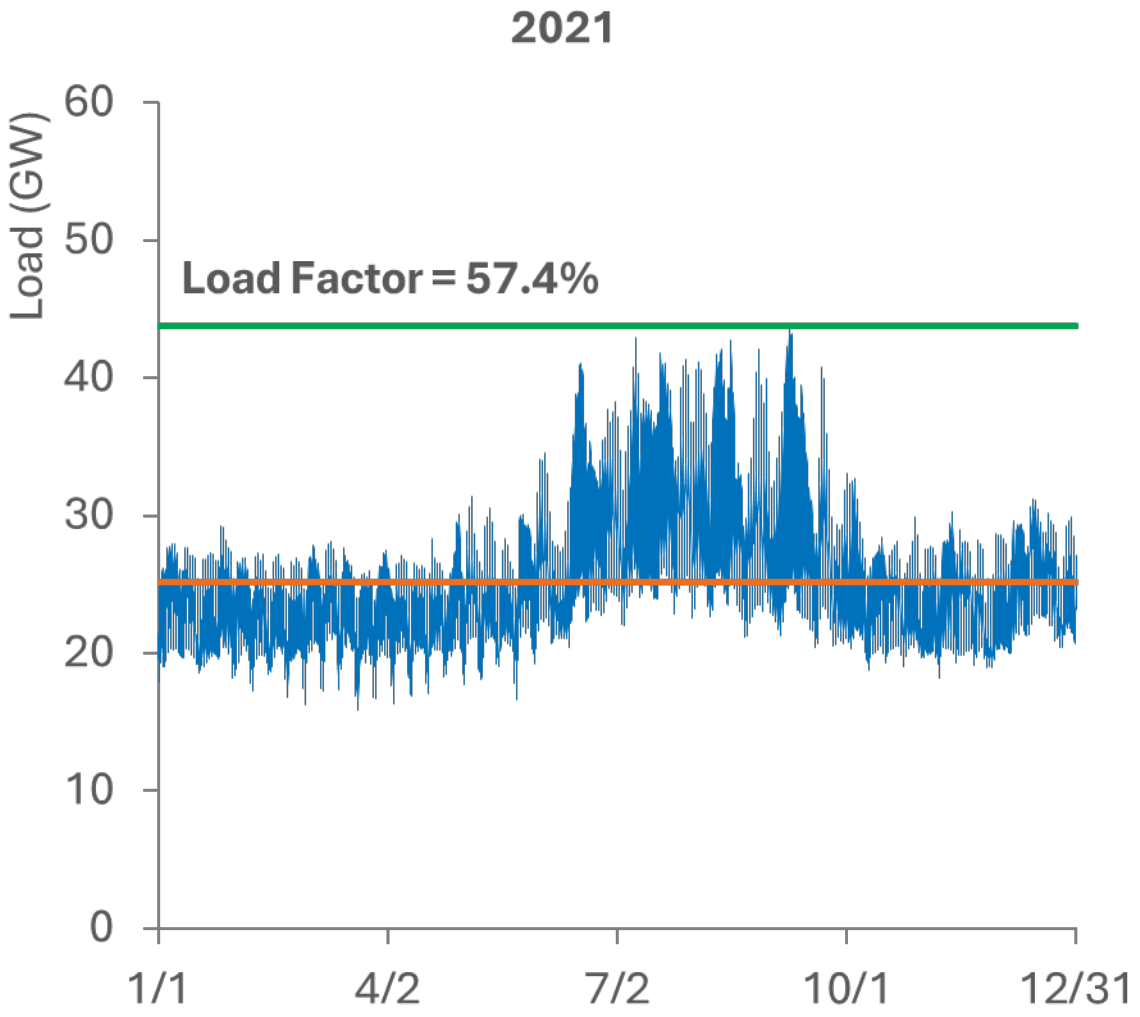


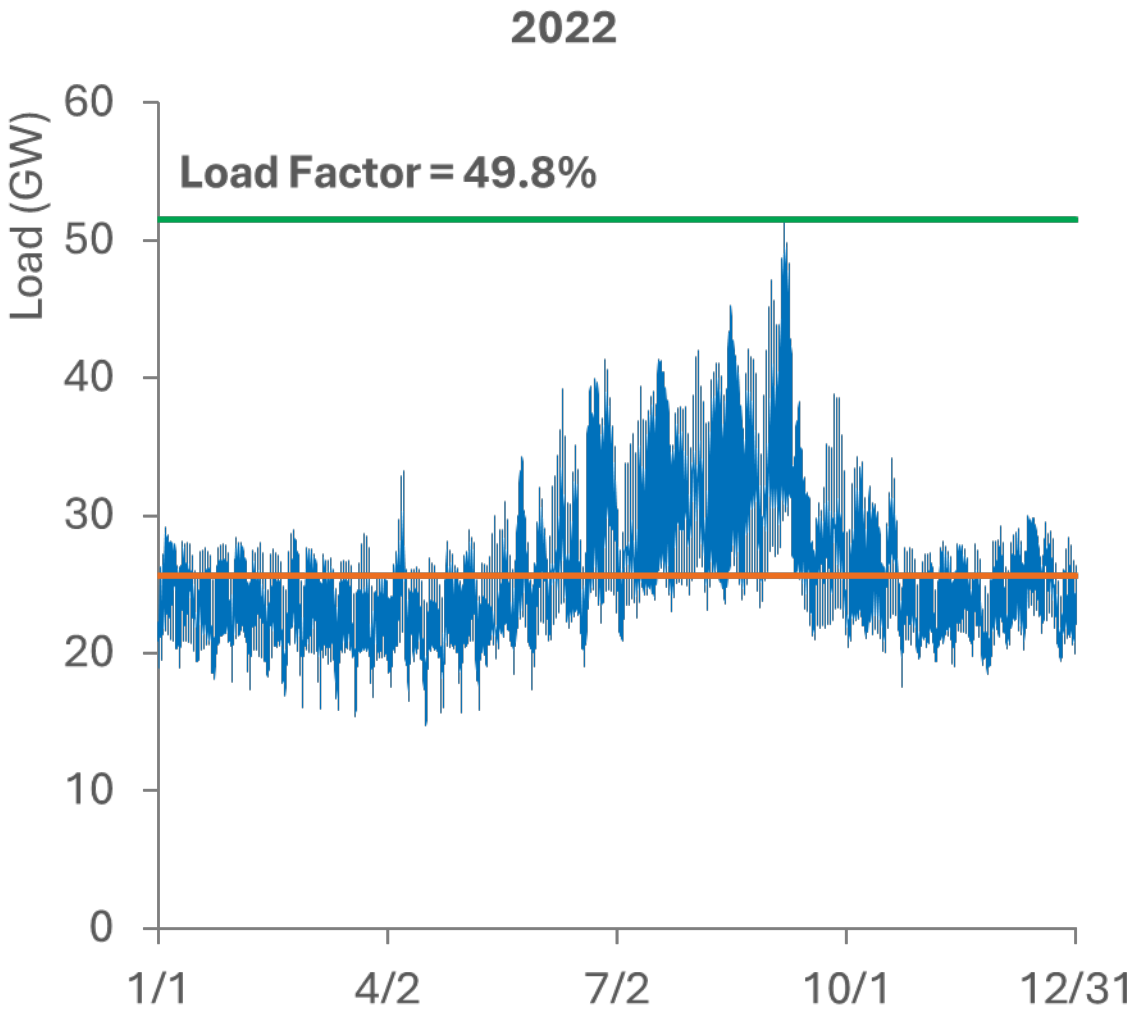
Total Electricity Sales Growth Exceeds Peak Growth



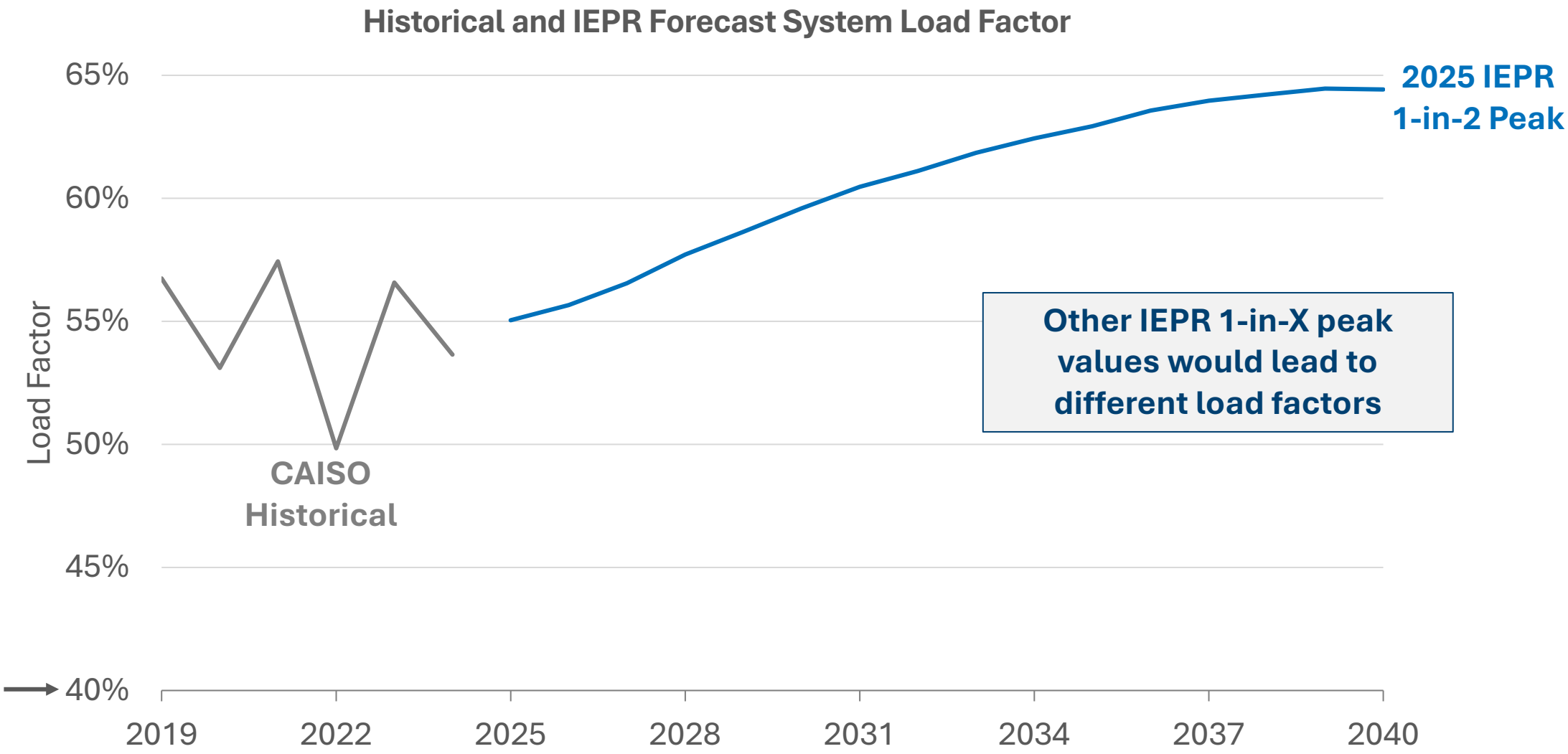
Annual Load Factor

Average Load as a Proportion of Peak Load





Increasing Annual Load Factor



Increasing Load Factor

- Correlated with downward pressure on rates
  - Greater use of existing capacity
  - Greater use of expanded capacity
  - More kWh sales for per dollar invested in infrastructure
- May help to increase system reliability
- Some demand management questions remain for distribution
  - Substation peaking
  - Circuit peaking
  - Transformer peaking

Thank You!

Questions?

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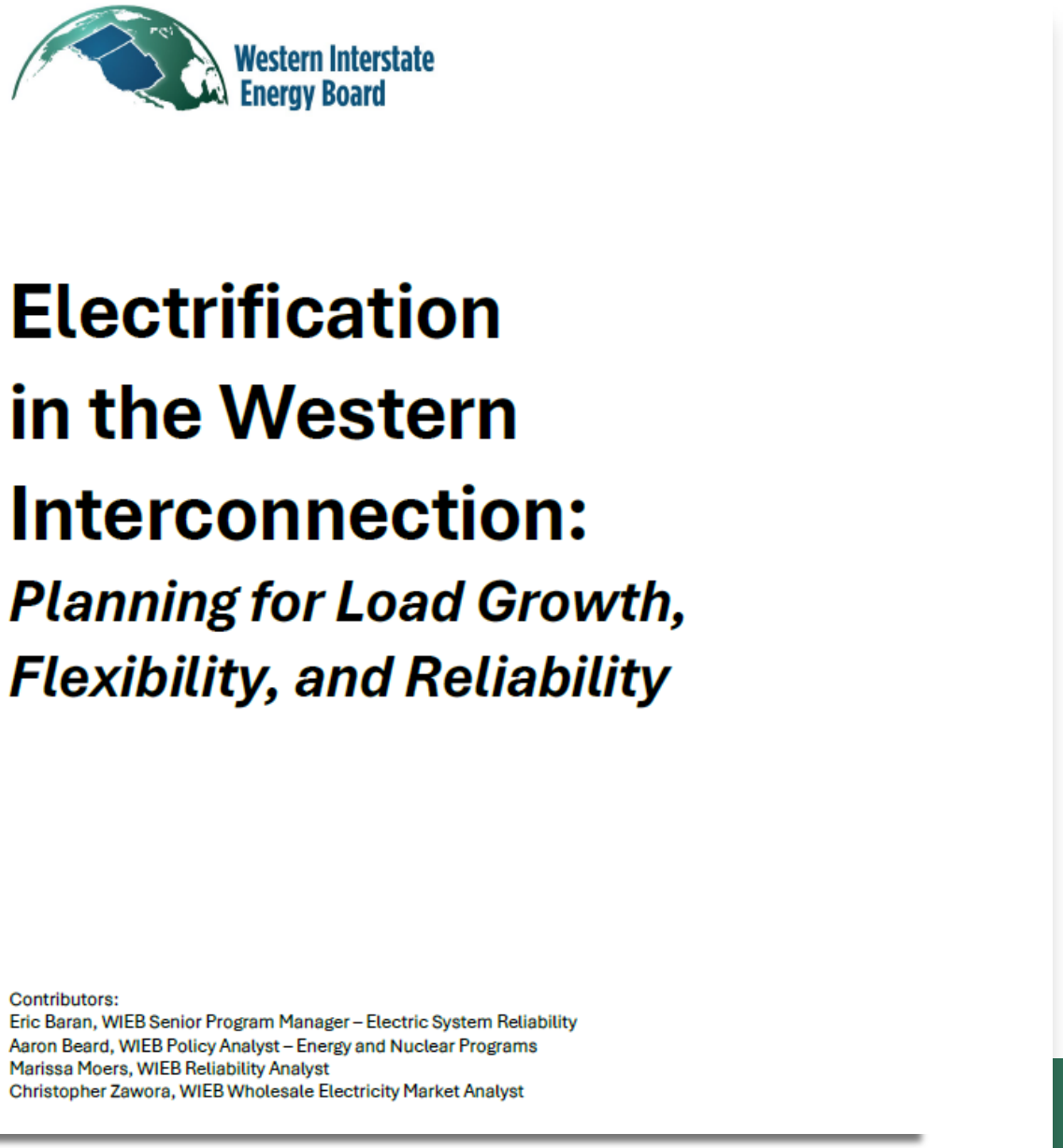
Western Interstate Energy Board

Questions?

Please submit questions using the chat box or raise your hand



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Thank You!

Access the Paper: https://www.westernenergyboard.org/wieb-paper-webinar-electrification-in-the-western-interconnection/

For more information: ebaran@westernenergyboard.org