DOCKETED	
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Document Title:	Presentation - Hourly Electricity Demand
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Hourly Electricity Demand

California Energy Demand Forecast, 2023 - 2040

Nick Fugate, Energy Assessments

Use cases

- Input to system and reliability modeling
- Monthly system peaks serve as a system-level benchmark for Resource Adequacy
- Detailed planning use cases outlined in Single Forecast Set agreement published in each IEPR

For IOU TAC areas, peak loads are derived from hourly load modeling

HLM approach

1. Apply base load profile to annual “consumption” forecast
2. Adjust hourly consumption using profiles for:
   - Climate change impacts
   - Electric vehicle charging
   - Behind-the-meter PV generation and storage
   - “Additional Achievable” efficiency and electrification
3. Calibrate to weather-normal base-year peak load

Updates and Objectives

Staff rebuilt significant portions of the peak and hourly forecast process during the IEPR 2023 cycle

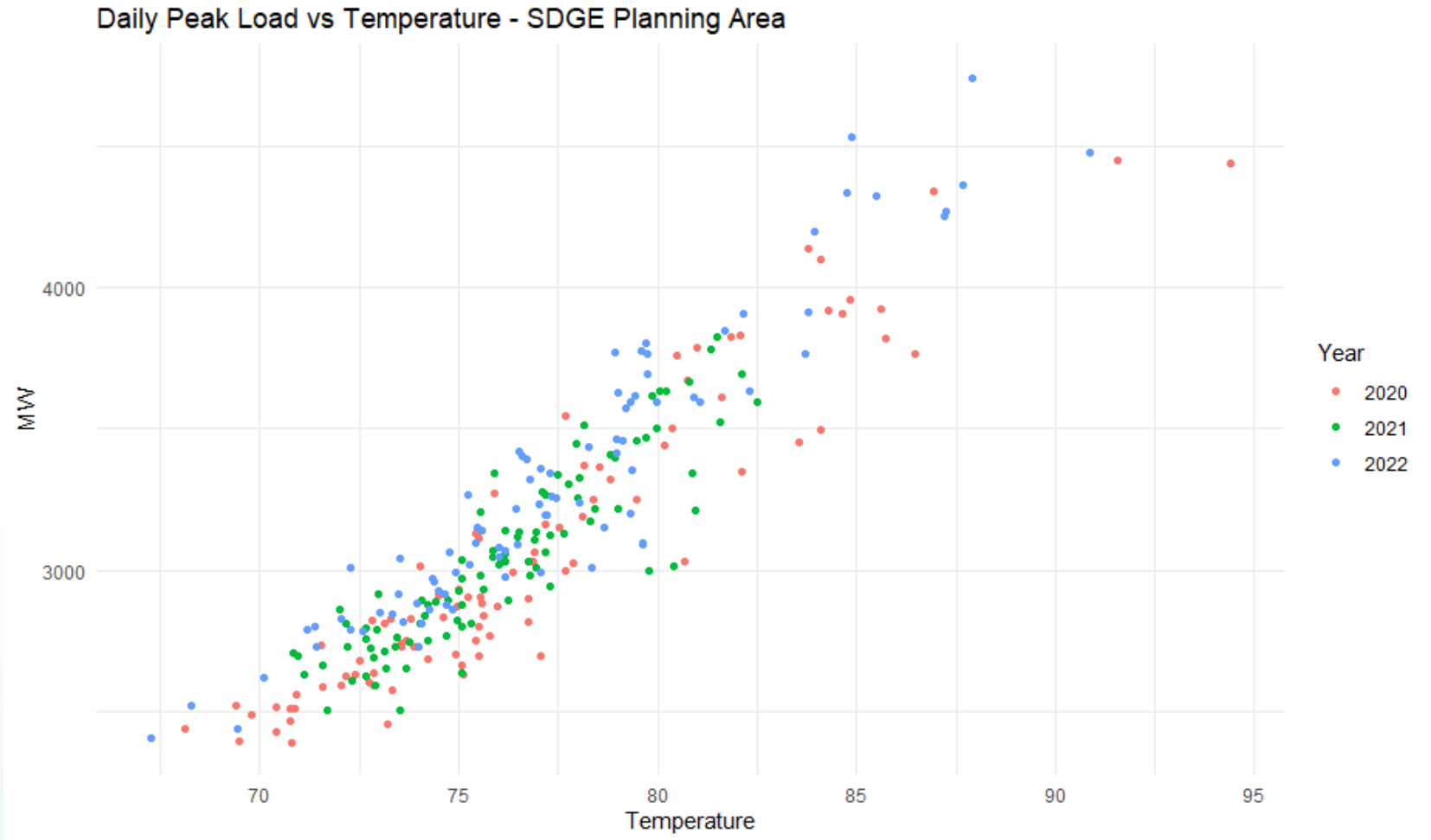
1. Refresh and expand climate considerations
2. Update base-load consumption profiles
3. Support development of stochastic data sets

Weather-Normal Base Year

Load vs Temperature

Daily peak load is highly correlated with temperature

Normalization approach characterizes this relationship over recent years and simulates peak loads over a more comprehensive set of weather patterns



Source: CEC

Existing Method

1. Data sources:
   - Hourly system loads by TAC (CAISO)
   - DR event impact estimates (IOUs / CAISO)
   - Historical daily weather statistics
2. Estimate counter-factual daily peaks after adding demand response program and other load reduction impacts to recorded system load
3. Regress daily peaks against daily weather statistics and calendar effects using most recent three years of data
4. Simulate daily peaks over 30 historical weather years
5. Taking the maximum simulated value for each year, find the median

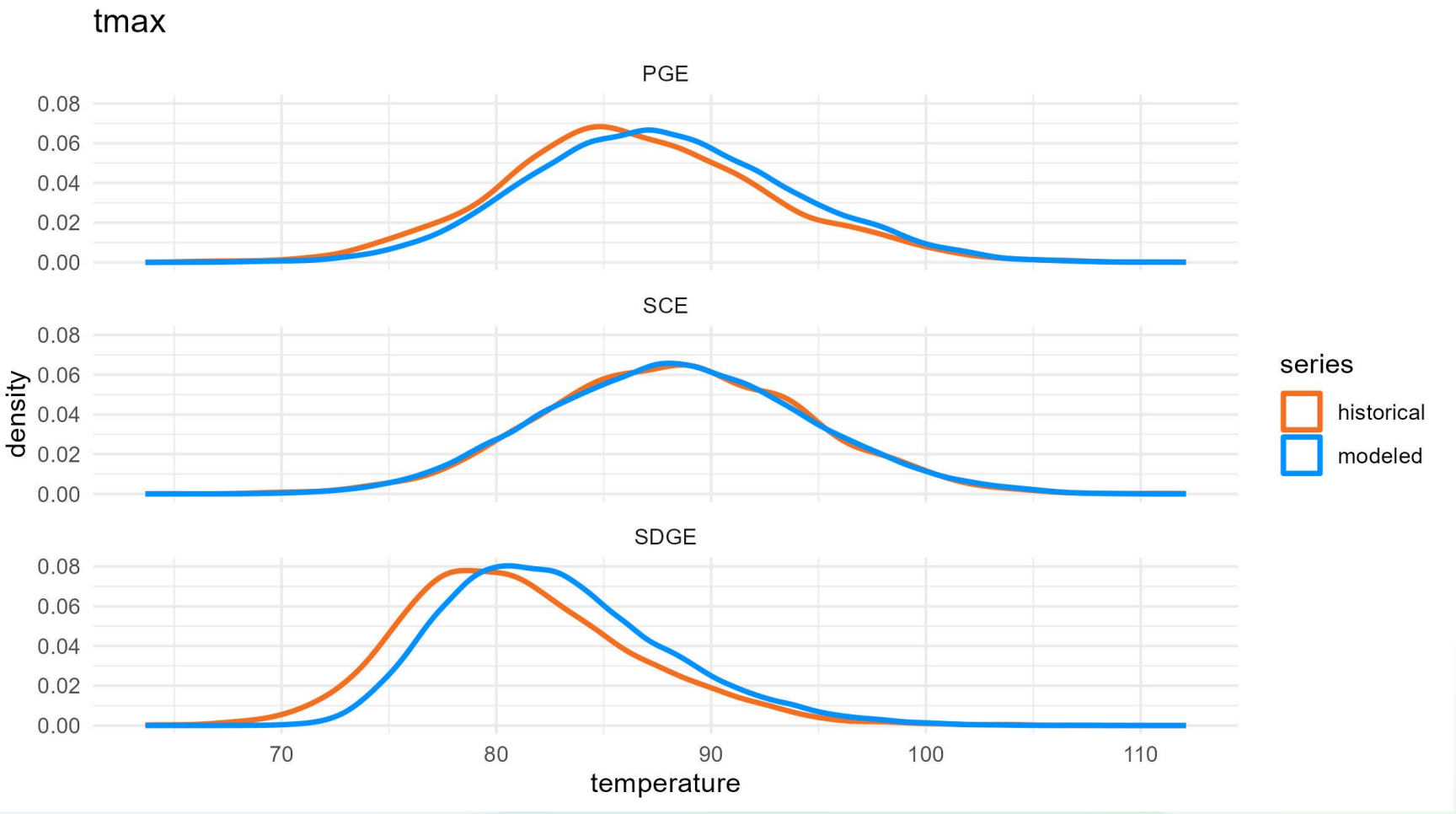
Updates

- Transitioned from historical weather patterns to synthetic climate variants for the purpose of load simulation
- Transitioned from a single daily peak model to an individual model for each hour where peak load may occur
  - Daily peak load is taken as the maximum value of the hourly simulations across each day
- Added dewpoint and cloud cover as explanatory variables

Historic vs Modeled Temperature

Shows distribution of summer daily maximum temperatures.

Compares latest 30-year historical record to new detrended climate values (centered on 2023.)



Source: CEC staff

2023 Weather Normal Peaks

Consistent with CED 2021, greater weight was given to more recent weather years during the normalization process

Planning Area	Actual Peak* 2023	Normal Peak 2023	Normal Peak 2022	% Change
PGE	19,995	20,672	20,585	0.4%
SCE	22,364	23,433	23,597	-0.7%
SDGE	4,045	4,404	4,385	0.4%

*Accounts for demand response events

Source: CEC staff

1-in-x Peak Factors

New peak-factors are implied by climate-informed peak normalization analysis.

Planning Area	Analysis	1-in-5	1-in-10	1-in-20
PGE	Existing	4.0%	6.4%	8.1%
	New (draft)	5.1%	7.9%	10.6%
SCE	Existing	4.2%	6.4%	8.2%
	New (draft)	6.5%	9.4%	12.0%
SDGE	Existing	6.0%	9.0%	10.0%
	New (draft)	4.7%	7.6%	10.5%

Source: CEC staff

Hourly Load Model

HLM Existing Method

- Regression models for each territory and hour of day
  - Models predict consumption ratios (ratios) as a function of weather and calendar variables
  - Similar data sources as peak normalization approach
  - Five years of historical data for estimation
- Ratios are simulated using 22 historical weather patterns
- Ratios are rank ordered and medians selected by rank
- Median ratios are assigned to calendar based on average ranks derived from recent history

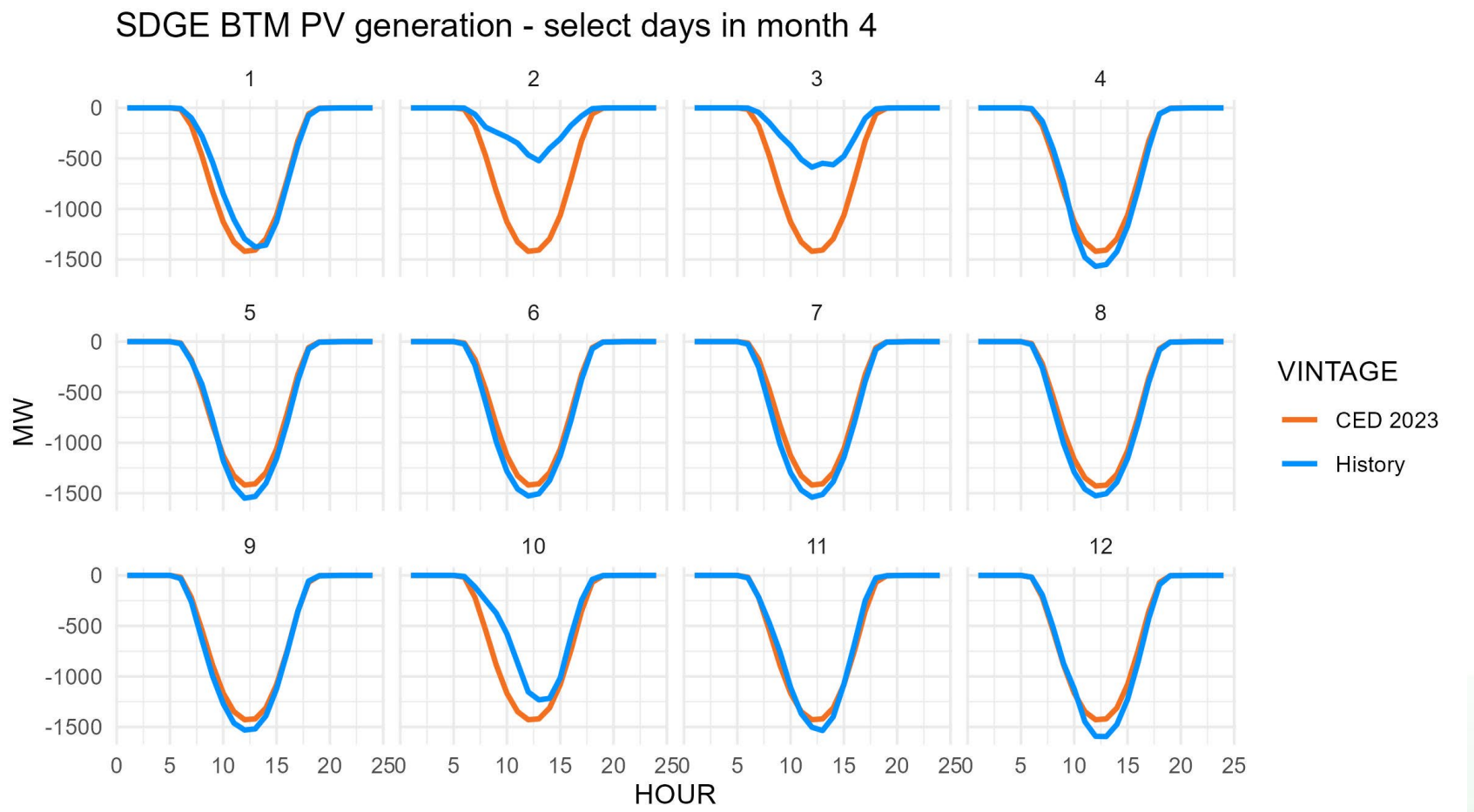
HLM Updates

- Full rebuild of the model aimed at accommodating climate data for simulation
- Three years of historical load data used for model estimation
- Median ratios are assigned to calendar based on average ranks derived from simulation results
- Transitioned from using normal BTM PV profiles to using historical generation data for the purpose of creating a counterfactual hourly consumption history

Historical BTM PV Data

Previous HLM model estimations used normal PV profiles (red) to create a counterfactual hourly consumption history.

Relative to actual generation (blue) these normal profiles slightly underestimate PV impact on clear days and significantly overestimate the impact on cloudy days.

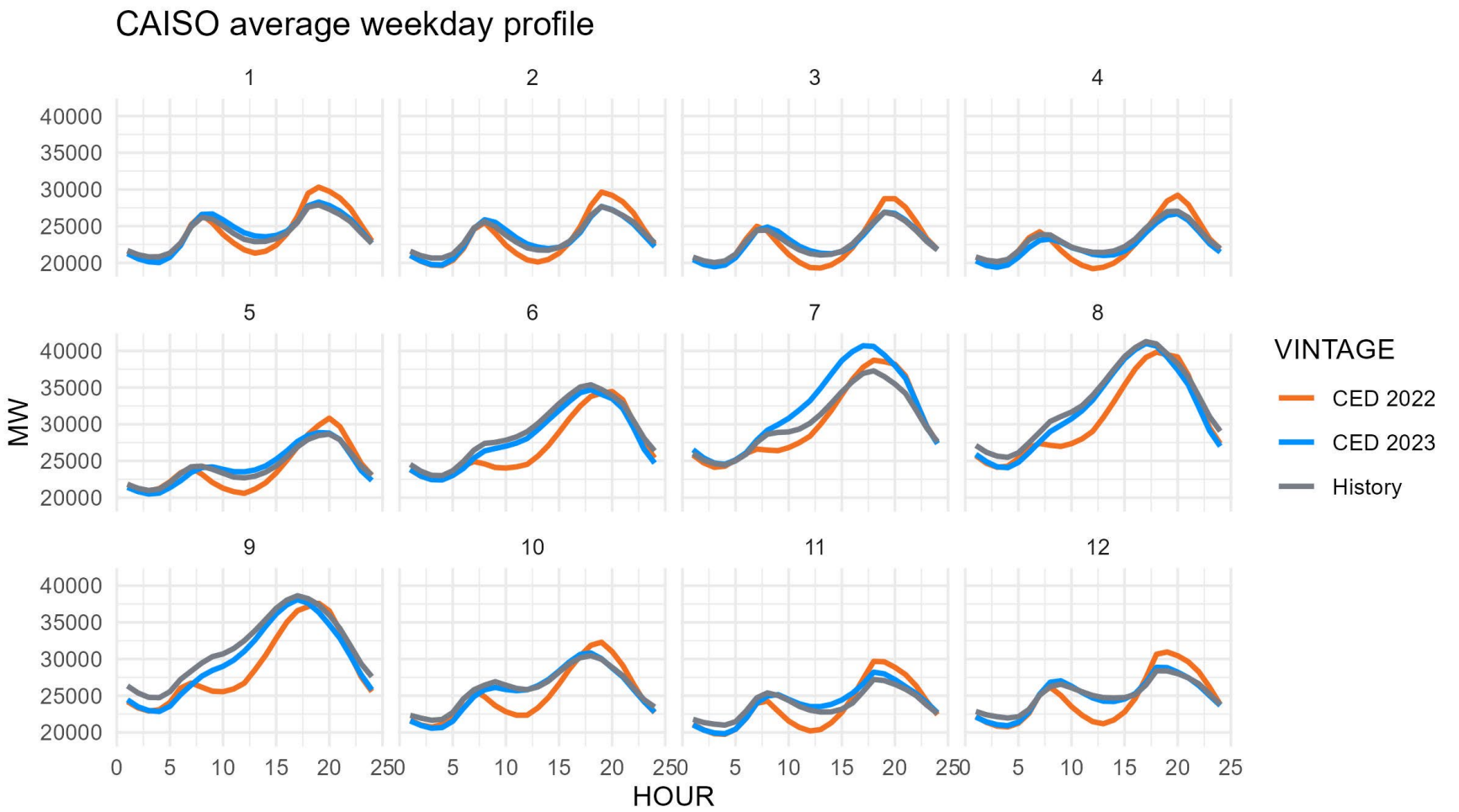


Source: CEC staff

Average System Profiles

Chart compares average weekday system profiles between forecast vintages for forecast year 2022.

CED 2023 values are generally more closely aligned with the historical series for that year.

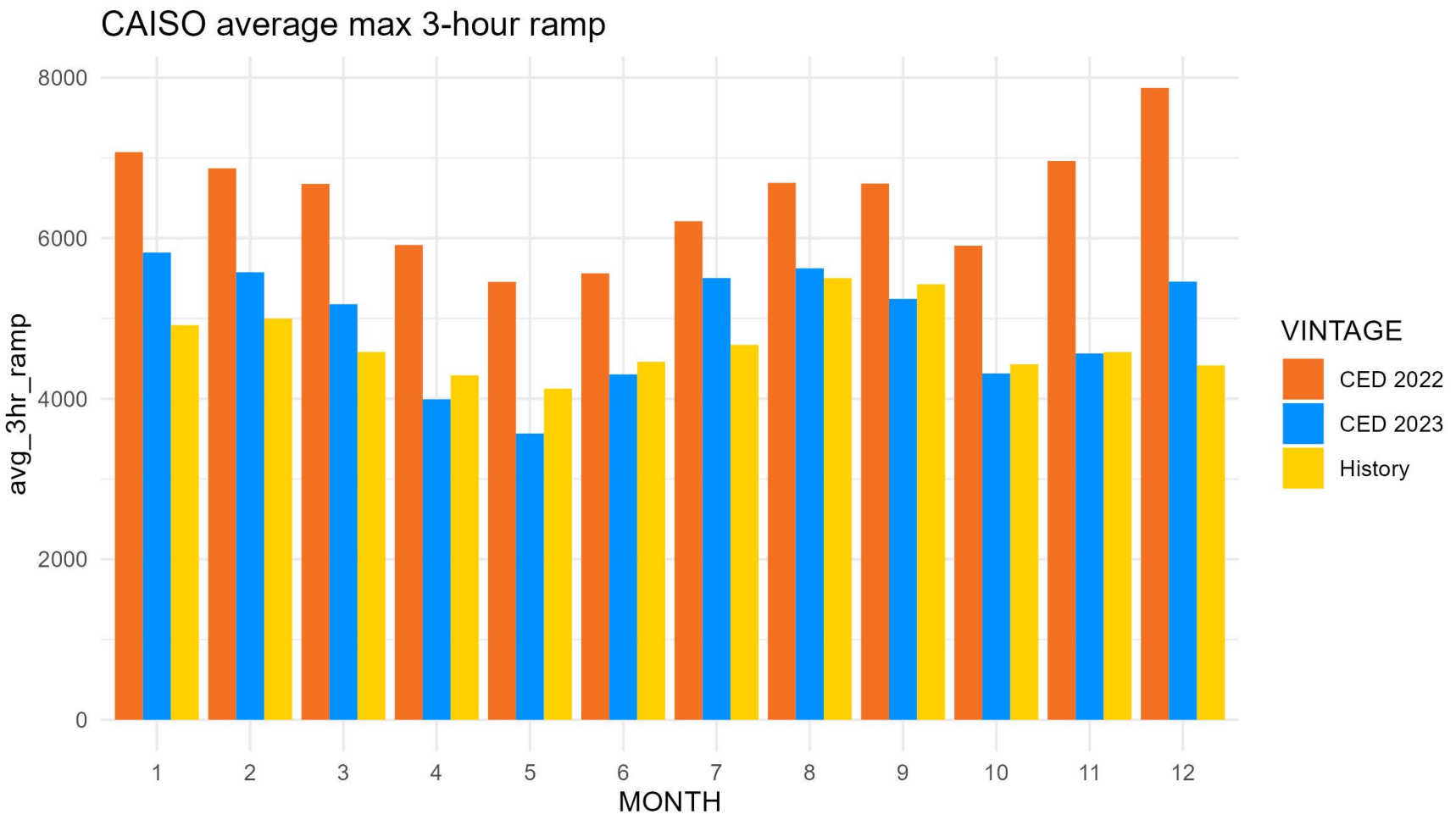


Source: CEC staff

Average Daily Ramps

Chart shows average maximum daily 3-hour ramp by month across forecast vintages for year 2022.

CED 2023 values do not show the same exaggerated ramps exhibited by previous forecasts.

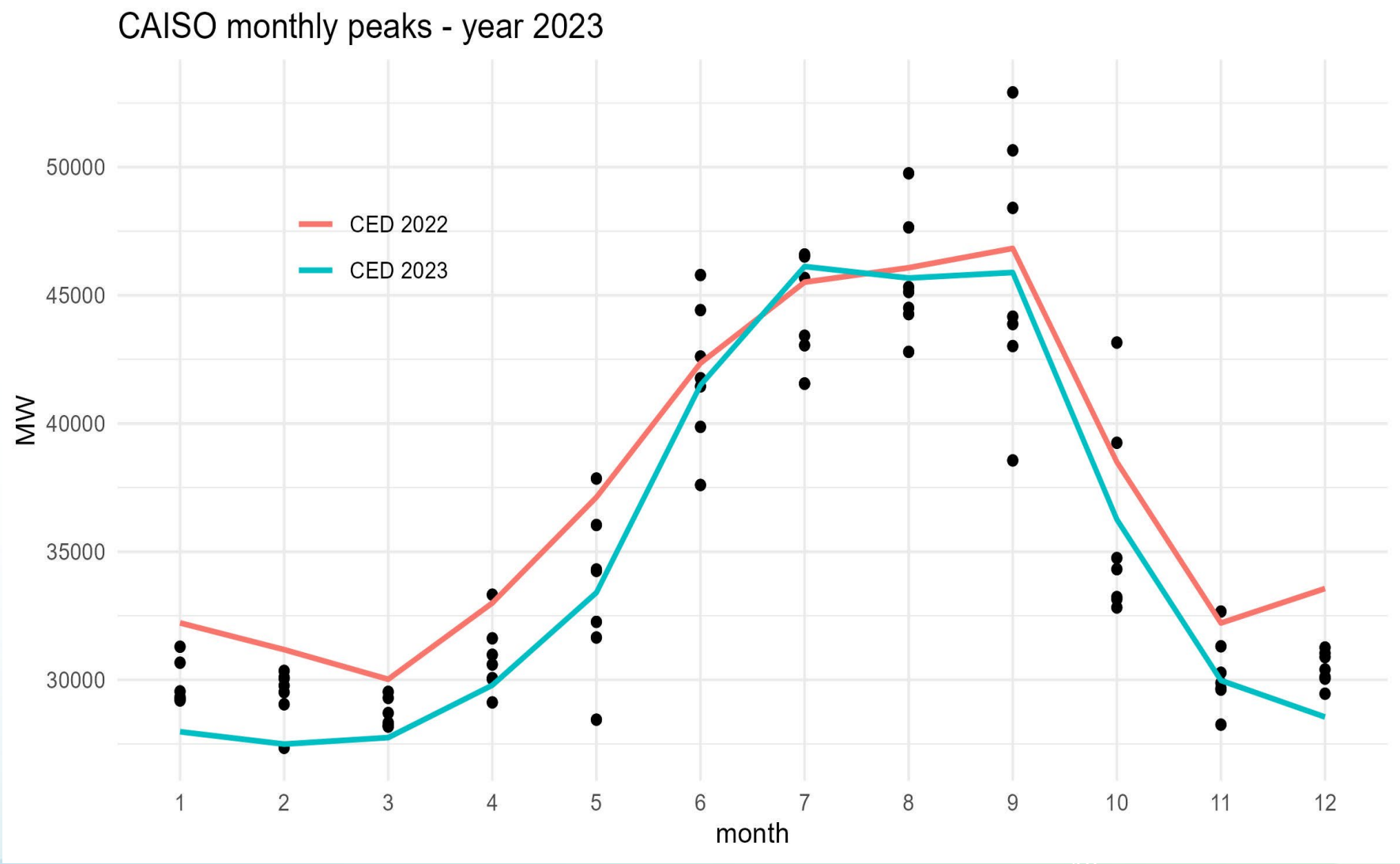


Source: CEC staff

Monthly Peak Loads

Chart compares monthly peaks across forecast vintages.

CED 2023 values are generally lower than recent historic peaks (shown in black) for winter and spring months.



Source: CEC staff

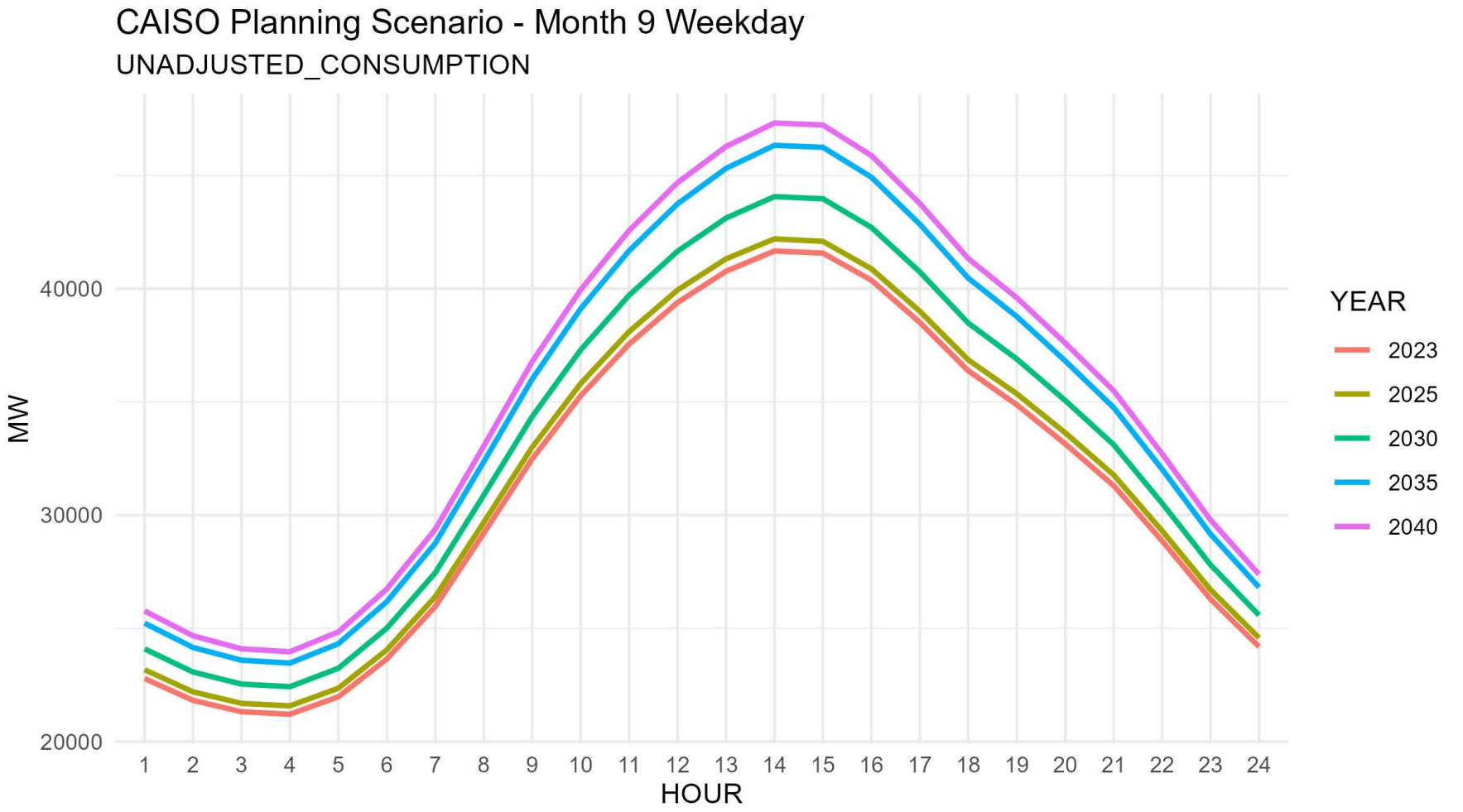
Load Modifiers

CAISO Consumption Profile

Unadjusted is the value predicted by the HLM modeling process.

This value excludes the incremental effects of load modifiers.

Values shown here are averaged across September weekdays.

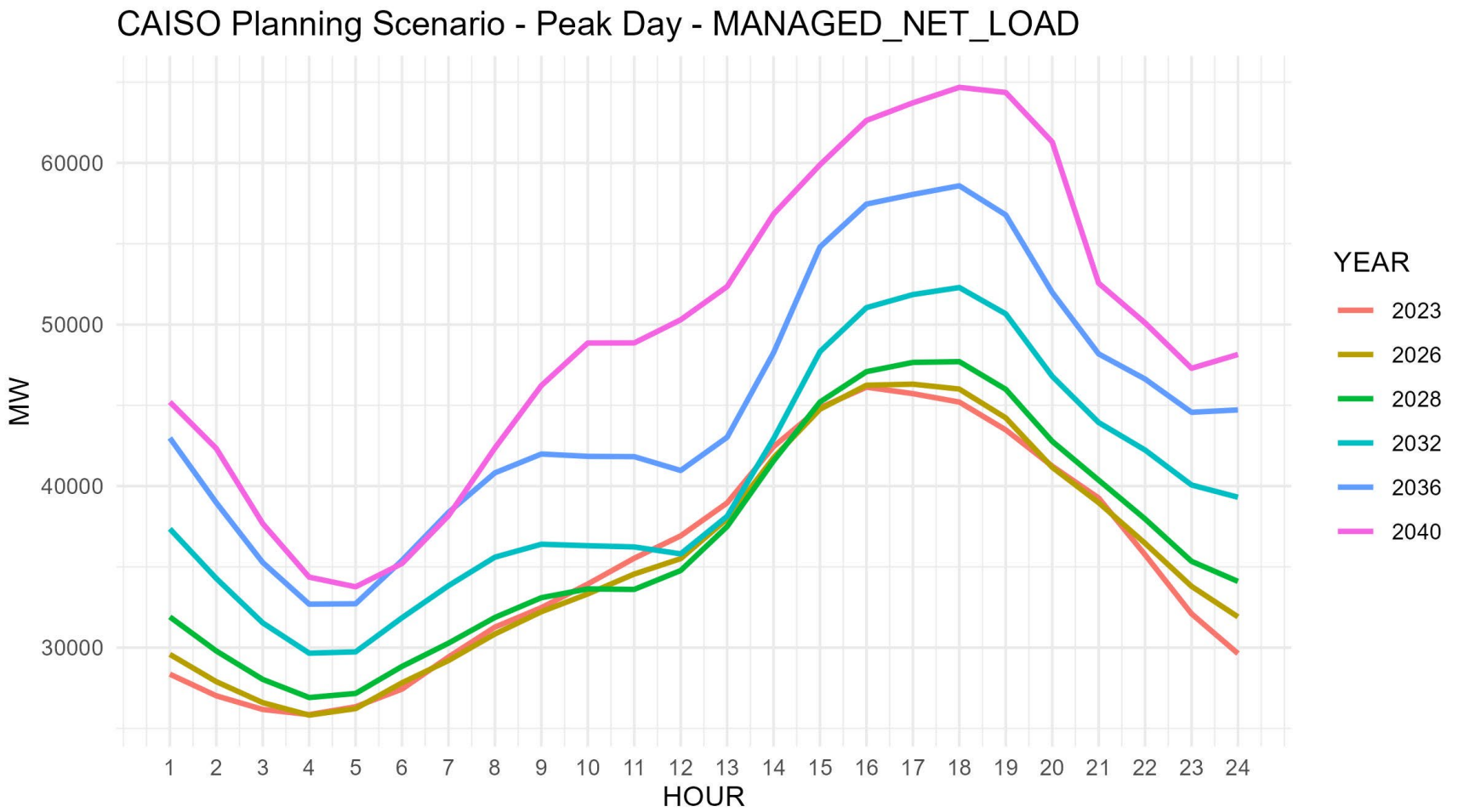


Source: CEC staff

CAISO System Profile

System profiles reflect the net effect of layering load modifiers onto the unadjusted consumption profile.

PV and energy efficiency reduce load during the day. Fuel substitution increases morning and evening load. EV charging is most impactful at night and early-to-mid day.

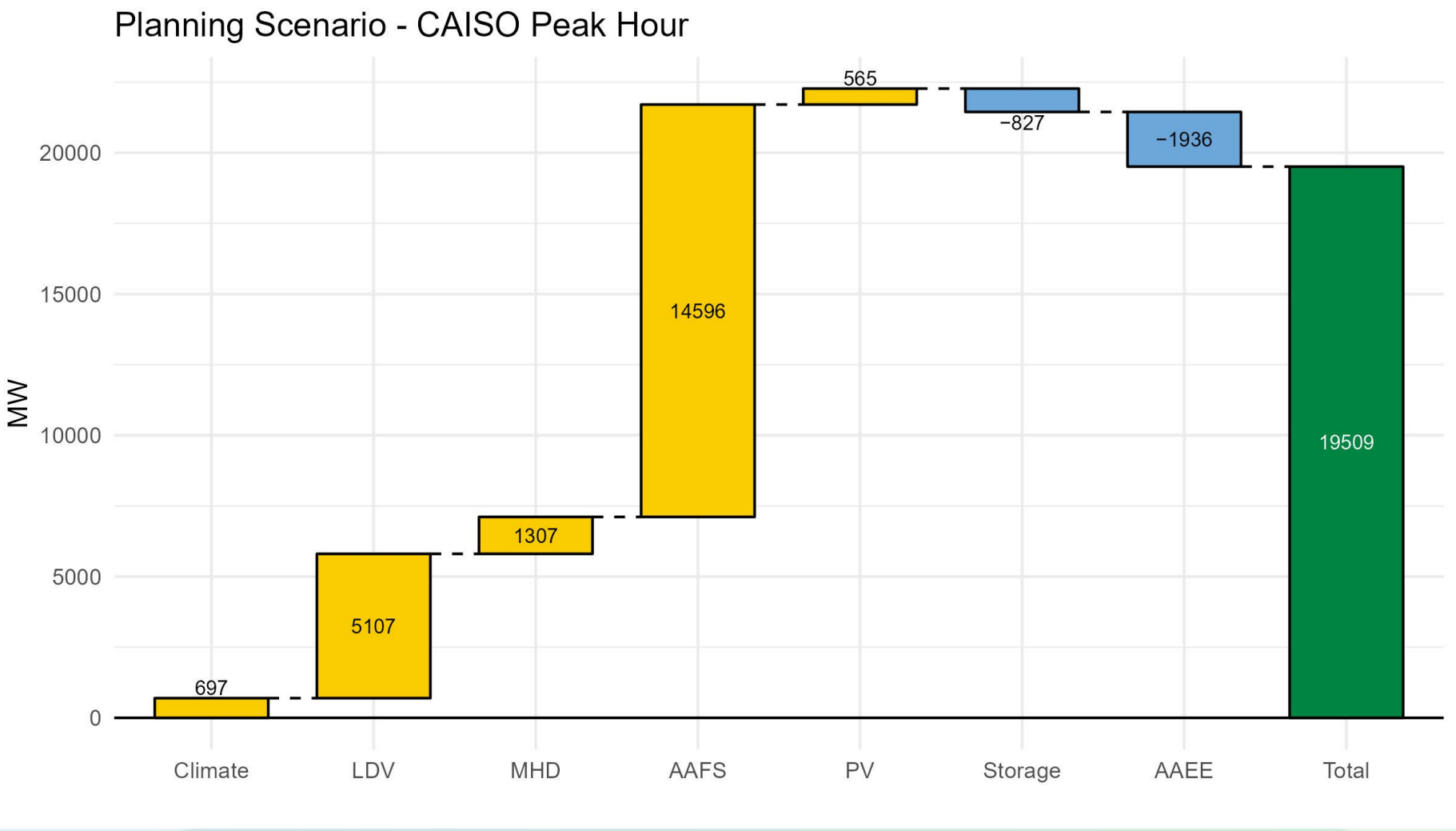


Source: CEC staff

Impact on Peak Hour

Shown here are the impacts of load modifiers in forecast year 2040 relative to 2022 during hour 18.

Building and vehicle electrification represent the bulk of the total impact.

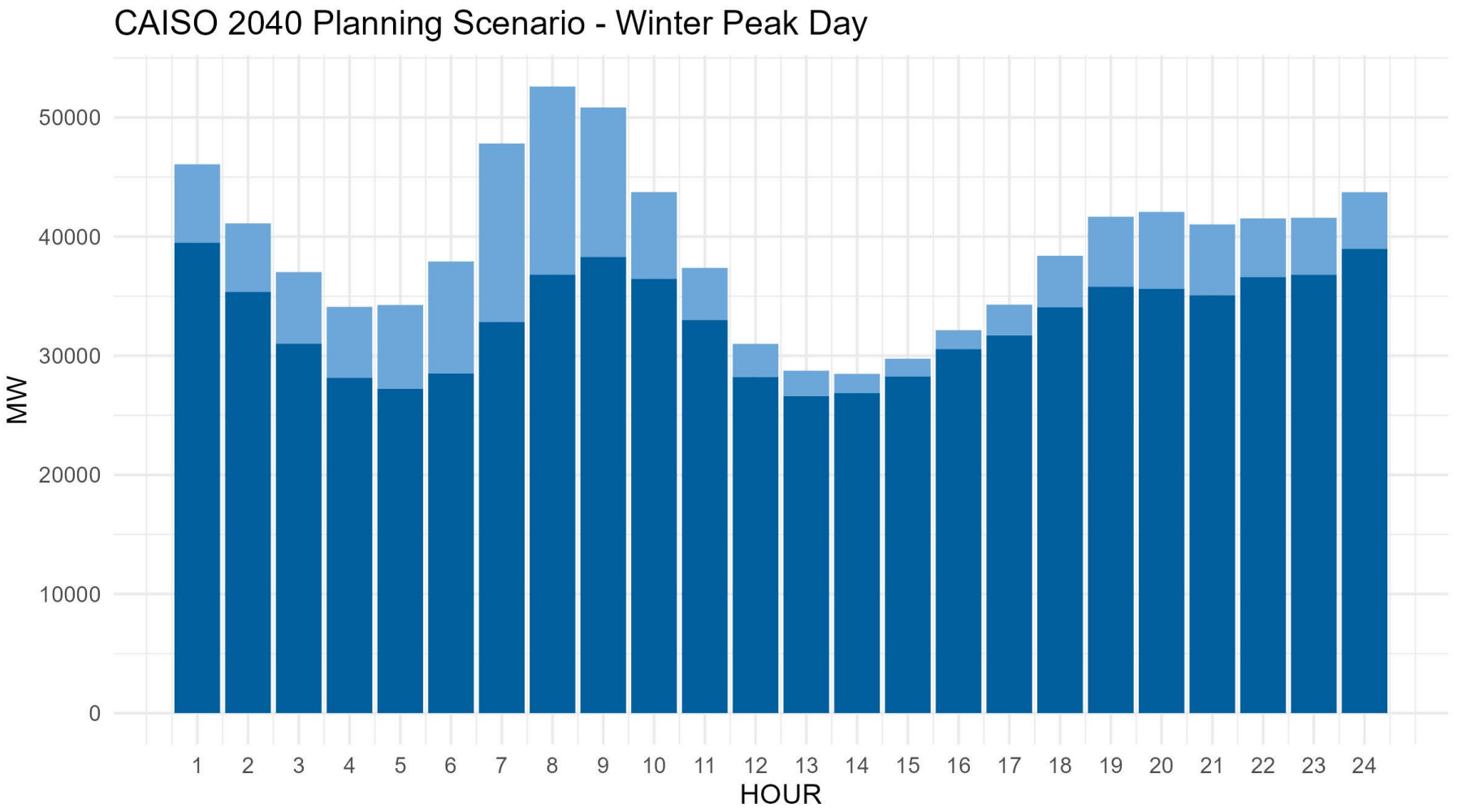


Source: CEC staff

CAISO Winter Peak

By 2040, fuel substitution impacts (light blue) substantially increase winter peaks.

This effect is now present in both the Planning Forecast and Local Reliability Scenario.

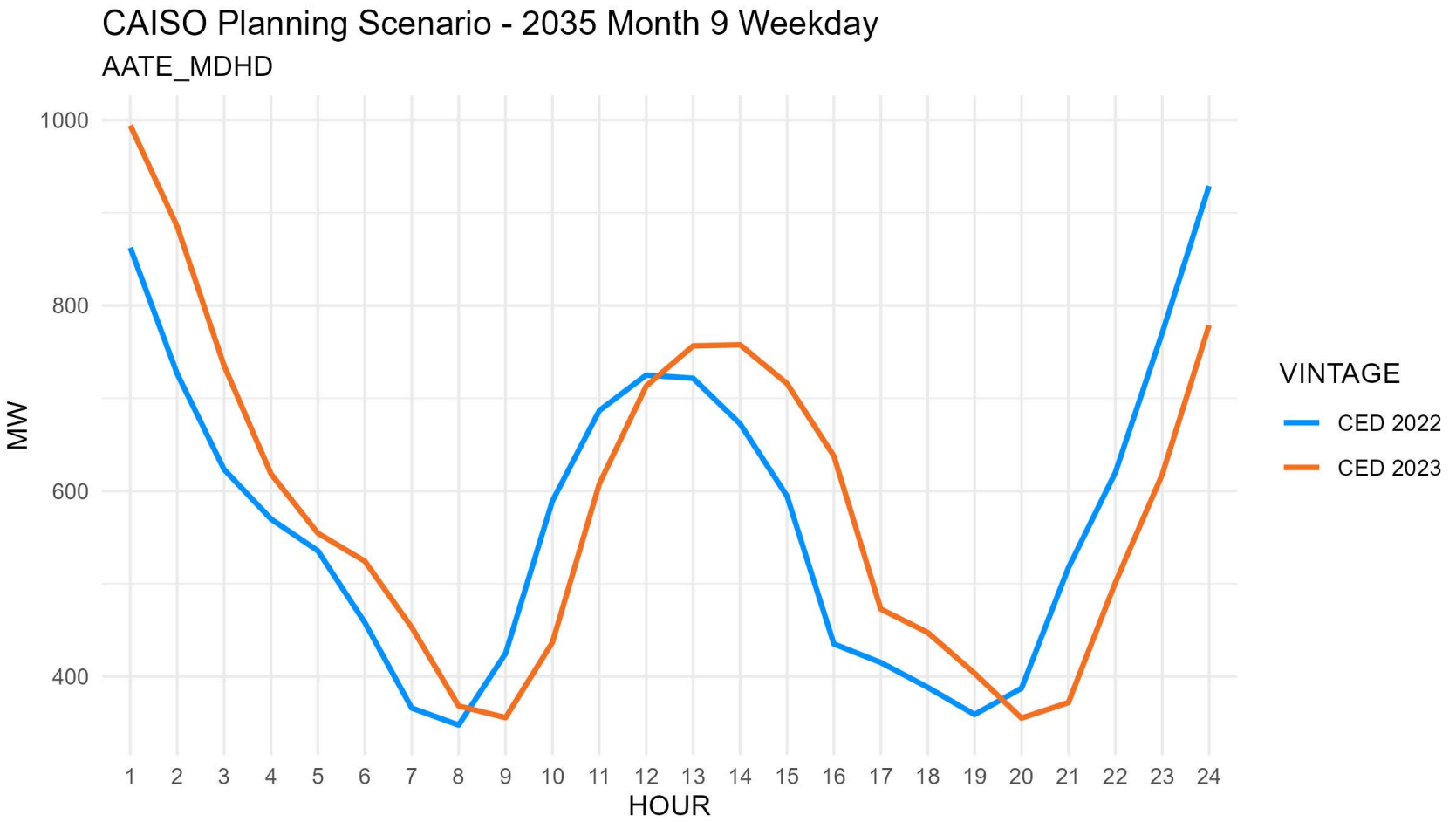


Source: CEC staff

Additional Review

Results are still under internal review.

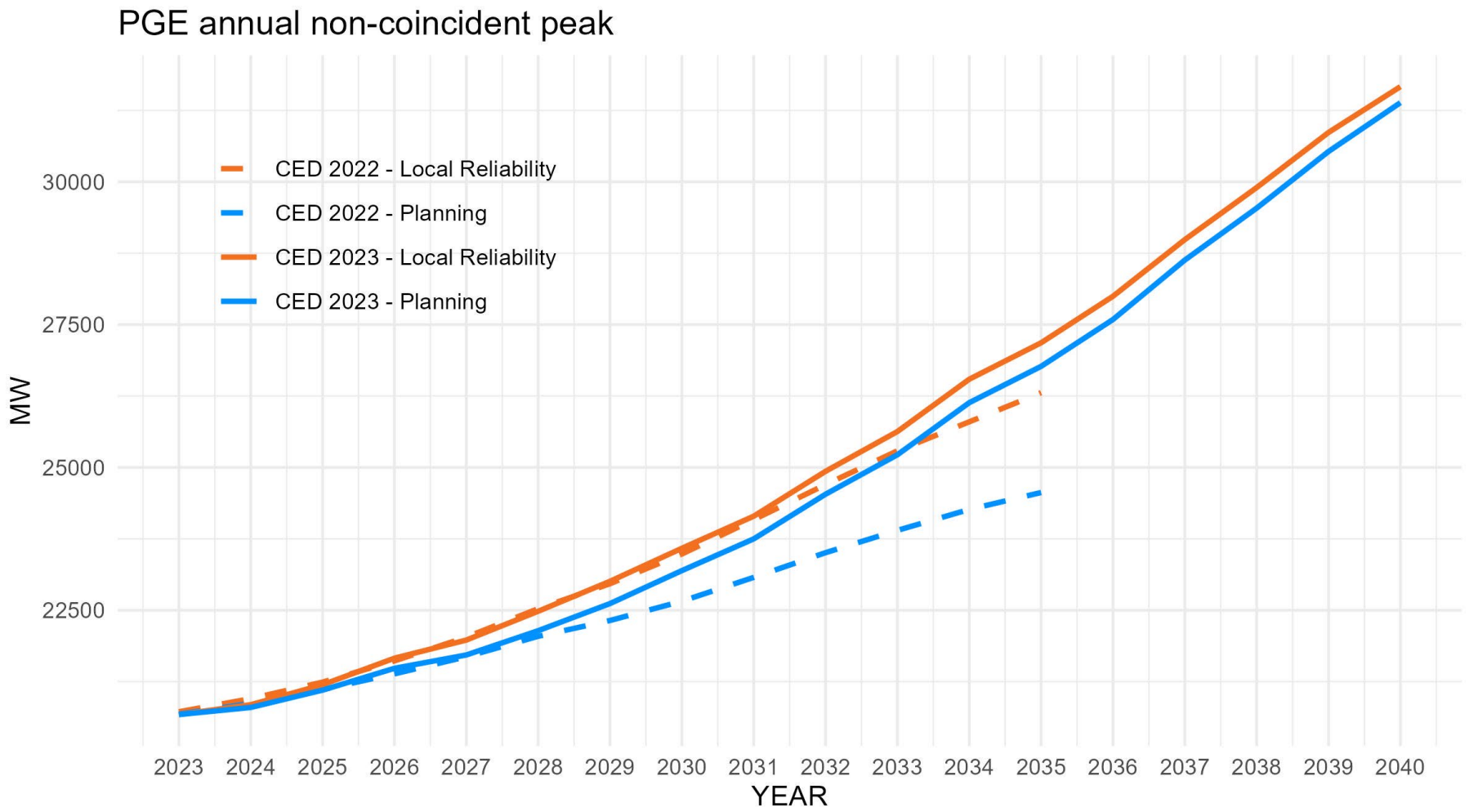
Shown here, a potential misalignment of vehicle charging profiles could be contributing to higher-than-expected load in hour 16 relative to CED 2022.



Source: CEC staff

Preliminary Peak Forecasts

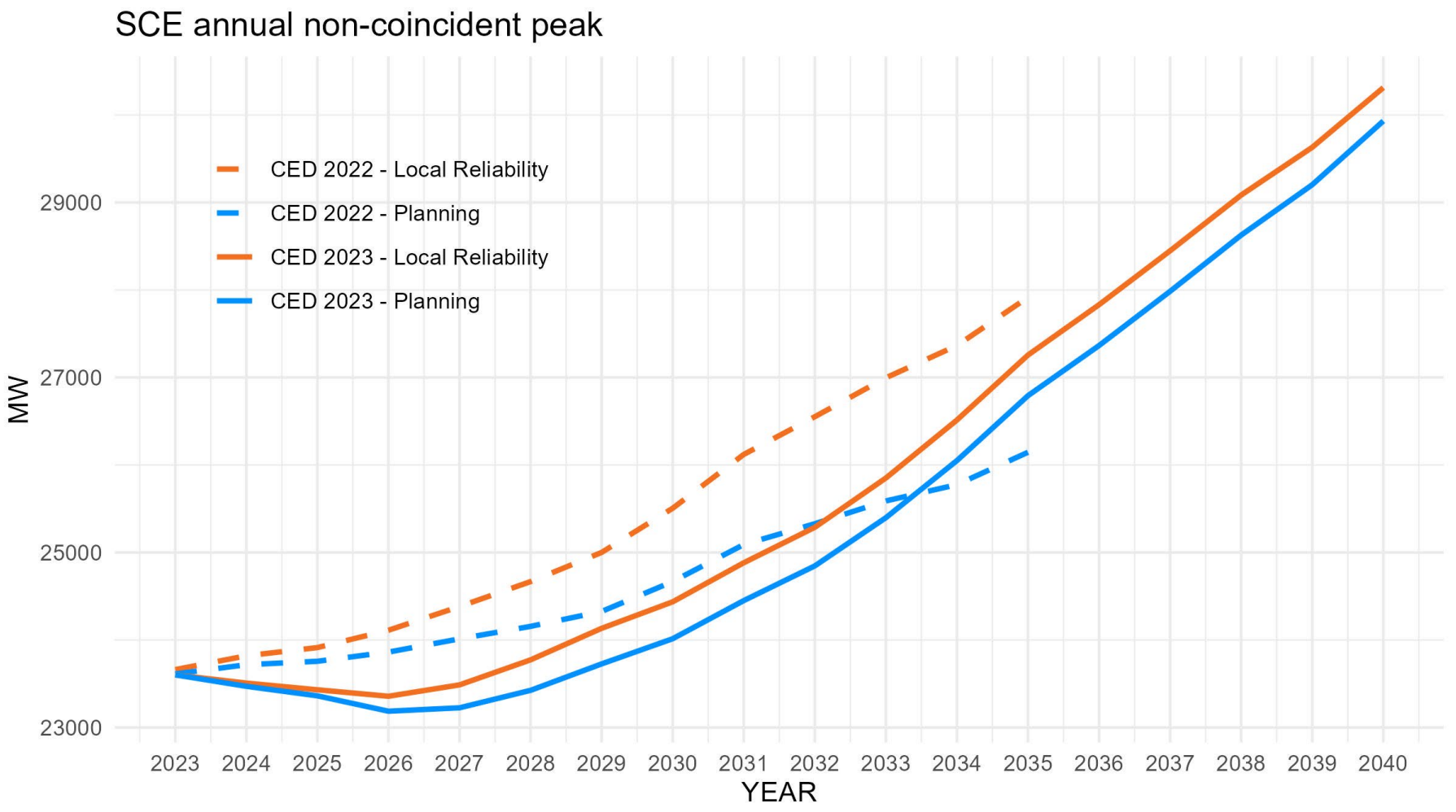
PG&E Non-Coincident Peak



Source: CEC staff

	CED 2023		History	
	Month	Hour	Month	Hour
2016			7	18
2017			9	17
2018			7	18
2019			8	18
2020			8	18
2021			6	18
2022			9	17
2023	7	18		
2024	7	18		
2025	7	18		
2026	7	18		
2027	7	18		
2028	7	18		
2029	7	18		
2030	7	18		
2031	7	18		
2032	7	18		
2033	7	18		
2034	7	18		
2035	7	18		
2036	8	18		
2037	9	18		
2038	9	18		
2039	9	18		
2040	9	18		

SCE Non-Coincident Peak



	CED 2023		History	
	Month	Hour	Month	Hour
2016			6	16
2017			9	15
2018			7	16
2019			9	15
2020			8	15
2021			9	15
2022			9	16
2023	8	15		
2024	8	15		
2025	8	15		
2026	9	16		
2027	9	16		
2028	9	16		
2029	9	16		
2030	9	16		
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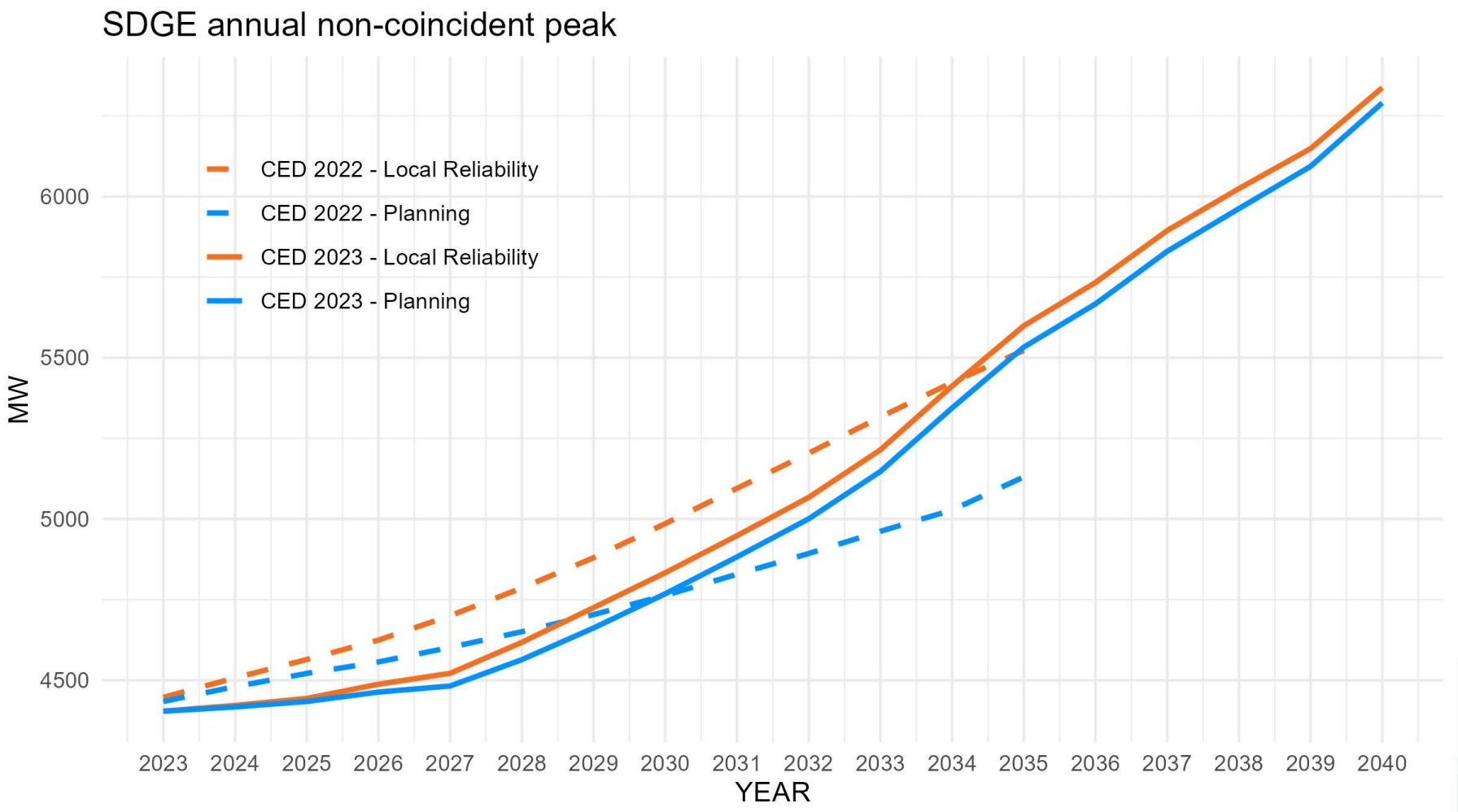
2036	9	16		
2037	9	16		
2038	9	16		
2039	9	16		
2040	9	16		

Source: CEC staff

SDG&E Non-Coincident Peak



	CED 2023		History	
	Month	Hour	Month	Hour
2016			7	17
2017			9	16
2018			8	14
2019			9	15
2020			9	17
2021			8	17
2022			9	17
2023	9	16		
2024	9	16		
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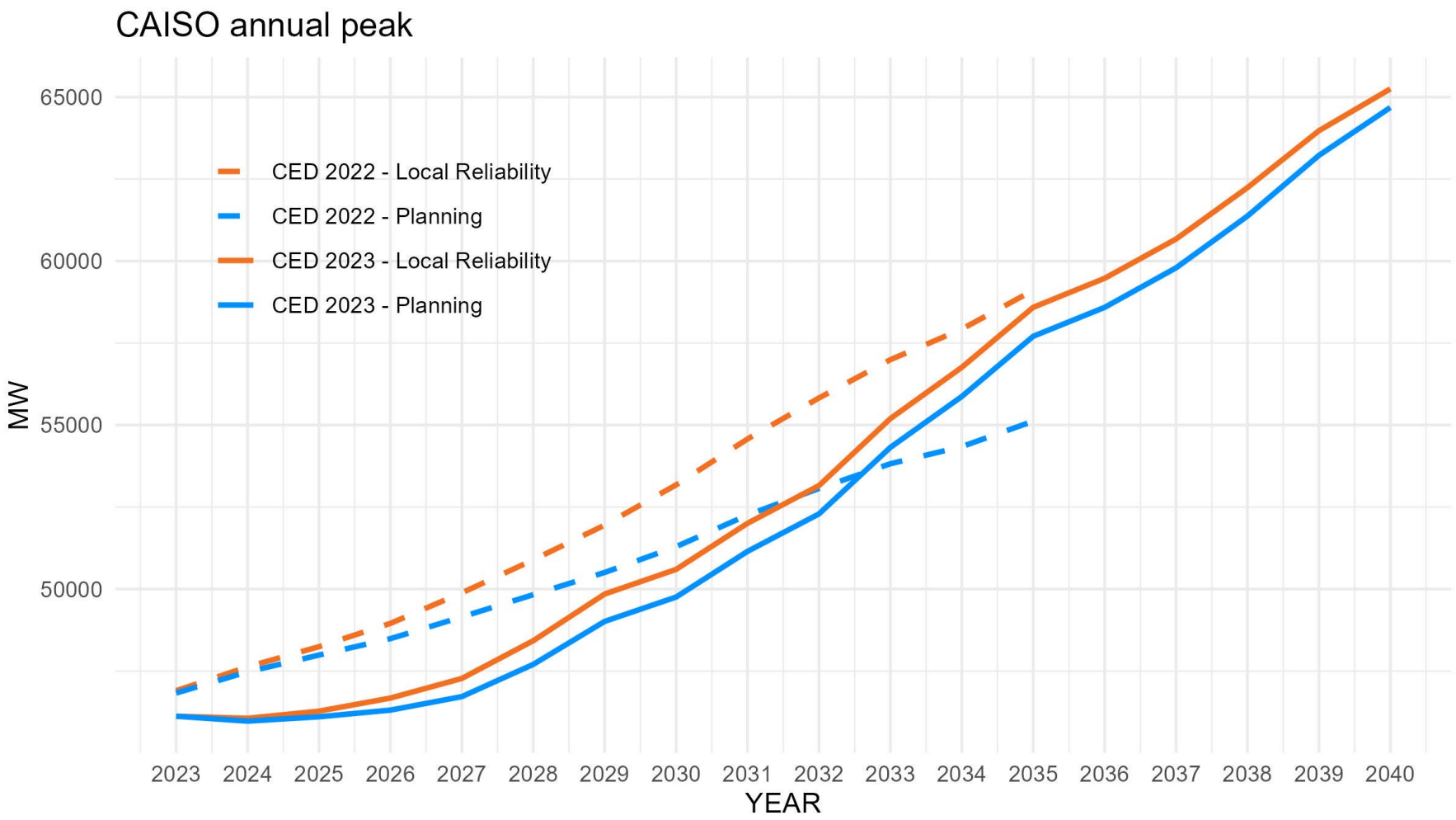
2037	9	16		
2038	9	16		
2039	9	16		
2040	9	16		

Source: CEC staff

CAISO Annual Peak



Source: CEC staff

	CED 2023		History	
Year	Month	Hour	Month	Hour
2016			7	16
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2018			7	17
2019			8	17
2020			8	17
2021			9	17
2022			9	17
2023	7	16		
2024	7	16		
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2038	9	18		
2039	9	18		
2040	9	18		

Next Steps

Finalizing IEPR 2023

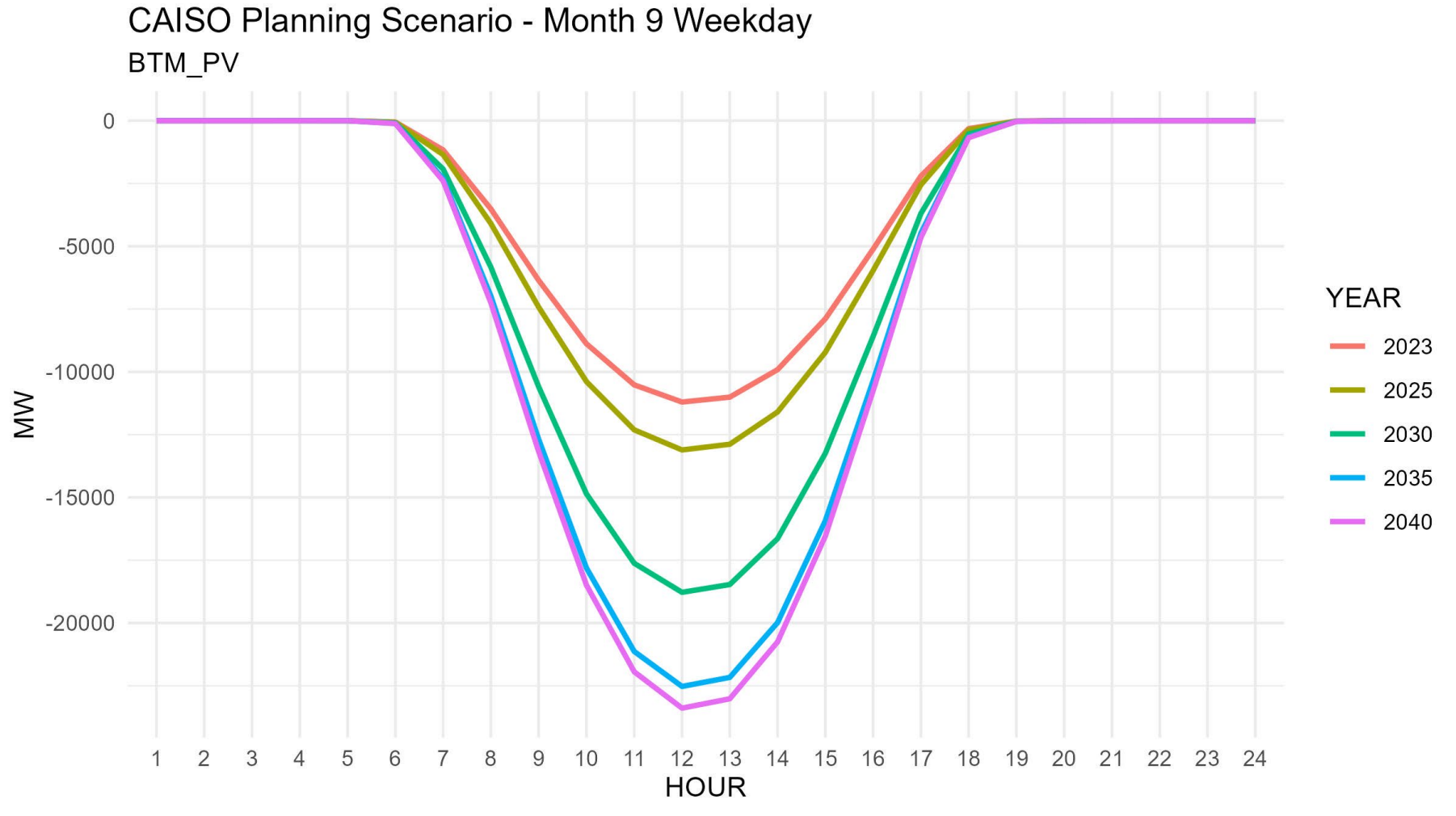
- Docket preliminary data sets
- Continue staff review and stakeholder discussion
- Any necessary changes will be incorporated in a final set of results to be posted in January and considered for adoption

IEPR 2024

- Data sharing and detailed stakeholder review of methods
- Integrate climate libraries into HLM simulation step

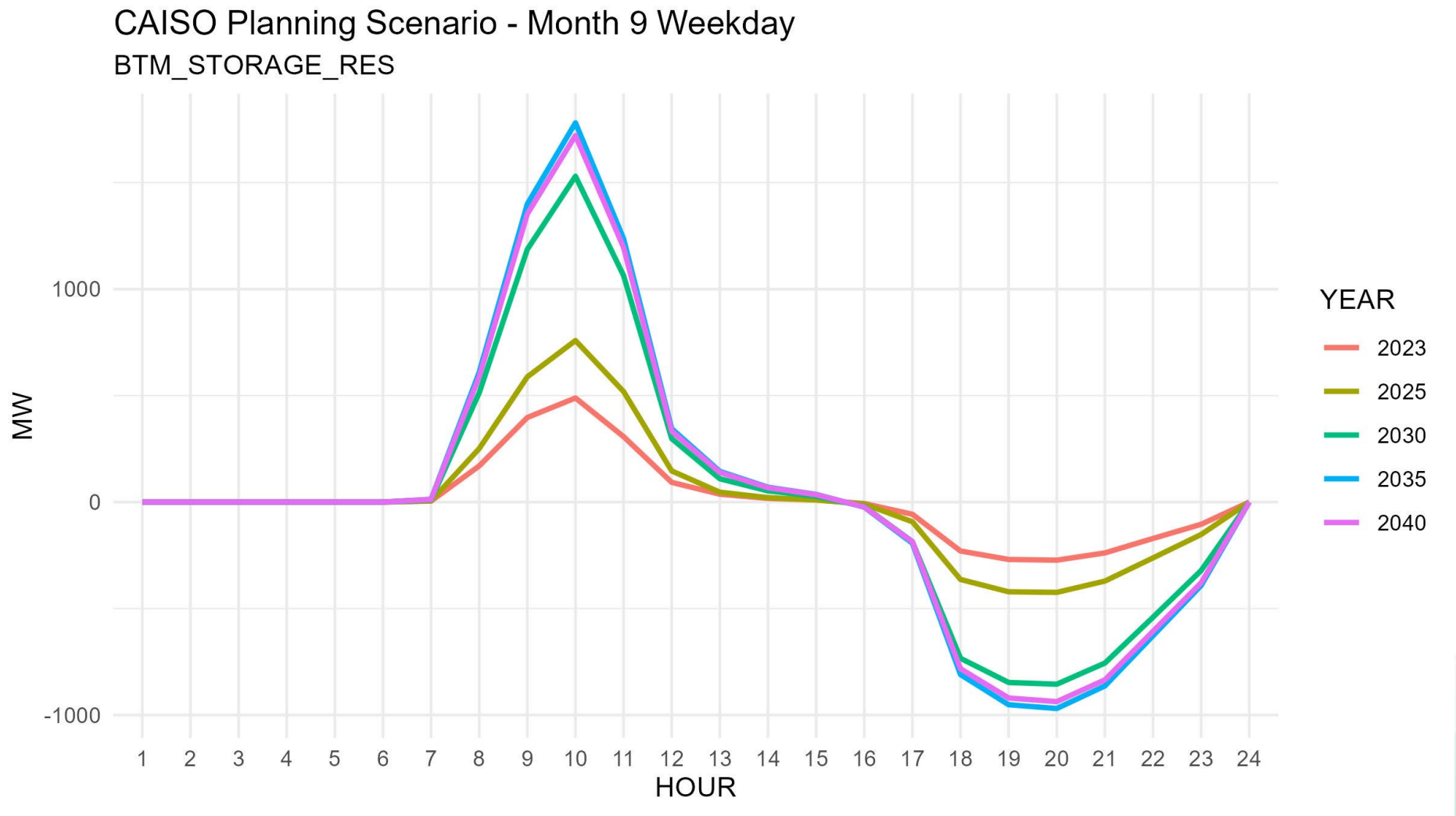
Appendix – Load Modifiers

Behind-the-Meter PV



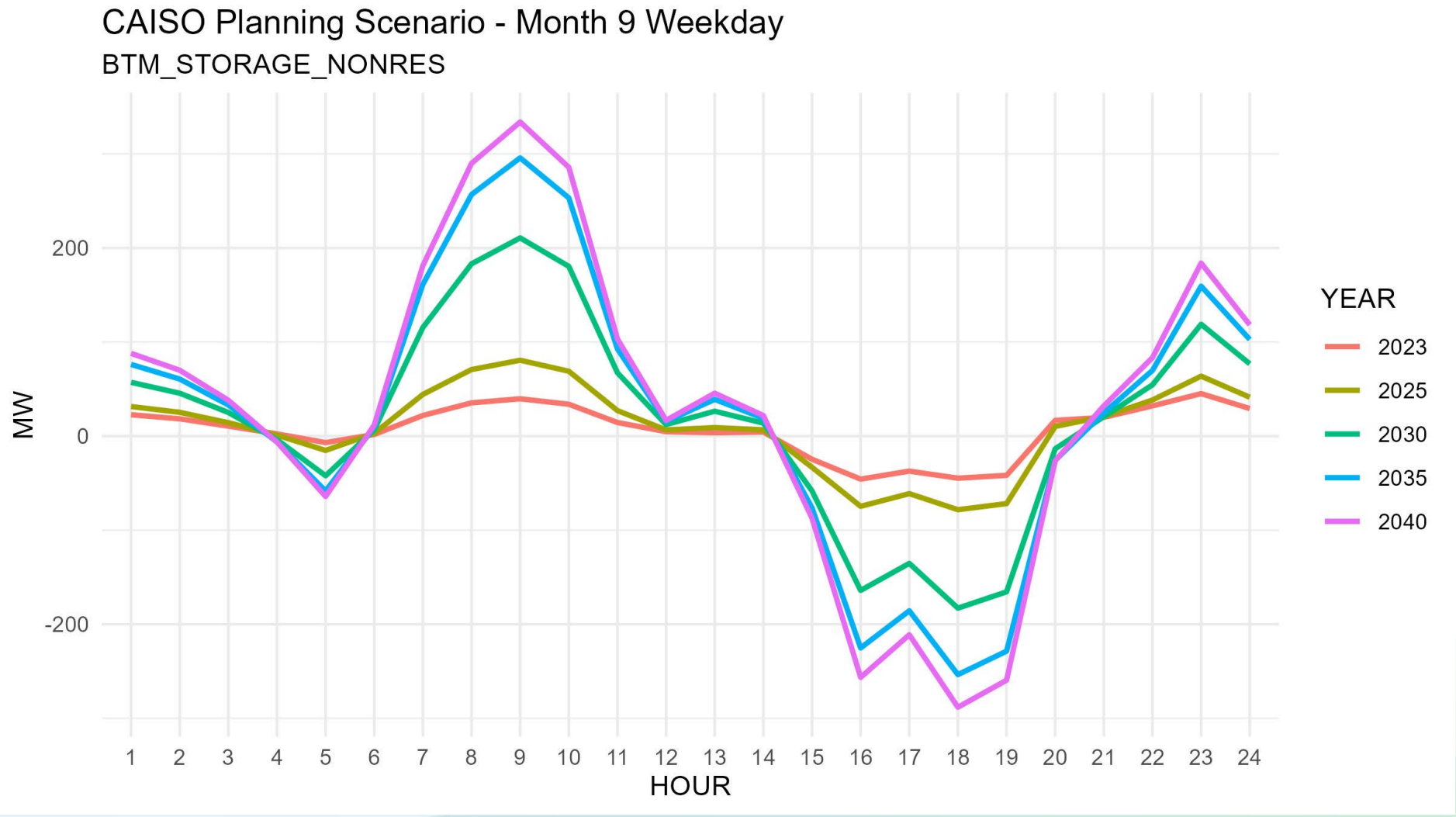
Source: CEC staff

Residential Storage



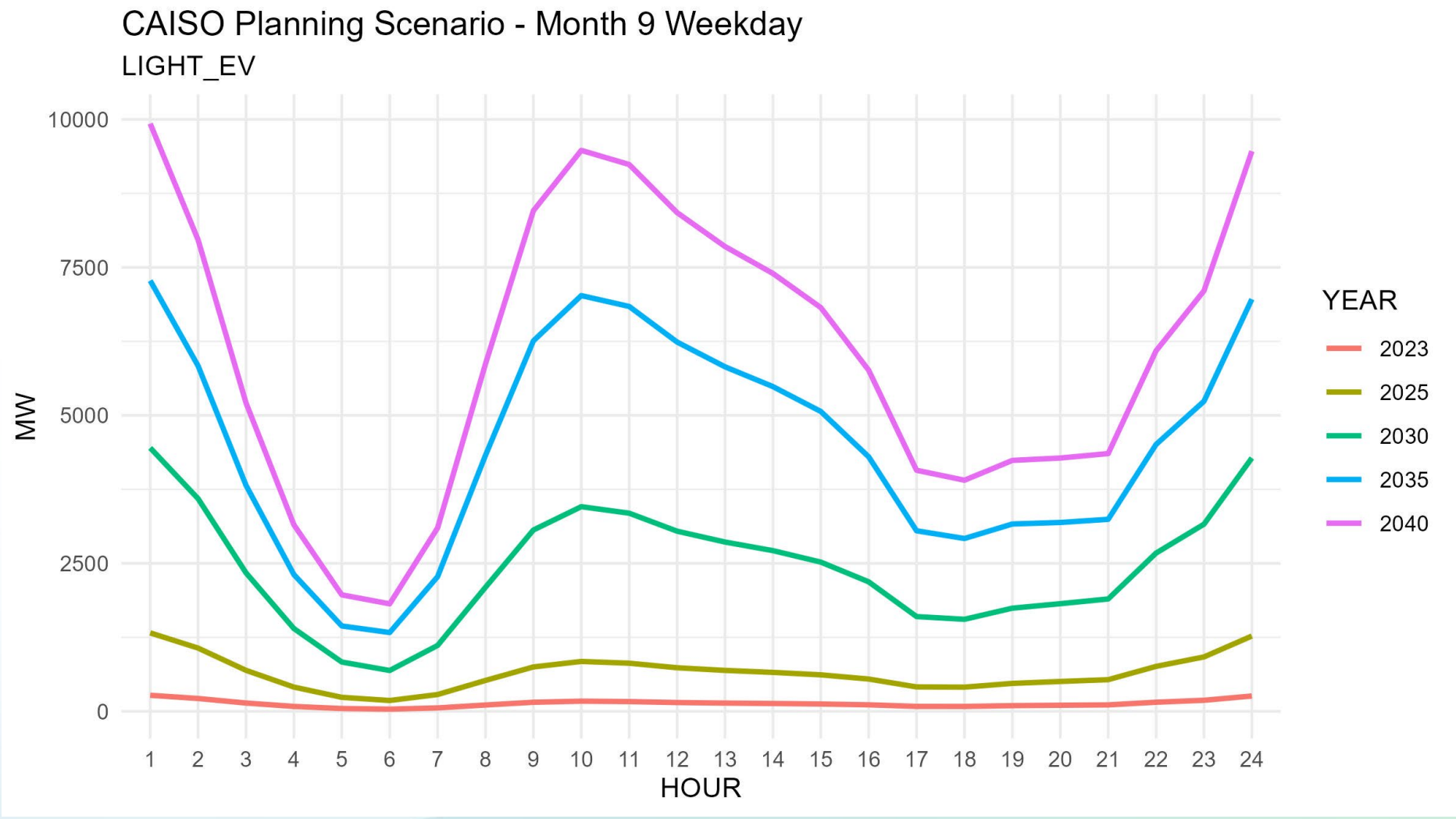
Source: CEC staff

Non-Residential Storage



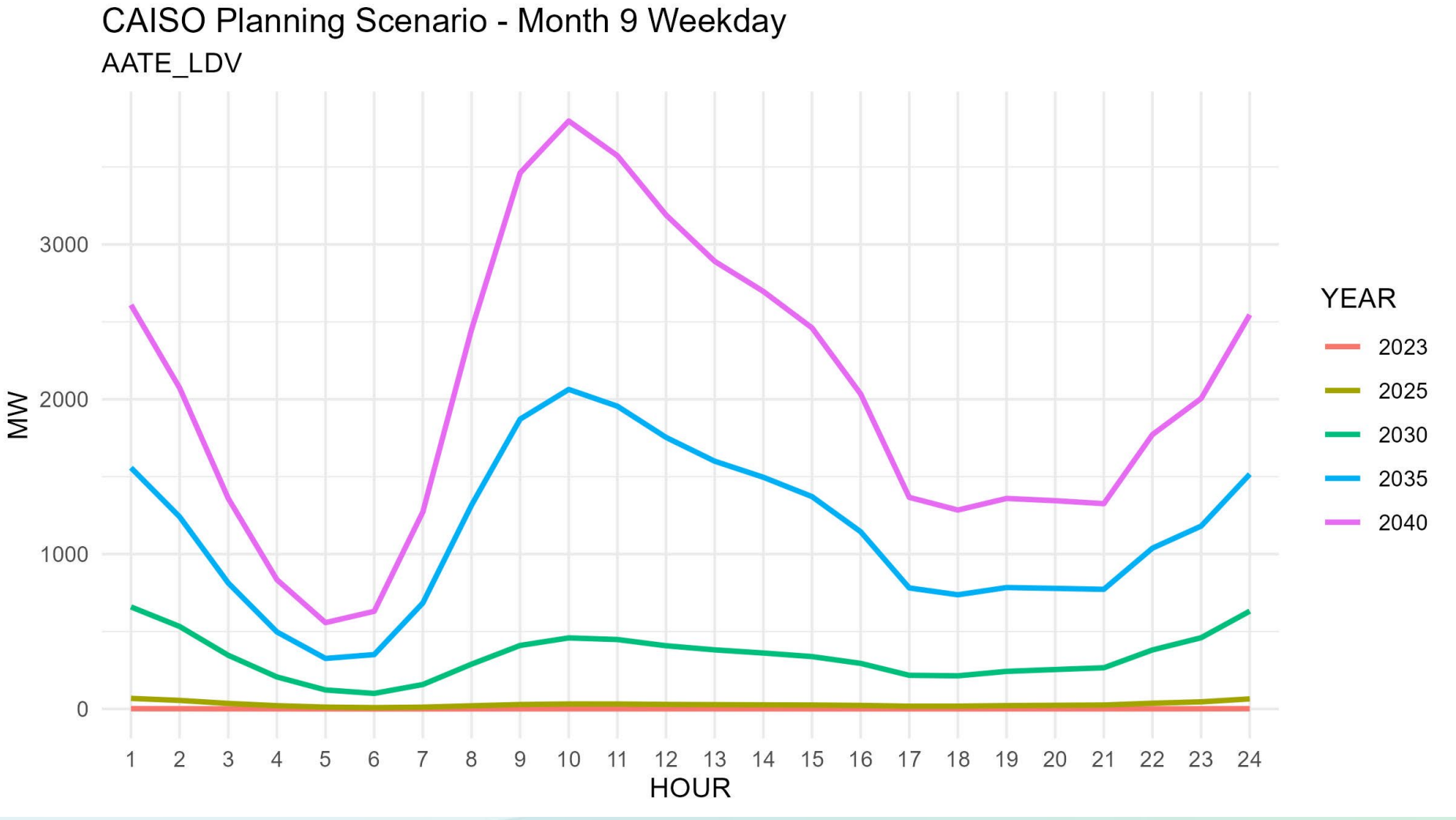
Source: CEC staff

Light-Duty EV



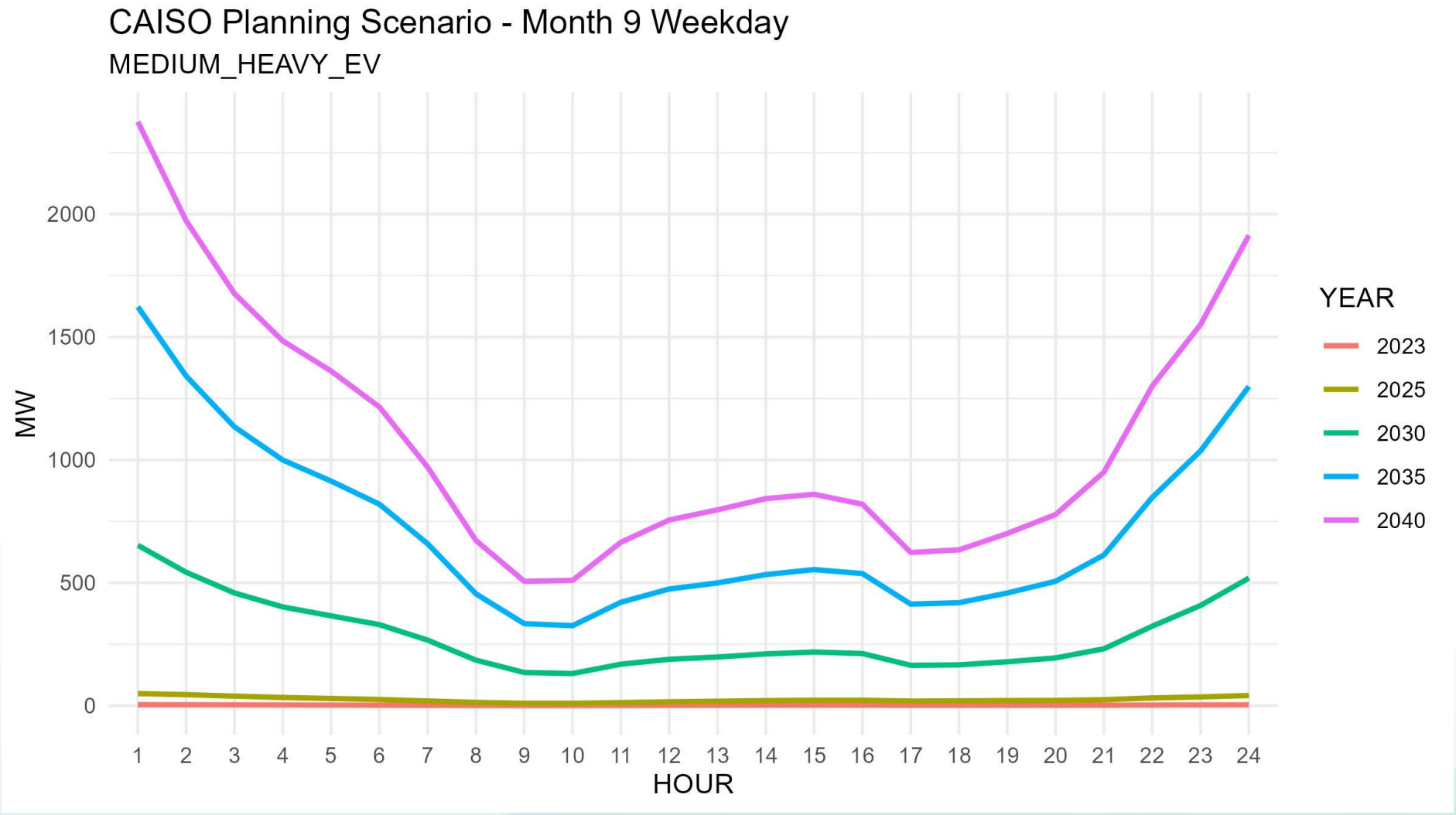
Source: CEC staff

Additional Achievable Transportation Electrification – Light Duty



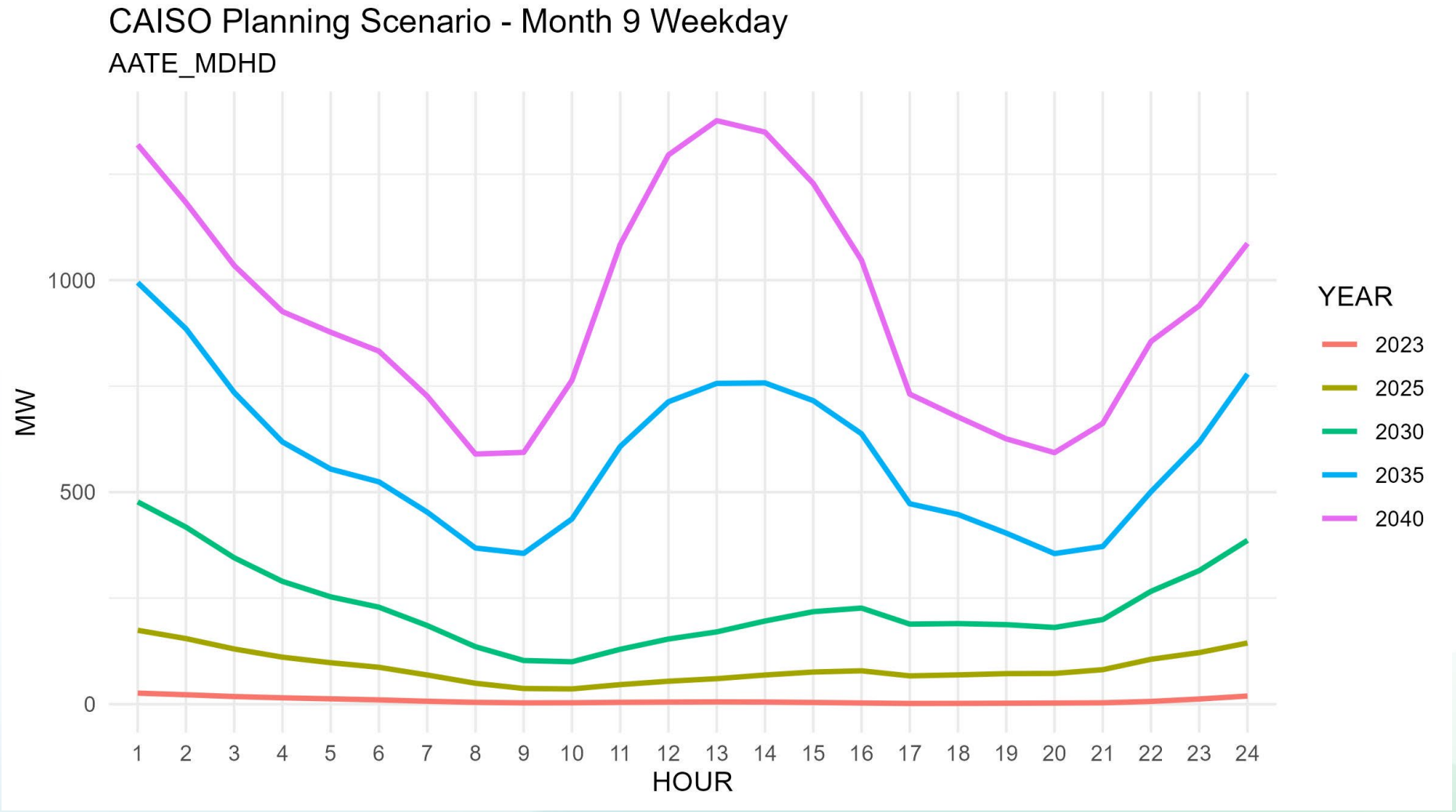
Source: CEC staff

Medium/Heavy-Duty EV



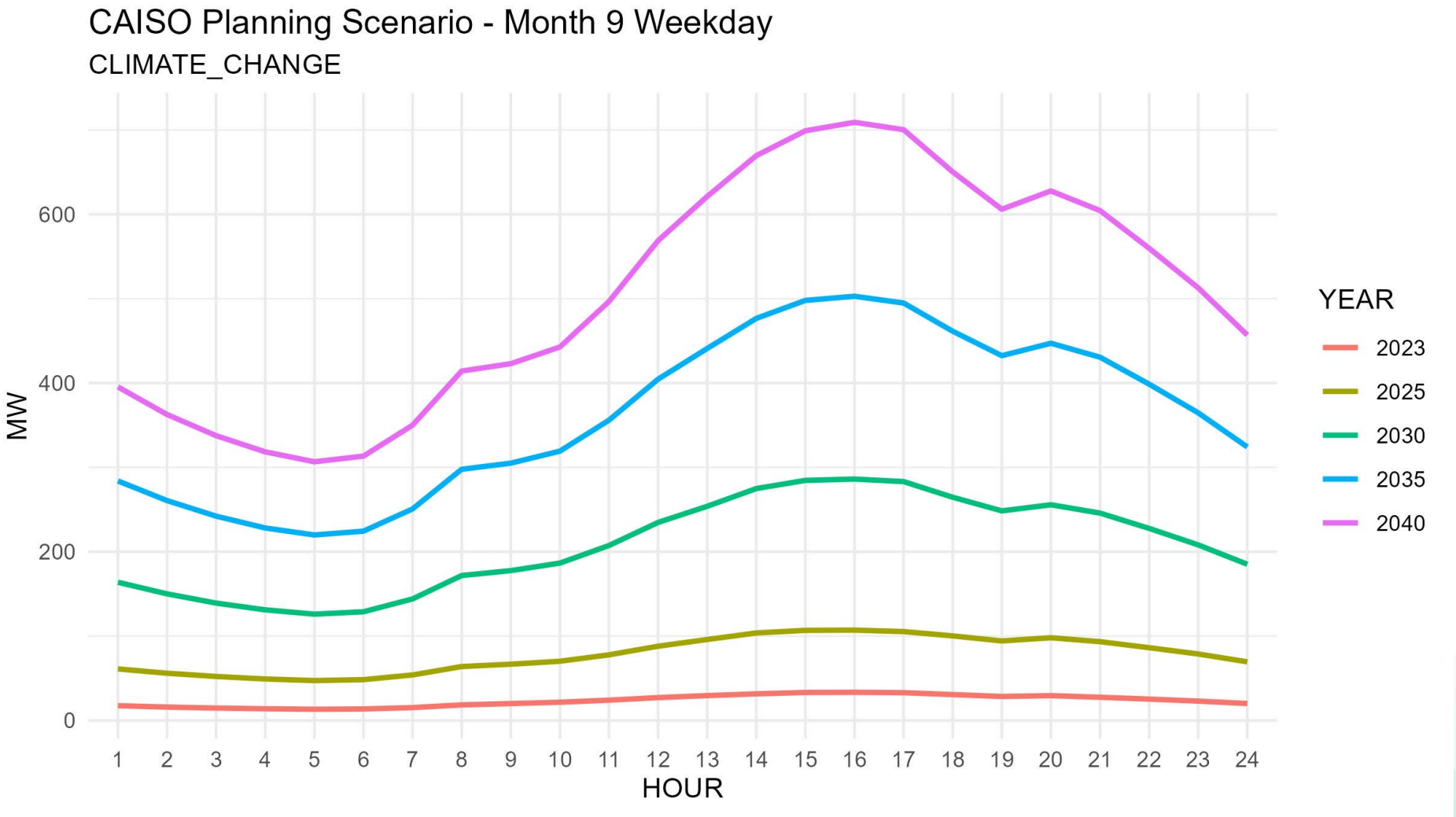
Source: CEC staff

Additional Achievable Transportation Electrification – Medium/Heavy Duty



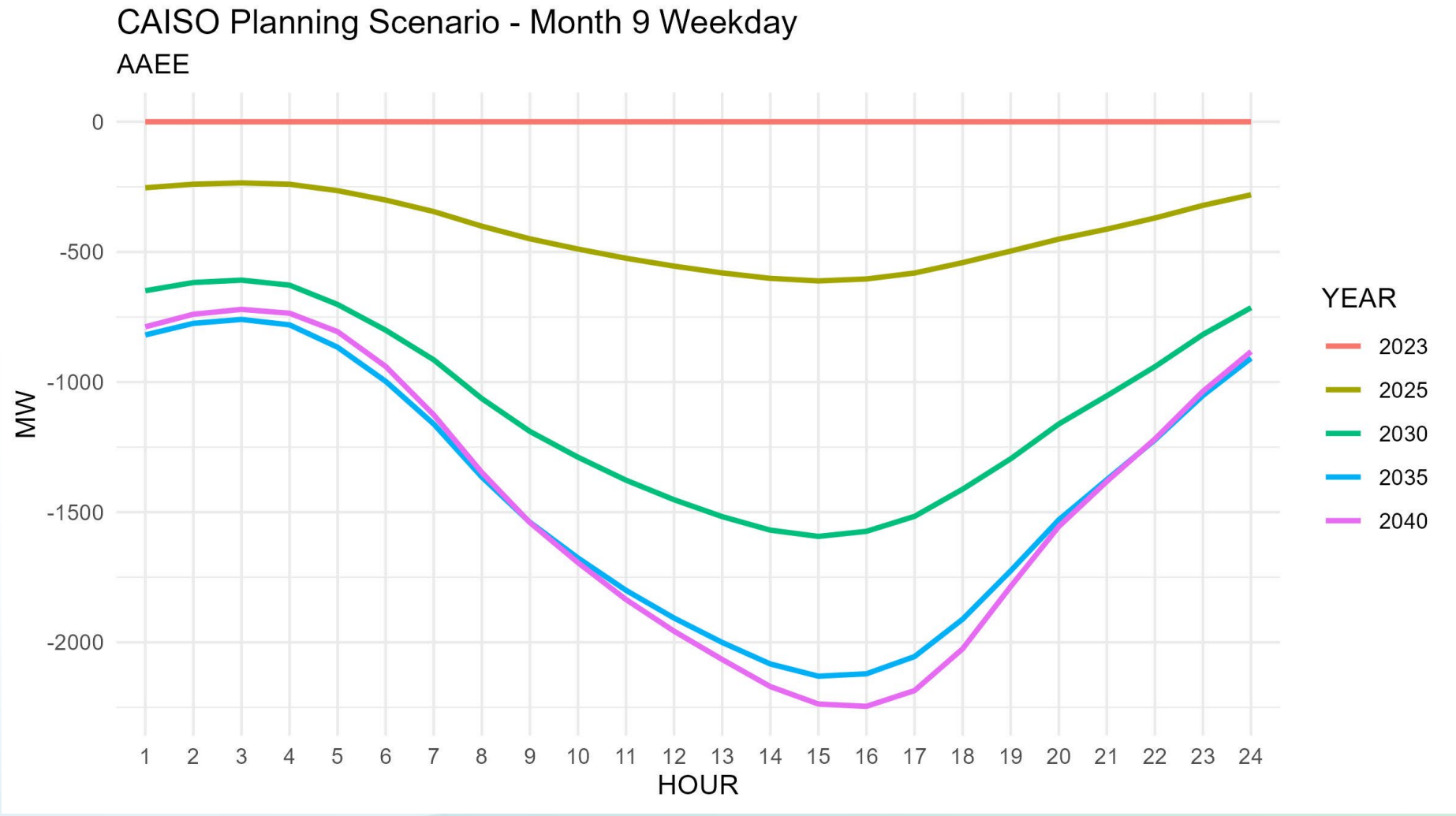
Source: CEC staff

Climate Change



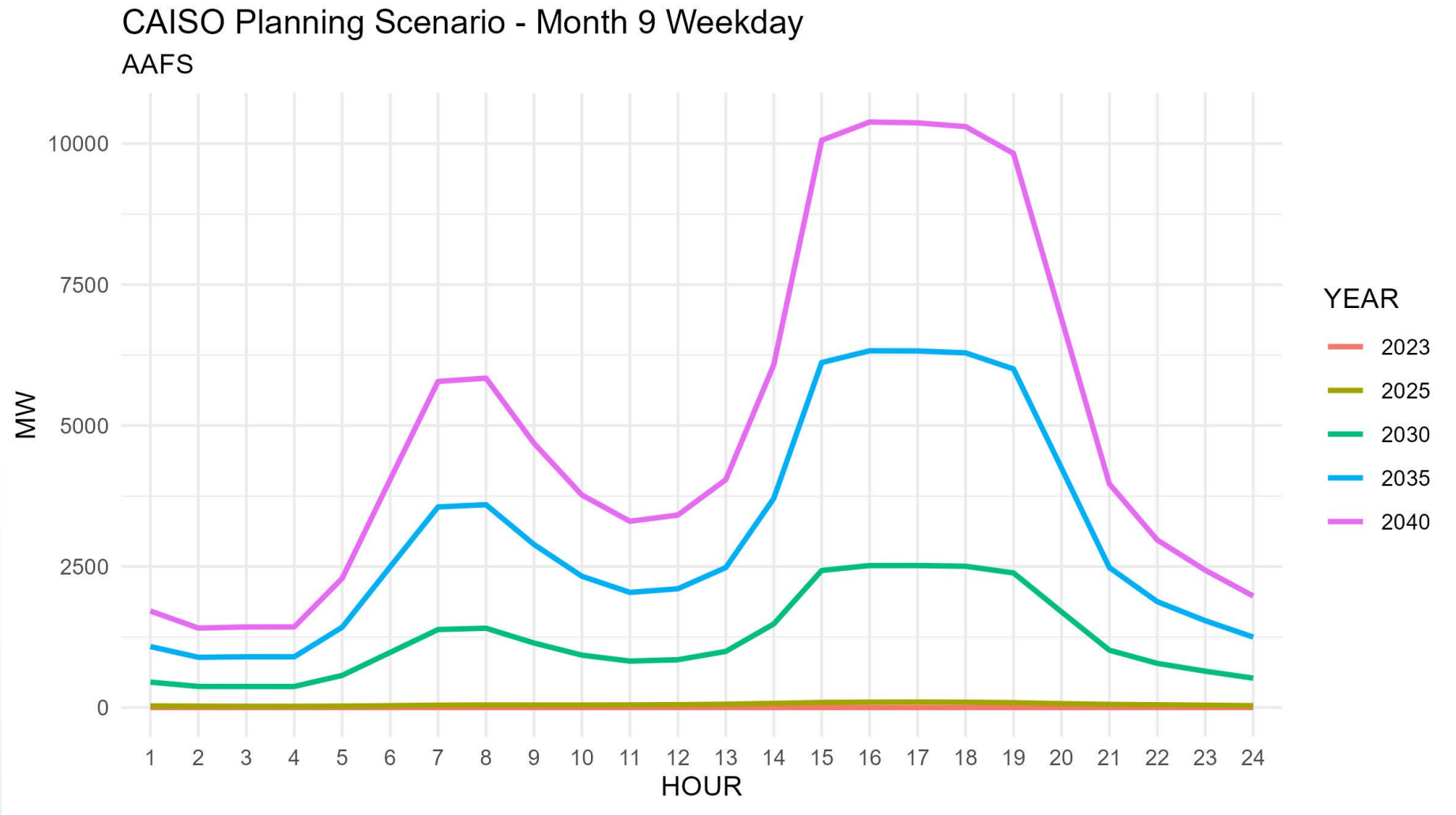
Source: CEC staff

Additional Achievable Energy Efficiency



Source: CEC staff

Additional Achievable Fuel Substitution



Source: CEC staff