

# 2023 Preferred System Plan Proposed Decision

Modeling & Analysis

Energy Division Staff  
January 12, 2024



California Public  
Utilities Commission

# Outline

- Introduction
- Reliability & Emissions Analysis – Proposed PSP Portfolio
  - Proposed PSP Portfolio: 25 MMT “Core”
  - Reliability & Emissions results
- Imports & exports analysis
- Conclusions

# Introduction

# Context: Overview of Proposed PSP Analysis & Former Analyses

- This deck focuses on reliability and emissions analysis needed to support PD's Proposed PSP.
- The focus of this deck is on the 25 MMT Core case. Analysis related to the Least-Cost Cases was primarily released with materials that supported the October 5, 2023, ALJ Ruling.

Analysis Name	Description	Model(s) Used	Use Case(s)
Proposed PSP Portfolio	RESOLVE portfolios simulated in SERVM to examine reliability and GHG emissions		Decision-making for 2023 PSP and 2024-25 TPP
Core Cases	<i>Proposed PSP case optimized with 11/1/2022 LSE Plans as minimum build constraint</i>	RESOLVE SERVM	As above
Least-Cost Cases	<i>Potential PSP Cases previously analyzed that were optimized to least-cost without 11/1/2022 LSE Plans</i>	RESOLVE SERVM	As above

# Background to Staff's Updated Analysis to Support the 2023 Preferred System Plan Proposed Decision

- On October 5, 2023, the CPUC issued an Administrative Law Judge (ALJ) Ruling seeking comments on a proposed Preferred System Plan (PSP) and Transmission Planning Process (TPP) portfolio. CPUC staff released supplementary slides alongside that ruling:
  - [2023 Proposed PSP and 2024-2025 TPP RESOLVE Analysis Slide Deck](#)
  - [2023 Proposed PSP Reliability & Emissions Slide Deck](#)
  - [2023 Proposed PSP and 2024-25 TPP Supplemental Analysis](#)
  - [Supplemental Criteria Pollutant Analysis](#)
- This January 2024 slide deck supports the 2023 PSP Proposed Decision (PD)
  - Since the Ruling was issued, staff has reviewed stakeholder comments and focused its analysis on the Ruling's Proposed PSP portfolio: a 25 MMT "Core" portfolio
  - Previously released materials included both 30 MMT cases and 25 MMT "Least Cost" cases
  - This deck focuses on the updated 25 MMT Core portfolio, which is the recommended portfolio in the Proposed Decision
- This updated analysis includes additional modeling years 2034 and 2039 for the 2024-25 TPP
  - 2022 IEPR data was used directly if post-2035 data was available, otherwise data was taken from the 2021 IEPR High Electrification Interagency Working Group (HEIAWG) dataset or linearly extrapolated
  - BTM CHP was assumed to ramp down to 0 between 2035 and 2040
  - In SERVM, non-CA loads and resources in 2039 were assumed to be the same as 2035

# RESOLVE-Specific Modeling Updates Since October 5, 2023, PSP Ruling

- **CAISO transmission constraint updates based on guidance from CAISO staff (as received by 11/28/23)**
  - Remapped Central Nevada Geothermal to Beatty substation
  - Red Bluff 500/230kV Upgrade: Incremental EODS Capacity updated to match FCDS
  - VEA 230 kV Conversion: Project has been approved by CAISO and its cost has been set to \$0
  - Q2008-Gates 500 kV Line Upgrade: Incremental EODS Capacity updated to match FCDS (relaxes build constraints for Morro Bay Offshore Wind)
- **Updated existing pumped storage round-trip efficiency from 81% to 69% to improve alignment with SERVM**
- **Load-related updates:**
  - BTM PV energy is scaled to improve the alignment with IEPR annual forecasts
  - BTM Storage is modeled as load modifier instead of resource
  - T&D scaling formula is adjusted to land on the same annual system load as in IEPR
  - Minor changes in 2036+ AAEE and AAFS annual loads and gross peak in the 2022 IEPR Planning Scenario to adjust for the disconnect between two CEC IEPR load forecast vintage files
- **RESOLVE code was updated to fix an error that allowed resources to switch between FCDS and EODS deliverability**

# RESOLVE-Specific Modeling Updates Since October 5, 2023, PSP Ruling

- Operating reserves and thermal ramp rates are now included in RESOLVE
- Non-modeled cost updates: BTM PV costs updated to NREL 2023 ATB
- Updated resource potential limits for in-state wind, out-of-state wind and geothermal based on feedback from Ruling stakeholder comments
  - All Northern California Wind is included in the resource potential (removed 30-mi substation distance threshold)
  - Southern Nevada Wind updated to exclude AviKwa Ame National Monument
  - All out-of-state wind resources given 80% discount to resource potential totals
  - Max build limits for out-of-state resources updated to extend restrictions through 2040

Wind Area	Resource Potential (GW)	
	Ruling Version	Proposed Decision
Southern Nevada - El Dorado	5.0	0.7
Idaho	7.7	1.5
New Mexico	166.9	33.4
Utah	18.9	3.8
Wyoming	67.1	13.4

# SERVM-Specific Modeling Updates Since October 5, 2023, PSP Ruling

- Input updates:
  - Corrected Idaho Wind to connect to SCE region
  - Made Biomass/Biogas units have minimum dispatch of 0.55 of installed capacity versus being dispatched at lower amounts in previous modeling
  - Corrected new Pumped Storage round-trip efficiency to be 0.81, matching RESOLVE
    - SERVM existing Pumped Storage average round-trip efficiency is about 0.69; RESOLVE was updated to match this as mentioned in the above description of RESOLVE-specific updates
- Staff corrected and updated the imports and exports analysis to address a reversed sign in the summary workbooks
  - Because of a sign error, previous results were showing CAISO as a net exporter in most months outside spring months
  - Corrected results showing CAISO as a net importer except for spring months in year 2035 are included in this deck



# Reliability & Emissions Analysis – Proposed PSP Portfolio

# Proposed PSP/TPP Portfolio Modeling Steps

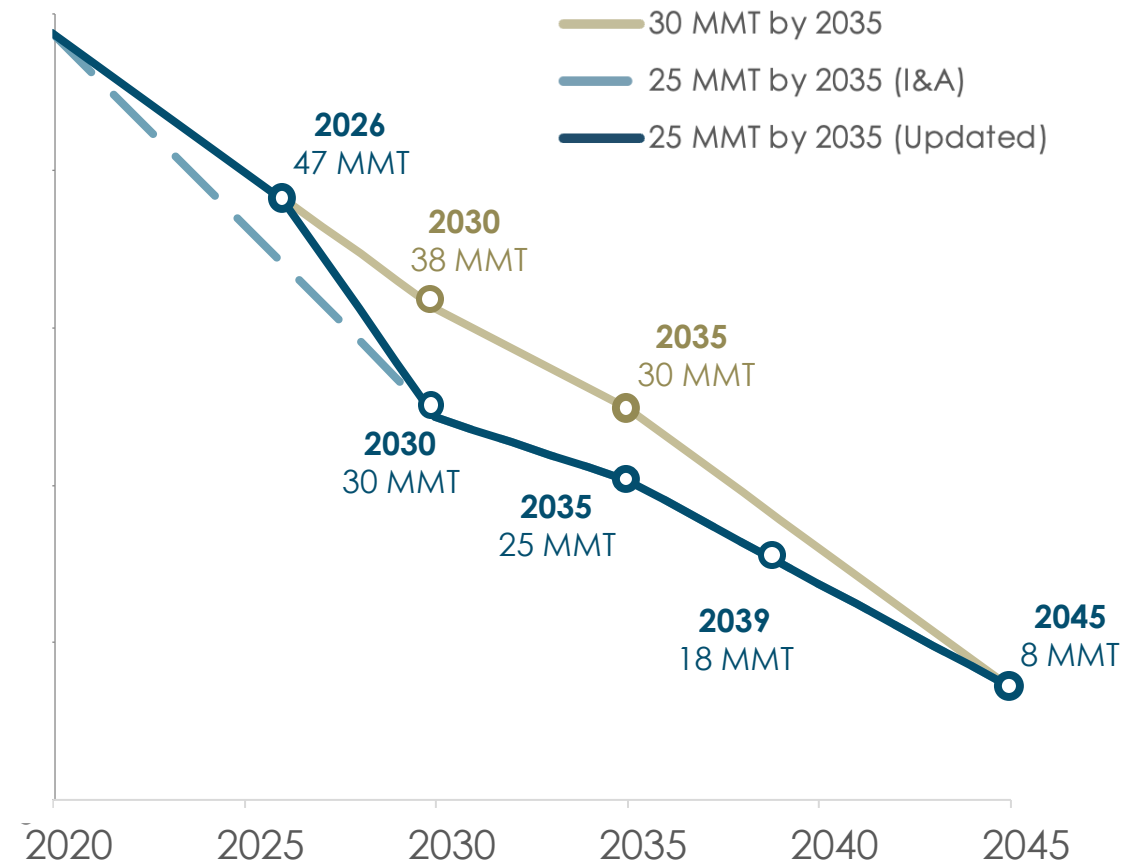
- The modeling results included in this deck build off work done to develop the PSP/TPP portfolio released with the October 5, 2023, ALJ Ruling.
- Staff used RESOLVE to produce the Proposed PSP portfolio:
  - Core: Baseline resources with 11/2022 LSE plans “forced in,” plus RESOLVE selecting additional resources and/or gas retention to meet policy and reliability constraints
- The RESOLVE portfolio was translated into SERVVM inputs and simulated in SERVVM for 2026, 2030, 2034, 2035, and 2039 to determine LOLE and GHG emissions

# GHG Planning Target Trajectories

- Changes from previous cycle:
  - GHG targets have been renamed but remain the same by 2030 & 2035:
    - “30 MMT by 2030” → “25 MMT by 2035”
    - “38 MMT by 2030” → “30 MMT by 2035”
  - 2045 target updated to 8 MMT to reflect 2022 CARB Scoping Plan<sup>1</sup>
  - Baseline historical electric sector emissions updated to 59.5 MMT for 2020, based on CA GHG Inventory<sup>2</sup>
- GHG trajectory updated through 2026 from 2023 PSP draft I&A<sup>3</sup> to reflect near-term resource availability constraints

## CA-wide GHG Emissions Planning Target<sup>4</sup>

million metric tons



<sup>1</sup> <https://ww2.arb.ca.gov/sites/default/files/2022-11/2022-sp-PATHWAYS-data-E3.xlsx>

<sup>2</sup> [https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/ghg\\_inventory\\_by\\_scopingplan\\_00-20.xlsx](https://ww2.arb.ca.gov/sites/default/files/classic/cc/inventory/ghg_inventory_by_scopingplan_00-20.xlsx)

<sup>3</sup> [https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/draft\\_2023\\_i\\_and\\_a.pdf](https://www.cpuc.ca.gov/-/media/cpuc-website/divisions/energy-division/documents/integrated-resource-plan-and-long-term-procurement-plan-irp-ltpp/2023-irp-cycle-events-and-materials/draft_2023_i_and_a.pdf)

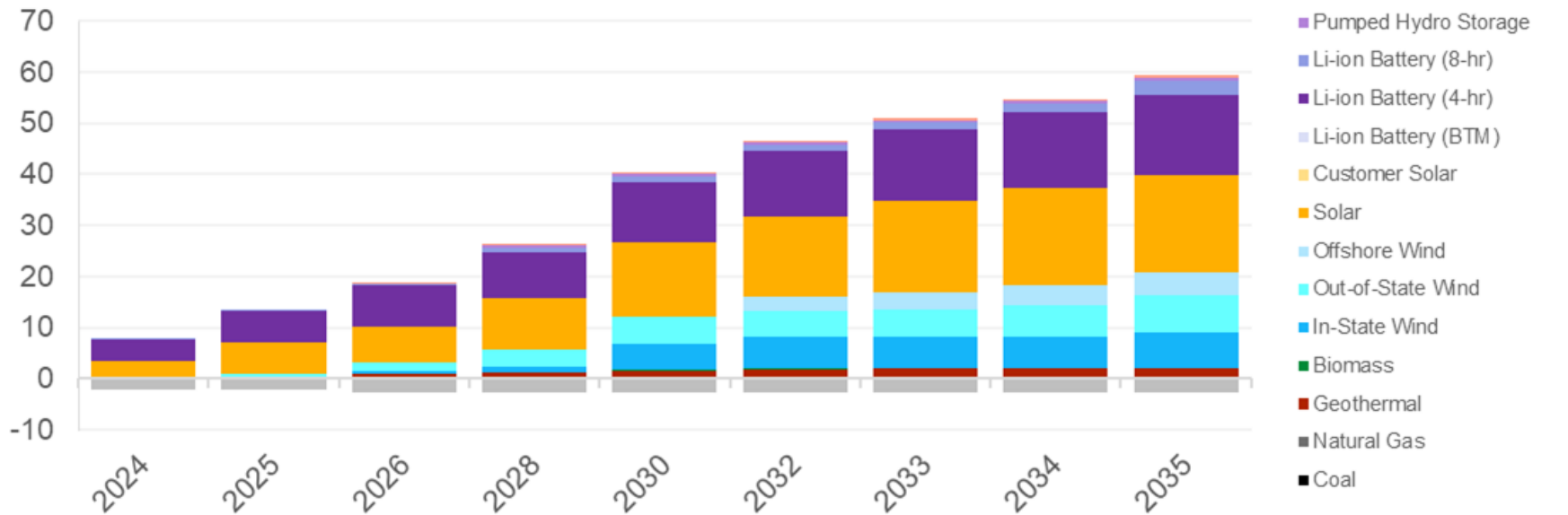
<sup>4</sup> CAISO-wide target is 81% of CA-wide target and includes emissions from BTM CHP equivalent to 4-5 MMT/year

# Proposed PSP Portfolio: 25 MMT “Core”

# Planned & Selected Capacity, Near- & Mid-Term (GW)

Solar and battery capacity grow steadily over time  
 Long duration storage is also added (primarily 8-hr batteries) per LSE plans to meet MTR

**Generic Planned & Selected Capacity**  
 Near- & Medium-Term  
 (GW)



All three categories of wind (in-state, out of state, offshore) also show growth over time. RESOLVE does not select offshore wind above the levels in the LSE plans, largely because of changing assumptions regarding resources costs for OSW and other resources as well as increased availability of other resources.

A relatively small amount of gas (2.7 GW) is not retained, starting in 2024, as MTR, LSE plans to build beyond MTR, and RESOLVE selected resources for GHG reduction create a capacity surplus

# Planned & Selected Capacity, Long-Term (GW)

- Along with increasing solar, RESOLVE-selected long duration li-ion batteries become a larger part of the portfolio in the late 2030s and beyond

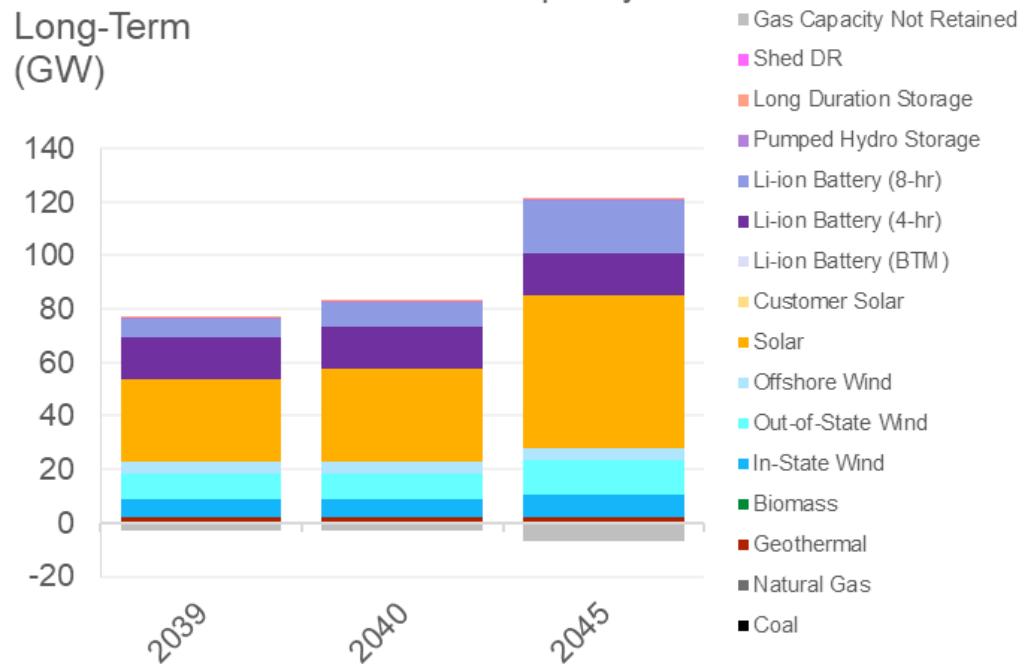
RESOLVE is currently set up to select either 4hr li-ion, 8-hr li-ion, 12-hr pumped storage, or 24-hr A-CAES. RESOLVE sees increased value from longer durations due to:

- Resource adequacy value as additional duration provides additional ELCC
- Greenhouse gas reduction from shifting continuously growing solar power
- Transmission availability, since longer duration batteries are modeled as requiring the same amount of transmission as 4-hour (but provide more resource adequacy per MW of capacity)

By 2035, the average duration of battery resources is 4.4 hours, increasing to 5.8 hours by 2045.

The specific optimal mix of storage durations is subject to the future cost of increased duration relative to the market value of that duration as captured in LSE procurement solicitations.

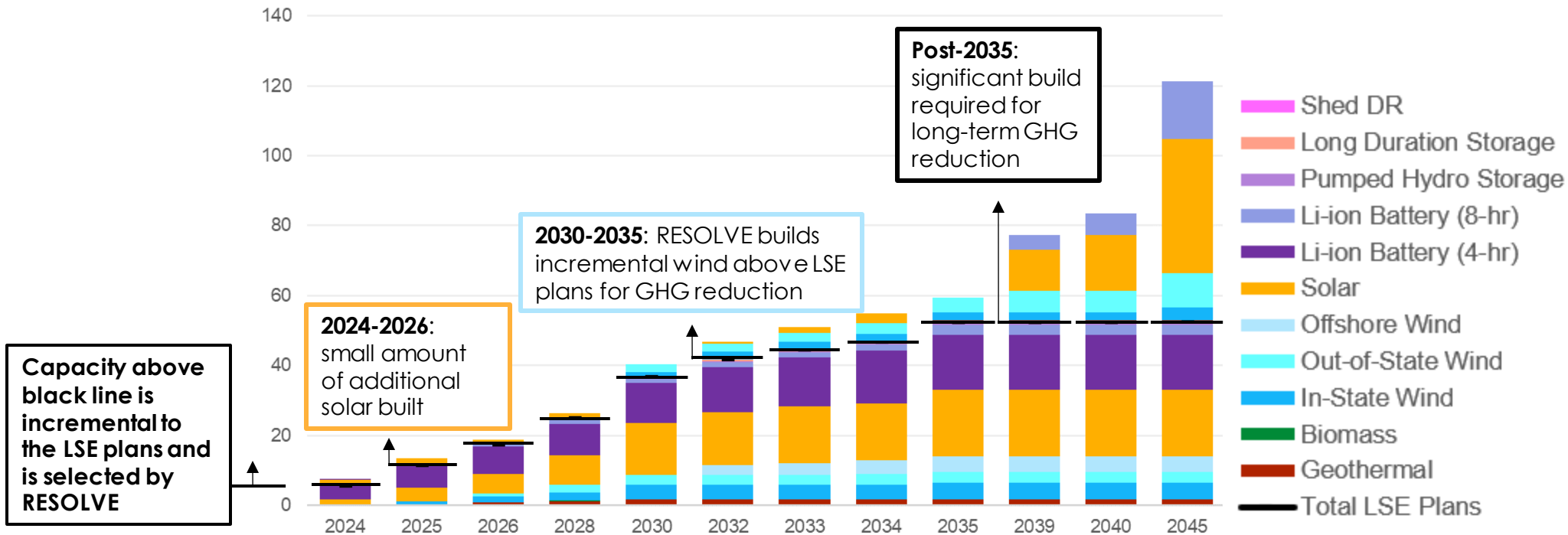
Generic Planned & Selected Capacity Long-Term (GW)



# Planned Builds vs. RESOLVE-Selected Builds (GW)

LSE Plans are mostly sufficient for reliability & GHG reduction needs until 2035

LSE Plans & RESOLVE-Selected Capacity in the 25MMT Core Case (GW)



# Planned & Selected Capacity (GW)

Resource Category	2024	2025	2026	2028	2030	2032	2033	2034	2035	2039	2040	2045
Geothermal	0.0	0.0	0.8	1.1	1.5	1.8	2.0	2.0	2.0	2.0	2.0	2.0
Biomass	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
In-State Wind	0.3	0.4	0.8	1.1	5.0	6.1	6.1	6.1	7.0	7.0	7.0	8.3
Out-of-State Wind	0.0	0.6	1.7	3.4	5.3	5.3	5.3	6.1	7.1	9.1	9.1	12.7
Offshore Wind	0.0	0.0	0.0	0.0	0.0	2.7	3.3	3.9	4.5	4.5	4.5	4.5
Solar	3.0	6.0	6.9	9.9	14.8	15.7	17.9	19.0	19.0	30.7	35.0	57.5
Li-ion Battery (4-hr)	4.3	6.3	8.0	9.0	11.6	12.7	14.0	15.0	15.7	15.7	15.7	15.7
Li-ion Battery (8-hr)	0.0	0.0	0.4	1.0	1.2	1.4	1.4	1.7	2.8	7.2	9.0	19.5
Pumped Hydro Storage	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Long Duration Storage	0.0	0.0	0.1	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Shed DR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas Capacity Not Retained	(2.2)	(2.2)	(2.7)	(2.7)	(2.7)	(2.7)	(2.7)	(2.7)	(2.7)	(2.7)	(2.7)	(6.6)
<b>Total</b>	<b>5.4</b>	<b>11.1</b>	<b>16.0</b>	<b>23.8</b>	<b>37.7</b>	<b>44.0</b>	<b>48.3</b>	<b>52.1</b>	<b>56.6</b>	<b>74.7</b>	<b>80.9</b>	<b>114.8</b>



25 MMT Core Case – Results released in October 5, 2023, PSP Ruling

# Planned & Selected Capacity (GW)

Resource Category	2024	2025	2026	2028	2030	2032	2033	2034	2035	2039	2040	2045
Geothermal	0.0	0.0	0.8	1.1	1.5	1.6	1.6	1.6	1.6	1.7	1.7	1.7
Biomass	0.0	0.0	0.0	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
In-State Wind	0.3	0.4	0.8	1.1	5.4	7.4	8.1	8.1	8.5	10.4	10.4	12.7
Out-of-State Wind	0.0	0.6	1.7	3.4	4.6	4.6	4.6	5.3	6.3	10.2	10.2	11.6
Offshore Wind	0.0	0.0	0.0	0.0	0.0	2.7	3.3	3.9	4.5	4.5	4.5	4.5
Solar	3.0	6.0	6.5	8.5	14.8	15.3	16.1	16.4	19.0	25.2	29.1	50.6
Li-ion Battery (4-hr)	4.3	6.3	8.0	9.0	11.6	12.7	14.0	15.0	15.7	15.7	15.7	15.7
Li-ion Battery (8-hr)	0.0	0.0	0.4	1.0	1.2	1.4	1.4	1.7	2.8	5.7	7.3	16.1
Pumped Hydro Storage	0.0	0.0	0.0	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Long Duration Storage	0.0	0.0	0.1	0.3	0.3	0.4	0.4	0.5	0.5	0.5	0.5	0.5
Shed DR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas Capacity Not Retained	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(2.1)	(4.0)
<b>Total</b>	<b>5.5</b>	<b>11.2</b>	<b>16.2</b>	<b>23</b>	<b>37.9</b>	<b>44.5</b>	<b>48.1</b>	<b>50.9</b>	<b>57.5</b>	<b>72.4</b>	<b>78</b>	<b>110.1</b>

# Planned & Selected Capacity (GW)

Resource Category	2024	2025	2026	2028	2030	2032	2033	2034	2035	2039	2040	2045
Geothermal	0.0	0.0	0.0	0.0	0.0	0.2	0.4	0.4	0.4	0.3	0.3	0.3
Biomass	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
In-State Wind	0.0	0.0	0.0	0.0	(0.4)	(1.3)	(2.0)	(2.0)	(1.5)	(3.4)	(3.4)	(4.4)
Out-of-State Wind	0.0	0.0	0.0	0.0	0.7	0.7	0.7	0.8	0.8	(1.1)	(1.1)	1.1
Offshore Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Solar	0.0	0.0	0.4	1.4	0.0	0.4	1.8	2.6	0.0	5.5	5.9	6.9
Li-ion Battery (4-hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Li-ion Battery (8-hr)	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	1.5	1.7	3.4
Pumped Hydro Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Long Duration Storage	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Shed DR	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Gas Capacity Not Retained	(0.1)	(0.1)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(0.6)	(2.6)
<b>Total</b>	<b>(0.1)</b>	<b>(0.1)</b>	<b>(0.2)</b>	<b>0.8</b>	<b>(0.3)</b>	<b>(0.6)</b>	<b>0.3</b>	<b>1.2</b>	<b>(0.9)</b>	<b>2.2</b>	<b>2.8</b>	<b>4.7</b>

# Reliability & Emissions Results

# Reliability and GHG Results – 25 MMT Core, Proposed PSP portfolio

Updated

25 MMT CORE	2026		2030		2034		2035		2039		
Category	RESOLVE	SERVM	RESOLVE	SERVM	RESOLVE	SERVM	RESOLVE	SERVM	RESOLVE	SERVM	Units
LOLE		0.015		0.001		0.012		0.021		0.130	days/year
CAISO emitting generation	59,916	72,578	36,793	44,477	22,361	40,104	18,080	37,643	6,365	37,577	GWh
CAISO generator emissions	23.5	30.0	14.5	19.0	8.8	16.4	7.1	15.3	2.5	15.1	MMT CO2
Unspecified imports	18,185	7,295	12,060	11,665	18,291	10,570	20,454	9,438	27,214	8,594	GWh
Unspecified imports emissions	7.8	3.1	5.2	5.0	7.8	4.5	8.8	4.0	11.7	3.7	MMT CO2
CAISO BTM CHP emissions	4.8	4.8	4.7	4.7	4.5	4.5	4.4	4.4	0.9	0.9	MMT CO2
Total CAISO emissions	36.1	37.9	24.3	28.6	21.1	25.3	20.3	23.8	15.0	19.6	MMT CO2
Difference in GHG emissions		1.8		4.3		4.2		3.5		4.6	MMT CO2

- Note: The RESOLVE portfolio was designed to meet the 25 MMT by 2035 statewide target, which equates to 20.3 MMT attributed to CAISO. The 2035 CAISO emissions result in SERVM was 23.8 MMT, which equates to about 29.4 MMT statewide.
- These results include the RESOLVE and SERVM modeling changes since the October 5, 2023 Ruling, described earlier in this deck

# Reliability and GHG Results – 25 MMT Core, October 5, 2023, PSP Ruling (for Reference)

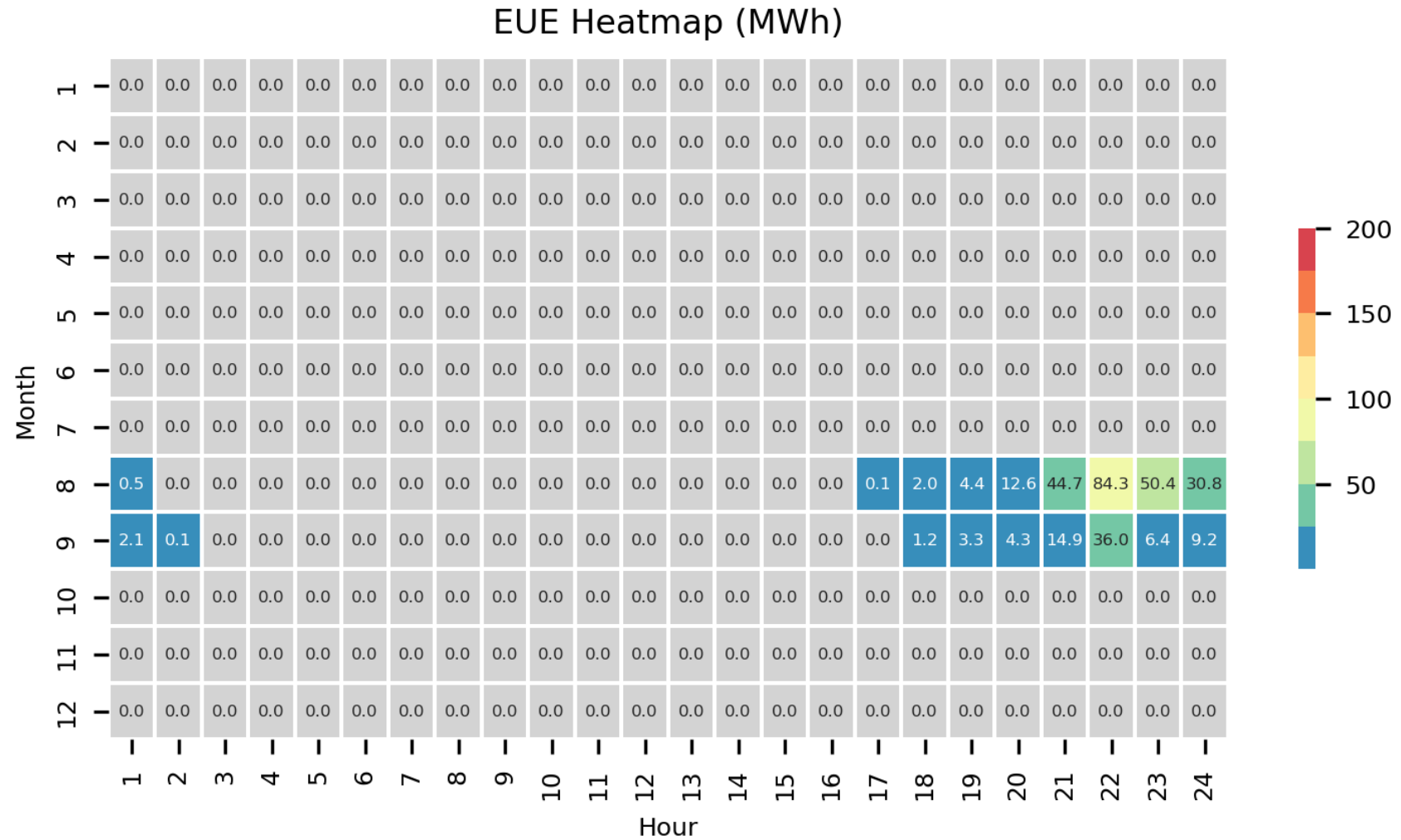
25 MMT CORE	2026		2030		2035		
Category	RESOLVE	SERVIM	RESOLVE	SERVIM	RESOLVE	SERVIM	Units
LOLE		0.009		0.002		0.053	days/year
CAISO emitting generation	59,691	73,118	33,506	45,946	16,773	39,674	GWh
CAISO generator emissions	23.4	30.1	13.2	19.5	6.6	16.2	MMT CO2
Unspecified imports	16,130	9,347	15,085	12,089	21,641	9,810	GWh
Unspecified imports emissions	6.9	4.0	6.5	5.2	9.3	4.2	MMT CO2
CAISO BTM CHP emissions	4.8	4.8	4.7	4.7	4.4	4.4	MMT CO2
Total CAISO emissions	35.1	38.9	24.3	29.4	20.3	24.8	MMT CO2
Difference in GHG emissions		3.8		5.1		4.5	MMT CO2

- Note: The RESOLVE portfolio was designed to meet the 25 MMT by 2035 statewide target, which equates to 20.3 MMT attributed to CAISO. The 2035 CAISO emissions result in SERVIM was 24.8 MMT, which equates to about 30.6 MMT statewide.

# 2035 EUE Heat Map – 25 MMT Core

Updated

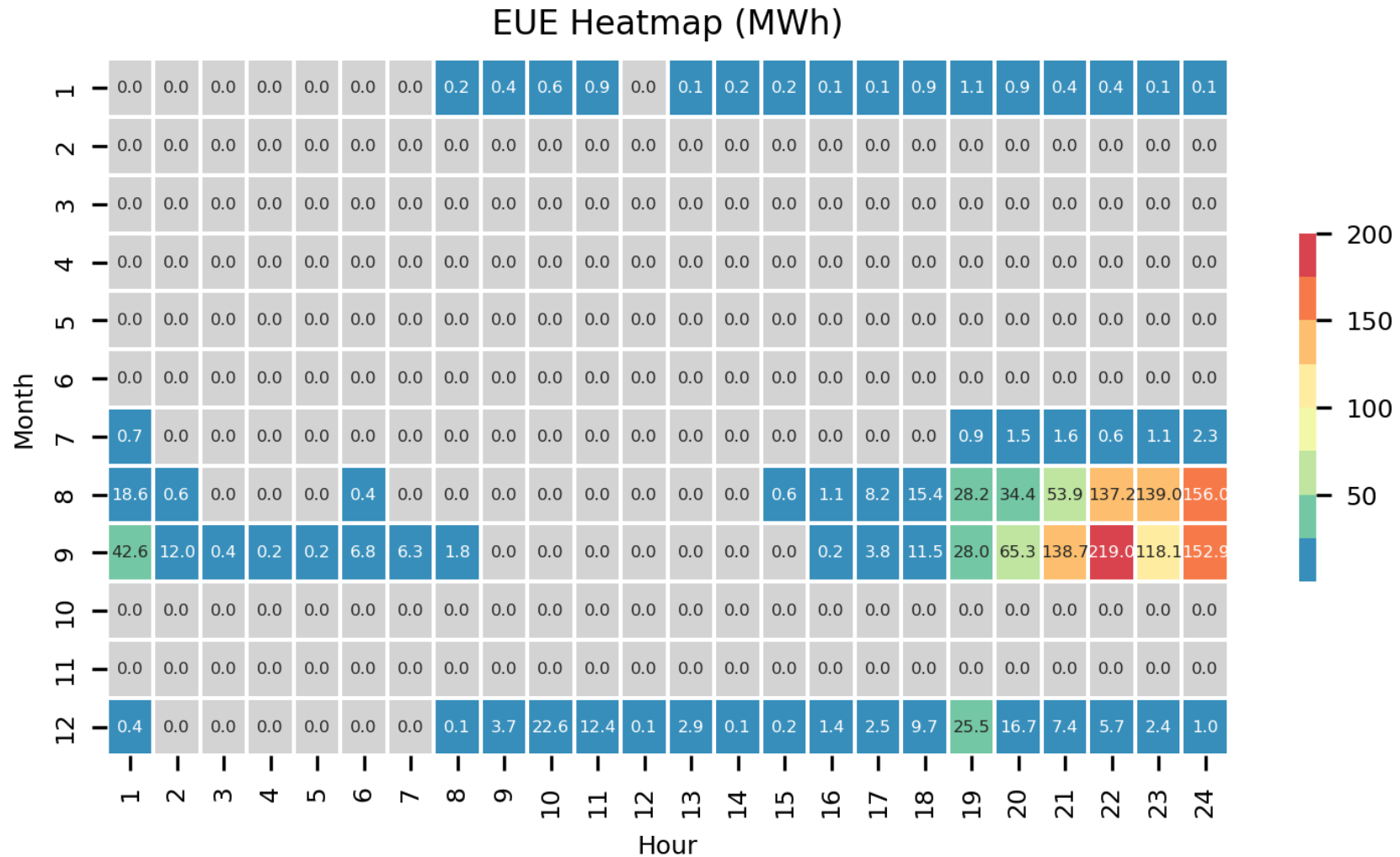
- For 2035, the highest Expected Unserved Energy (EUE) occurs in August and September, hours ending 21:00 to 23:00
- This pattern is similar in earlier study years



Average monthly EUE in MWh is shown for each hour of the day

# 2039 EUE Heat Map – 25 MMT Core

- For 2039, the highest Expected Unserved Energy (EUE) occurs in August and September, hours ending 20:00 to 24:00
- The summer pattern is similar in earlier study years, but with fewer and smaller EUE events
- EUE is also starting to happen in winter months by 2039, which does not happen in earlier study years



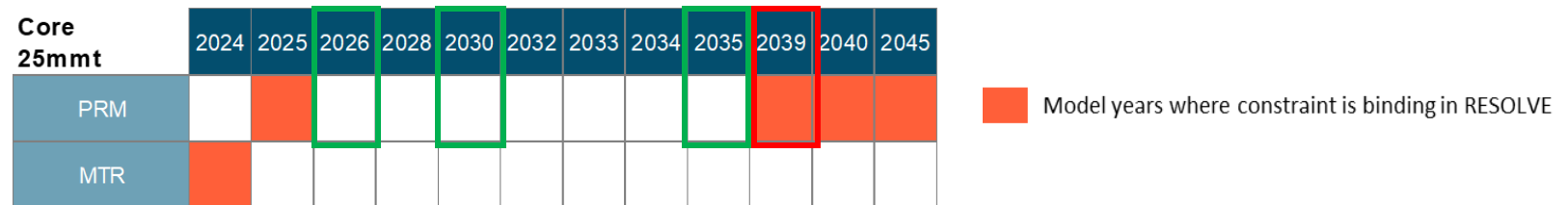
Average monthly EUE in MWh is shown for each hour of the day

# Proposed PSP Portfolio SERVM Modeling Results

## 25MMT Core Scenario

- **Consistency with RESOLVE's PRM constraint:**

- SERVM results show the scenario is over-reliable (below the 0.1 days/year LOLE target) in 2026, 2030, and 2035 – and RESOLVE's PRM constraint is not binding in these years, driven by MTR, LSE over-procurement above MTR, and RESOLVE's selection of additional GHG-free resources and retention of more gas plants than LSE plans assumed
- SERVM 2039 results show the scenario is only slightly under-reliable (0.13 LOLE), consistent with the RESOLVE PRM constraint binding in 2039 (indicating that system reliability should be close to 0.1 LOLE)





# Proposed PSP Portfolio SERVM Modeling Results

## 25MMT Core Scenario

- **Reliability results:**

- LOLE results for 2026, 2030, and 2035 are all well below the reliability target (0.1) and are not materially different from results in the October 5, 2023, Ruling.
- LOLE result for 2034 is 0.012, also well below the reliability target (0.1)
- LOLE result for 2039 is 0.13 – modestly higher than the 0.1 target. This is consistent with RESOLVE having a binding reliability constraint in 2039 meaning the portfolio should be just enough to get very close to the 0.1 LOLE target.
- Initial studies of 2039 revealed that the PG&E region was the driver of total CAISO LOLE in 2039. Thus, staff adjusted the final setup of 2039 in SERVM to locate all RESOLVE-selected gas retirement in the SCE and SDG&E regions, and none in the PG&E region. This is reasonable since RESOLVE is indifferent to the location of its selected gas retention. This brought the PG&E region's LOLE closer to the results for the SCE and SDG&E regions and reduced the total CAISO LOLE overall to the final value of 0.13.
- Staff further investigated possible drivers of higher LOLE in the PG&E region and found that PG&E tended to have relatively larger load growth than SCE or SDG&E, a significant amount of it coming from electric vehicle charging load. Because LOLE in the PG&E region was higher than 0.1 and LOLE in the SCE and SDG&E regions were lower than 0.1, there appeared to be extra capacity in the South that could be used to mitigate LOLE in the North. Expanding Path 26 South to North transmission capacity or locating more RESOLVE-selected new build in the North are among the options that could be studied in the next planning cycle to reduce the intra-CAISO LOLE imbalance appearing in the outer planning years.

# Proposed PSP Portfolio SERVM Modeling Results

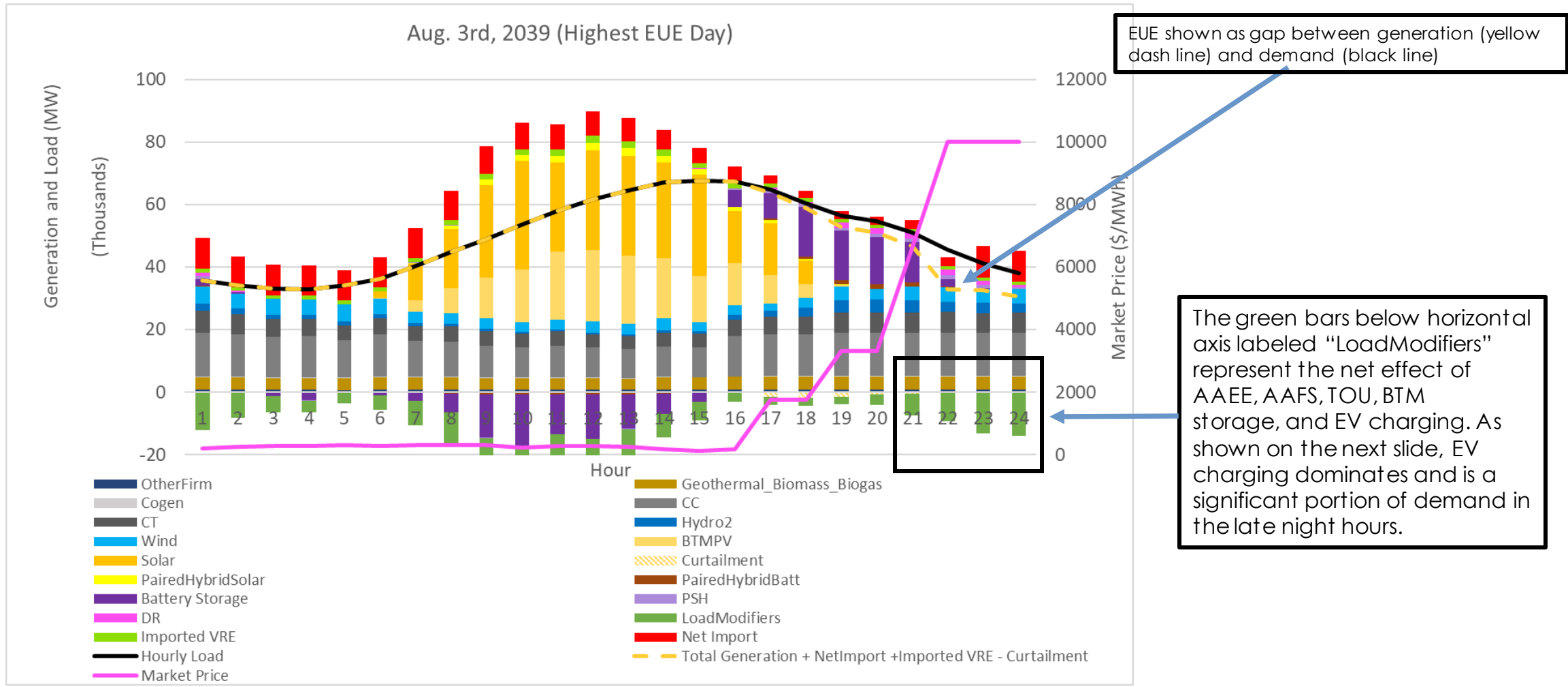
## 25MMT Core Scenario

- **Greenhouse gas emission results:**

- SERVM GHG results for CAISO are higher than RESOLVE results by approximately 1.8 – 4.6 MMT per annum depending on portfolio and year
- Modeling adjustments since the October Ruling have modestly closed the GHG gap
  - Annual energy demand, as well as annual generation from BTM PV, Biomass, OOS Wind, and Offshore Wind are now all aligned between models
  - Pumped Storage round-trip efficiency aligned between models
- Remaining drivers that will be explored during calibration work in the next IRP cycle:
  - Slightly higher storage usage in RESOLVE
  - Higher curtailment in SERVM
  - Higher total CC gas unit and unspecified import usage in SERVM

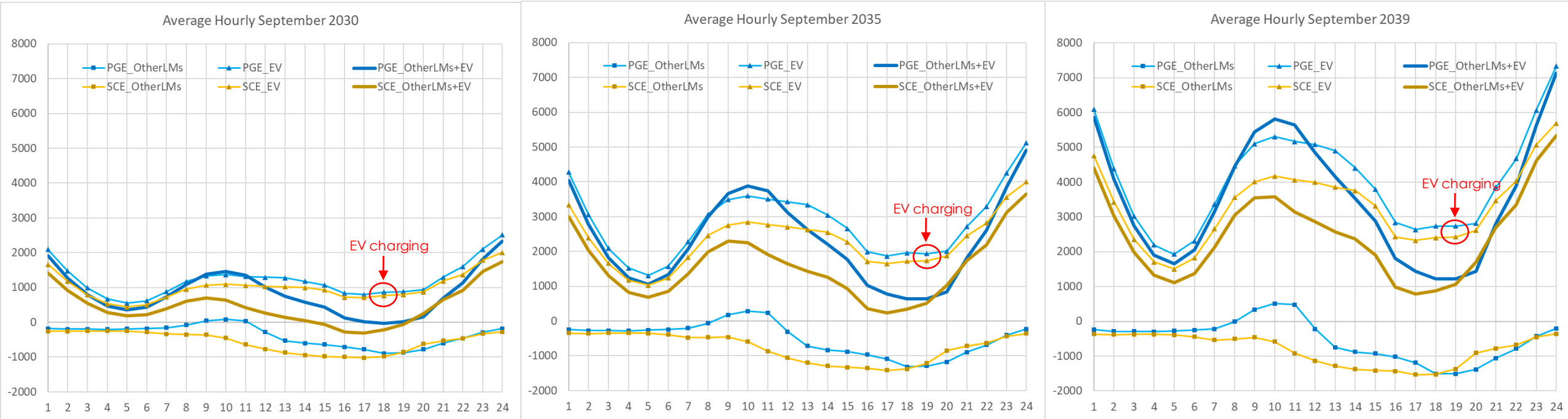
# Hourly Dispatch results – EV charging load over midnight hours correlated with EUE

New



# Electric Vehicle Charging Growth from the IEPR

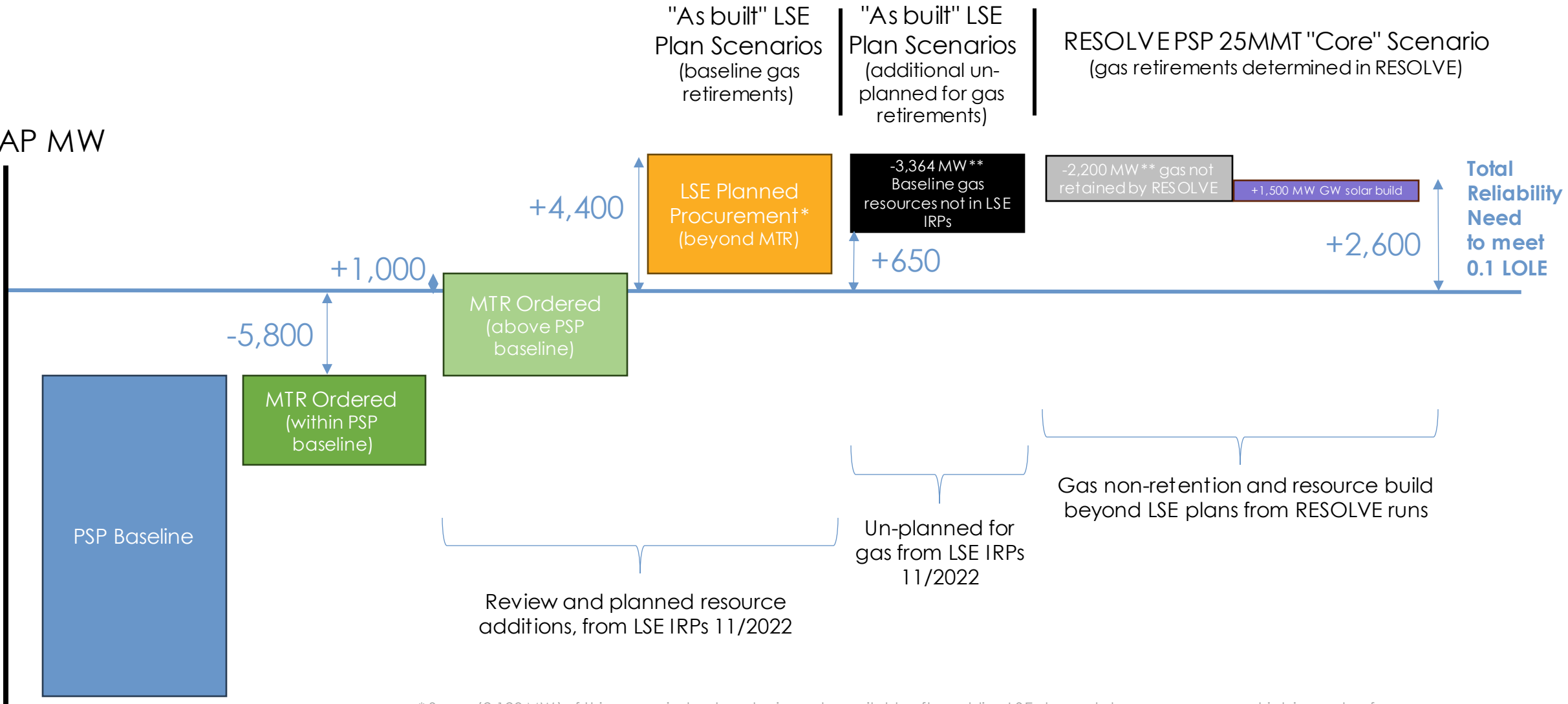
New



- The charts above show the 2030, 2035, and 2039 average September hourly pattern for Load Modifier (LM) components of the IEPR demand forecast for the CAISO subregions PGE and SCE
  - The X-axis is hours of day and the Y-axis is MW (positive means raises electric demand and negative means lowers electric demand)
  - "OtherLMs" is the net effect of AAEE, AAFS, TOU, and BTM storage. "EV" is electric vehicle charging by itself (and includes baseline EV and AATE from the IEPR). "OtherLMs+EV" is the net effect of OtherLMs and EV combined.
  - EV charging starts to dominate the hourly profile in 2035 and more so in 2039
  - Annual growth in EV charging and night charging peaking are relatively bigger in PGE than in SCE and 2039 modeling results show that PGE is beginning to fall short of capacity from this higher load growth, especially at night
  - The magnitude of average daily charging does not vary significantly by month (only September is shown here)

# Reliability Waterfall Chart (2026): Connecting MTR to the PSP

PCAP MW



\* Some (2,120 MW) of this excess is due to extra imports available after adding LSE planned storage resources, which is a value from shifting the loss of load risk back before HE18 vs. being solely driven by LSE resources. Values rounded from direct SERVM model outputs.

\*\* Gas and solar MW are nameplate values

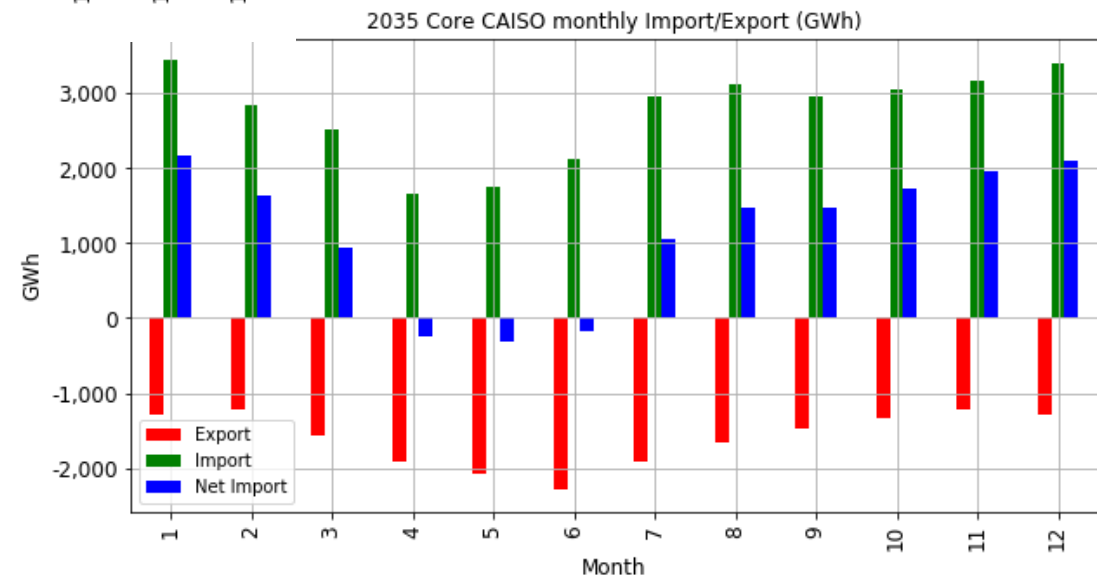
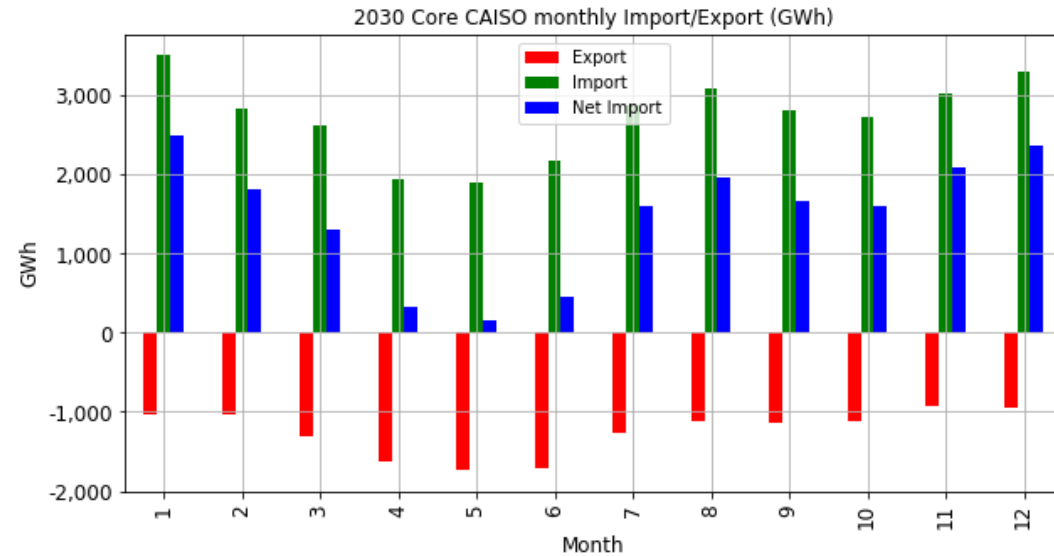
# Imports and Exports

# Background – Import/Export Between CAISO and External Regions

- Previous slides posted for PSP analysis showed CAISO as a net exporter in all months.
  - The slides were incorrect in that the signs of the reports were switched.
  - This was a SERVM report error rather than an issue with the underlying modeling.
  - This slide deck shows the correct import/export pattern.
- Imports and exports have been calculated and analyzed for all 3 studies (2026, 2030 and 2035 Core).
- The following slides show changes in future import/export patterns to CAISO

# Monthly Import/Export for 2030 and 2035 - Core Case

- Monthly imports in all months exceeds exports for 2030
- The analysis shows in 2030 CAISO will have mostly net imports
- This pattern changes in 2035 where the analysis shows net exports during months of April through June
- Highest exports happen between months of April to June in both years 2030 and 2035.





# Observations

- Monthly import/export results for both Core cases and Least Cost cases show an increase in exports during months of April to June compared to other months of the year. This trend can be seen in all study years.
- Most cases show a net import happening during all months of the year, though very small net import GWh during the spring, almost netting to zero in May and June.
- 2035 Core case shows that during months of April to June, net export is occurring, while in other periods interchange is net positive meaning net import is happening.

# Conclusions

# Proposed PSP Portfolio – Conclusions

- Staff studied RESOLVE portfolios in SERVVM to check the portfolios against GHG and LOLE metrics using the full SERVVM 23-weather year dataset
  - **Reliability:** The Proposed PSP Portfolio is reliable (LOLE below 0.1) through 2035. These dynamics are consistent with the dynamics of the RESOLVE model for the same scenarios
    - While 2039's LOLE is just slightly higher than 0.1 LOLE, Staff note that the 0.13 still indicates a largely reliable portfolio and translates to a shortfall of only a few hundred MWs of PCAP.
    - The 2039 LOLE result appears driven primarily by Path 26 constraints, which can be addressed via multiple methods without changing the adopted portfolio, such as changing where resources are retired and where resources are added, increasing the system's South to North transmission capacity, and others.
    - Additionally, the 2034 model year is the key determinate for policy-driven transmission approvals for the TPP. The CAISO is not required to approve transmission based on the 2039 portfolio, but it can use the results to inform and guide the upgrades recommended for approval for the 2034 portfolio.
    - Lastly, there are transmission and resource options to address shortfalls in the reliability standard in the outer years.
- **GHG emissions:** SERVVM modeling of the Proposed PSP portfolio result in GHG emissions that exceed RESOLVE results, with the difference generally rising from 2026 to 2039
  - While staff has done significant calibration between the models in this cycle, there remain lingering differences between the models which prevent absolute reconciliation
  - Staff will continue to explore these differences. The range of results is reasonable considering the uncertainties involved. The range of emissions between RESOLVE and SERVVM provide an indicator of possible outcomes for these portfolios.

# Priorities for Future IRP Reliability Studies

- Consider providing direction to LSEs on what to assume regarding the inclusion of existing resources in their plans, given their lack of visibility into other LSEs' planning
- Continue to improve alignment of reliability modeling inputs and methodologies across CPUC proceedings and across state agencies
- Update SERVM to include 2021 and 2022 weather years, including the September 2022 heat event
- Continue to improve baseline portfolio coordination across state datasets and ensure robust CPUC project tracking from planned → review → in-development → online
  - → to ensure accurate treatment of MTR needs v.s. baseline resources
  - → to allow CEC, CPUC, and CAISO to communicate shared understanding of new resources expected as they proceed through interconnection and other development steps
- Consider adjustments to methods to model import availability, as "off-peak" imports become more critical in a storage-heavy, energy-limited system
- Add ability to model weather dependent building electrification loads, to enable more accurate reliability modeling of post-2035 scenarios
- Incorporate climate-informed forecasting to capture climate change impacts on load and resource availability
- Continue to align ELCC inputs to RESOLVE with SERVM, including treatment of reliability portfolio effects / diversity benefits
- Improve hourly dispatch modeling alignment between SERVM and RESOLVE, especially storage usage, curtailment, and gas usage
- Study the impacts of Path 26 limits and locating new build in the North or South on modeling results

# Appendix

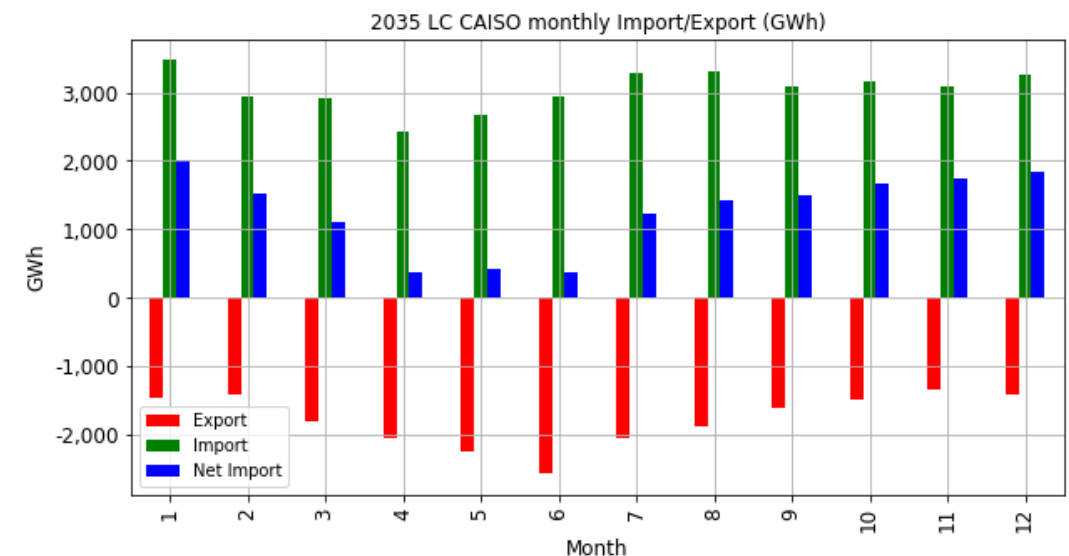
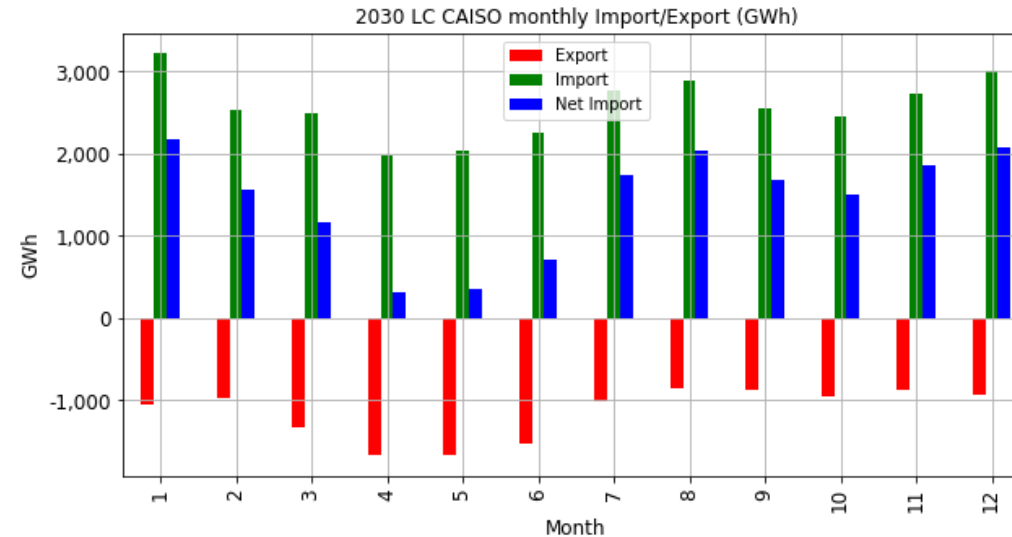
# Reliability and GHG Results – 25 MMT Least-Cost, October 5, 2023, PSP Ruling (for Reference)

25 MMT LEAST-COST	2026		2030		2035		
Category	RESOLVE	SERVM	RESOLVE	SERVM	RESOLVE	SERVM	Units
LOLE		0.014		0.005		0.078	days/year
CAISO emitting generation	63,683	77,851	39,240	49,875	20,470	45,224	GWh
CAISO generator emissions	25.0	31.8	15.4	21.0	8.1	18.3	MMT CO2
Unspecified imports	15,185	7,436	9,835	10,822	18,220	9,083	GWh
Unspecified imports emissions	6.5	3.2	4.2	4.6	7.8	3.9	MMT CO2
CAISO BTM CHP emissions	4.8	4.8	4.7	4.7	4.4	4.4	MMT CO2
Total CAISO emissions	36.4	39.8	24.3	30.3	20.3	26.6	MMT CO2
Difference in GHG emissions		3.4		6.0		6.3	MMT CO2

Note: The RESOLVE portfolio was designed to meet the 25 MMT by 2035 statewide target, which equates to 20.3 MMT attributed to CAISO. The 2035 CAISO emissions result in SERVM was 26.6 MMT, which equates to about 32.8 MMT statewide.

# Monthly Import/Export for 2030 and 2035 - Least Cost Cases

- For all Least Cost cases, monthly imports in all months exceed exports
- The analysis shows that in 2030 and 2035 CAISO will have mostly net imports
- Highest exports happen during months of April to June.



# Acronym Glossary

- BTM: Behind the Meter
- CCA: Community Choice Aggregation
- DCCP: Diablo Canyon Power Plant
- ELCC: Effective Load Carrying Capability
- ESP: Electric Service Provider
- EUE: Expected Unserved Energy
- HE: Hour Ending
- I&A: Inputs and Assumptions
- IOU: Investor-Owned Utilities
- LDES: Long Duration Energy Storage
- LLT: Long Lead-Time
- LOLE: Loss of Load Expectation
- LOLP: Loss of Load Probability
- LSE: Load Service Entity
- MTR: Mid Term Reliability
- MMT: Million Metric Tons
- MRN: Marginal Reliability Need
- NQC: Net Qualifying Capacity
- PCAP: Perfect Capacity
- PCM: Production Cost Modeling
- PRM: Planning Reserve Margin
- PSP: Preferred System Plan
- RDT: Resource Data Template
- TPP: Transmission Planning Process
- TRN: Total Reliability Need