



Q1 and Q2 2023 Report on Market Issues and Performance

December 1, 2023

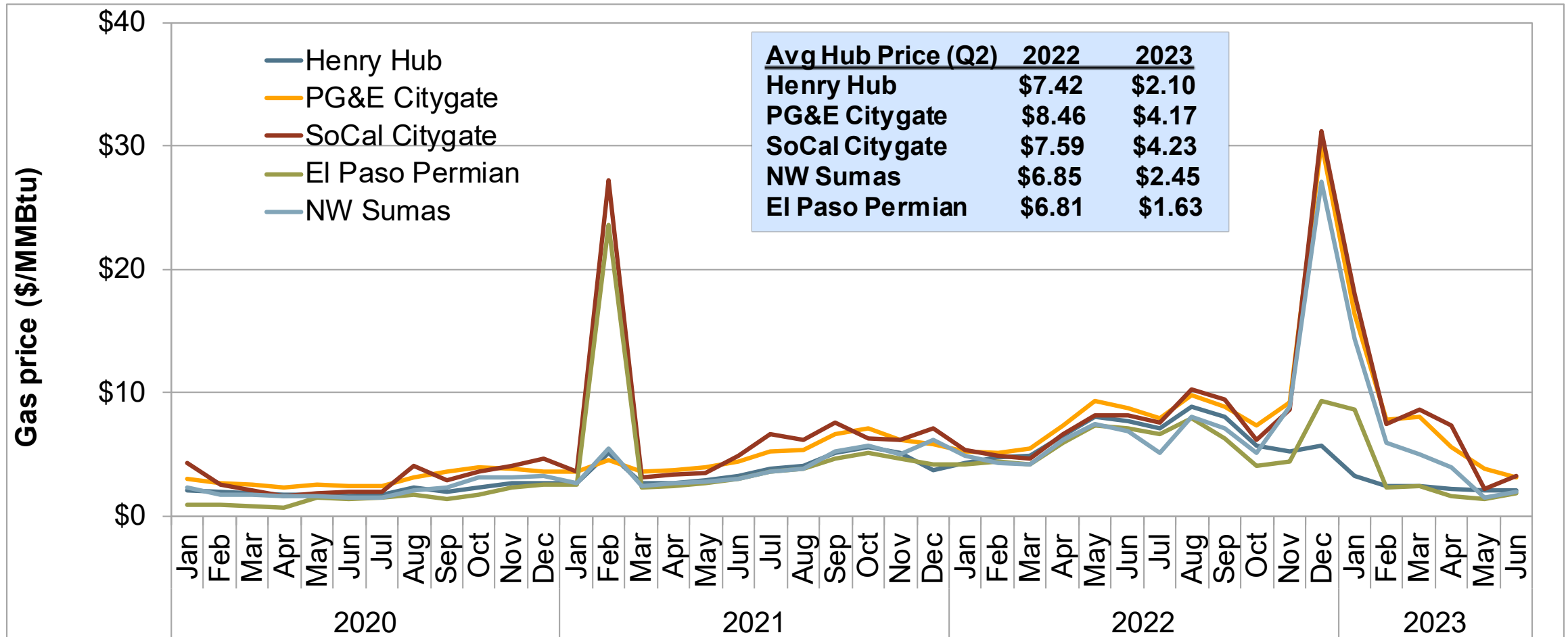
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Department of Market Monitoring

<http://www.caiso.com/Documents/2023-First-Quarter-Report-on-Market-Issues-and-Performance-Sep-19-2023.pdf>
<http://www.caiso.com/Documents/2023-Second-Quarter-Report-on-Market-Issues-and-Performance-Nov-16-2023.pdf>
<http://www.caiso.com/Documents/Review-of-the-Mosaic-Quantile-Regression-Nov-20-2023.pdf>
<http://www.caiso.com/Documents/Real-Time-Load-Settlements-and-Revenue-Imbalances-Aug-30-2023.pdf>
[Flexible-Ramping-Product-Enhancements-Demand-Curve-Implementation-Error-Jul-20-2023.pdf \(caiso.com\)](http://www.caiso.com/Documents/Flexible-Ramping-Product-Enhancements-Demand-Curve-Implementation-Error-Jul-20-2023.pdf)
<http://www.caiso.com/market/Pages/MarketMonitoring/Default.aspx>

Highlights of Q1 and Q2 2023 market performance

- **Natural gas price decreases, lower wholesale electricity price**
- **Expansion of WEIM continues**
- **High uplift costs (both bid cost recovery and offset costs)**
- **Nodal flexible ramping product implementation**
- **Mosaic quantile regression of net load uncertainty**
- **CAISO imbalance conformance**

Lower natural gas prices, lower electricity prices in Q2



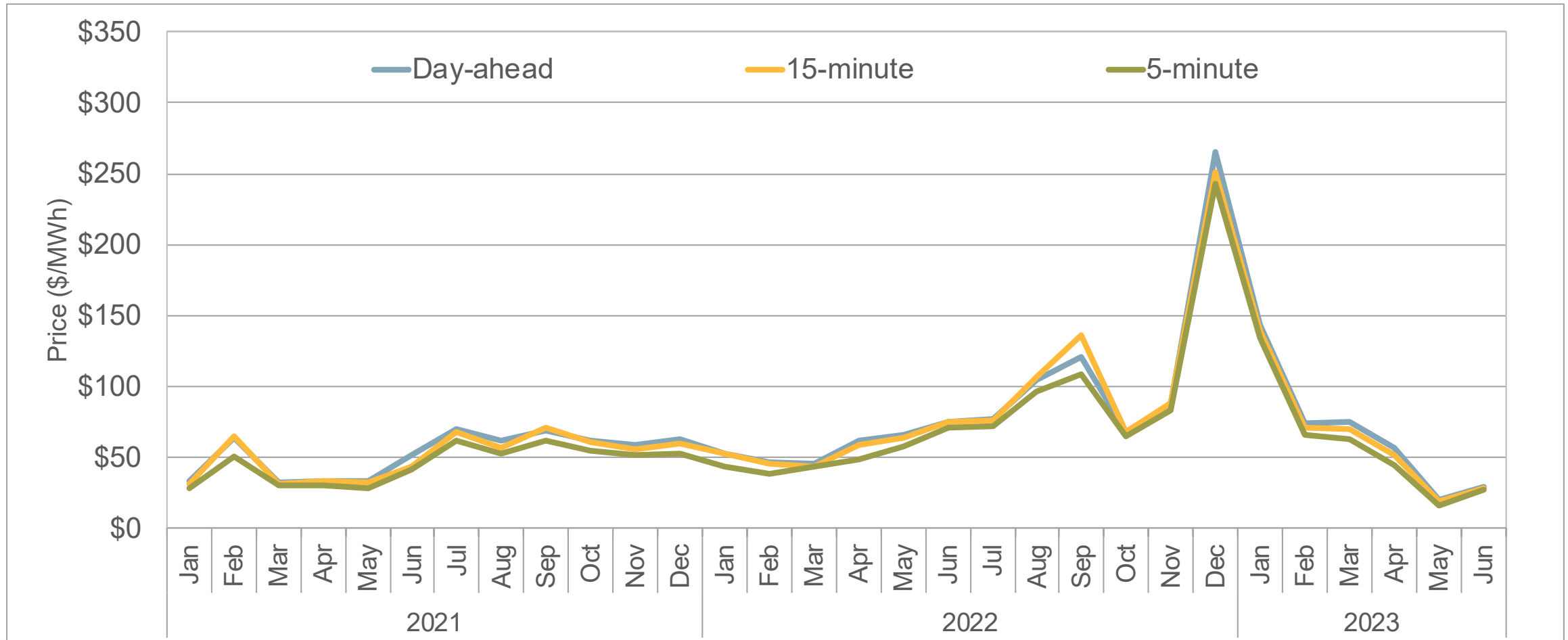
<https://www.cpuc.ca.gov/industries-and-topics/natural-gas/winter-2023-natural-gas-prices>

FERC report: <https://elibrary.ferc.gov/eLibrary/filedownload?fileid=d94641c2-e595-cf21-8bd2-8bd9d3900000>

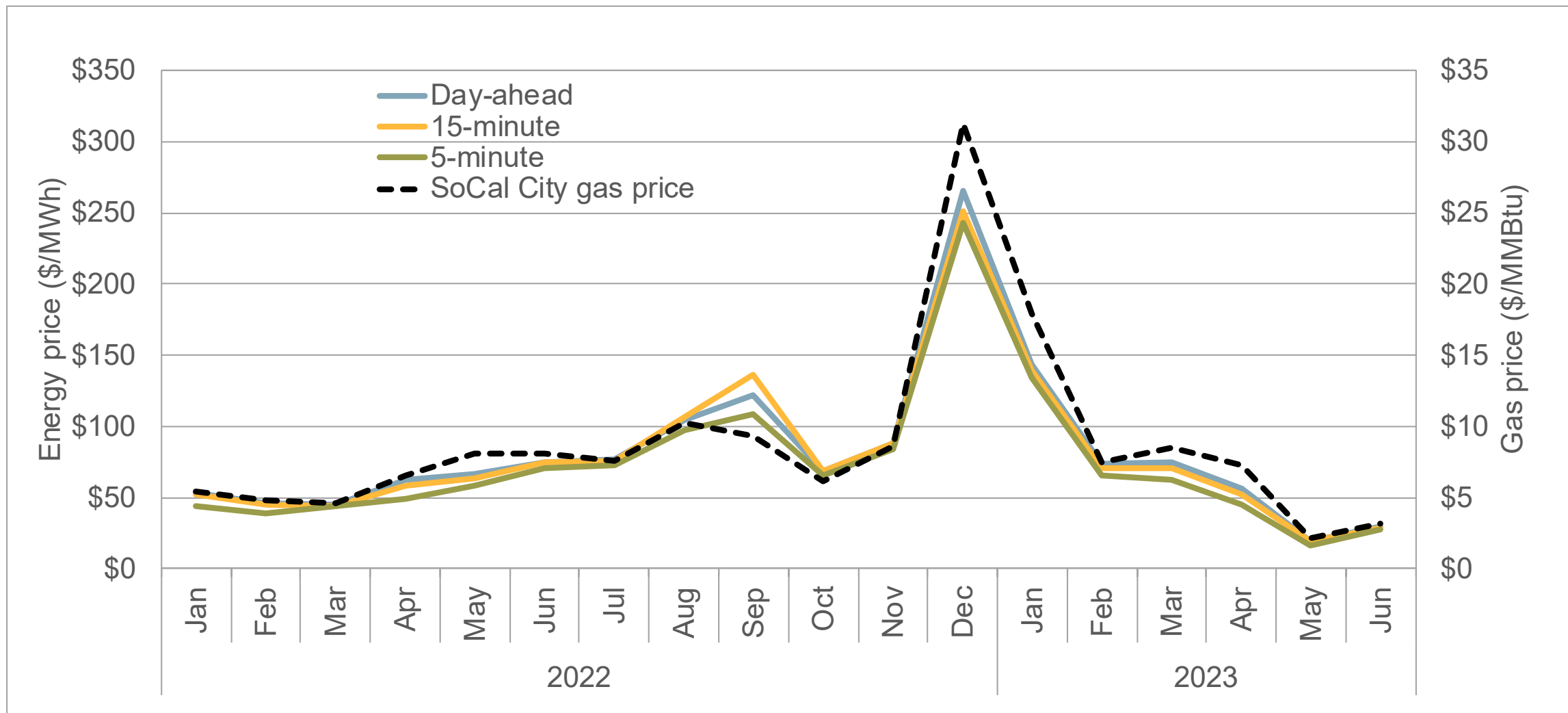
CAISO prices move with gas prices and electricity demand

Q1 CAISO day-ahead \$97/MWh, 15-minute \$93/MWh, 5-minute \$87/MWh

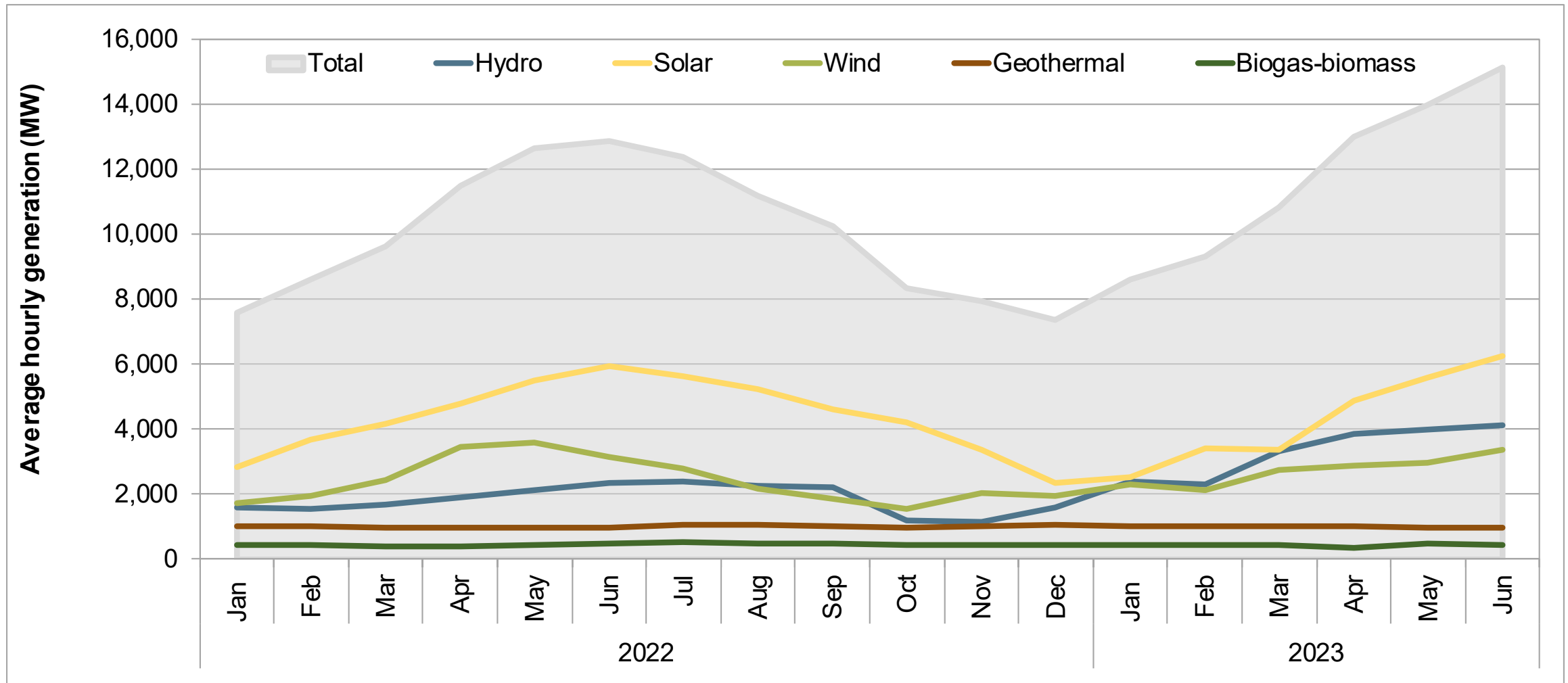
Q2 CAISO day-ahead \$35/MWh, 15-minute \$33/MWh, 5-minute \$29/MWh



As gas prices have fallen in 2023, so have electricity prices



High CAISO renewables, lower prices

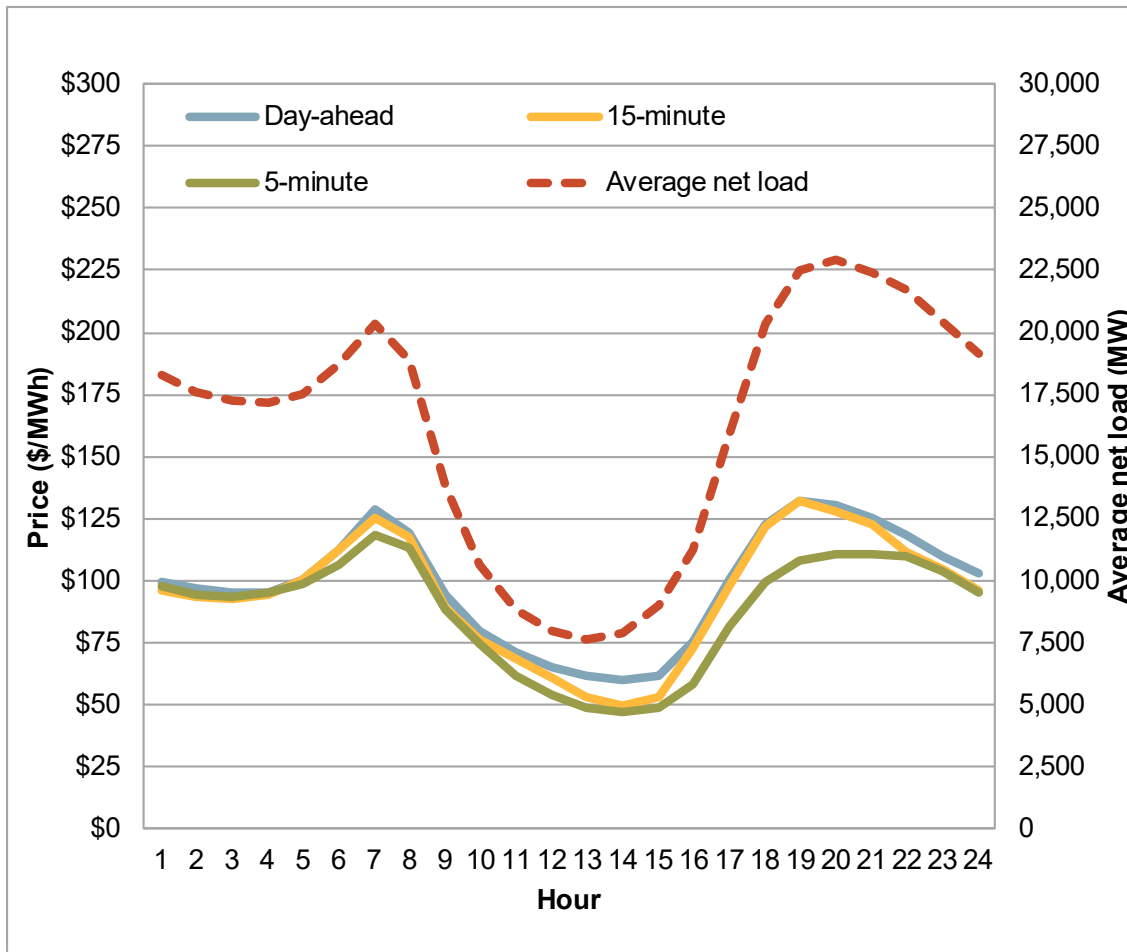


Frequency of low CAISO prices (\$/MWh) by month

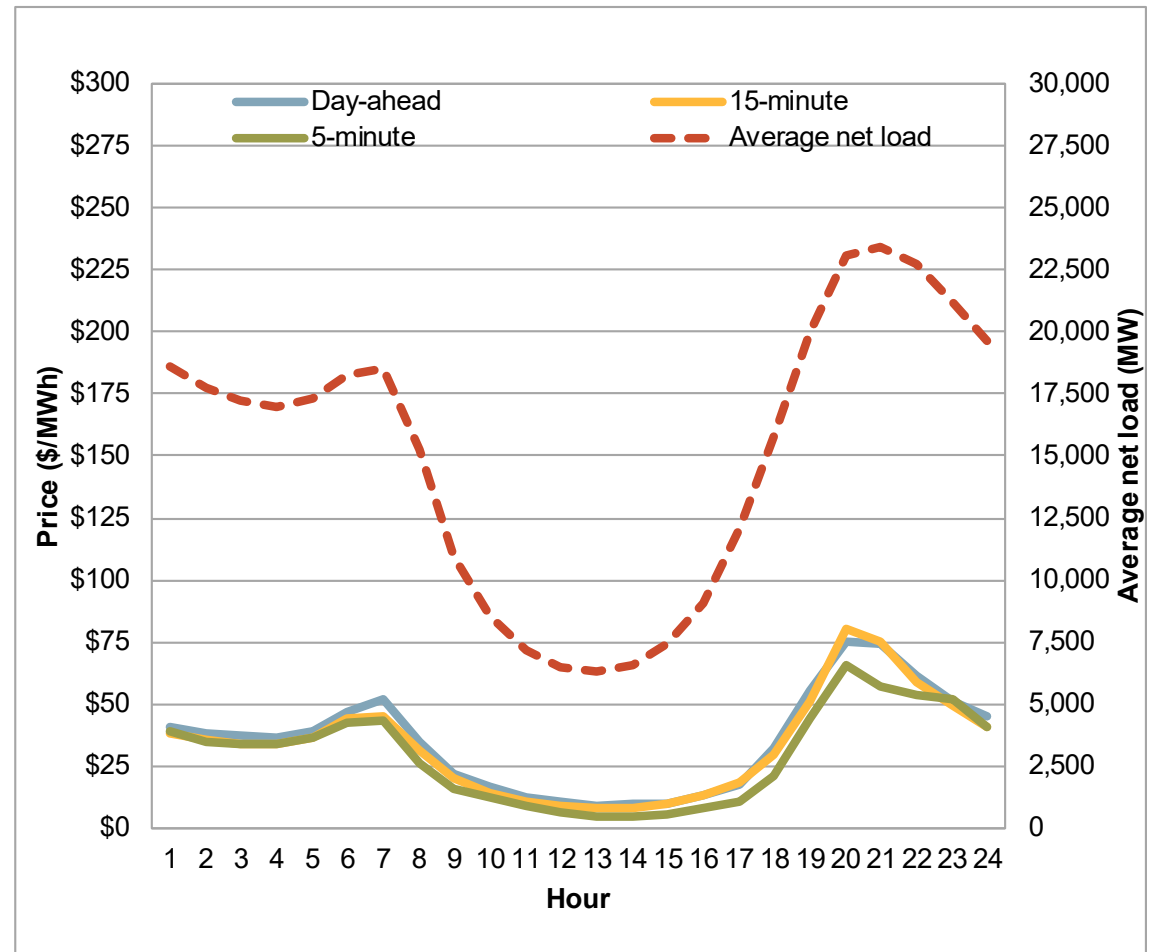


Average hourly CAISO prices mirror net load, with day-ahead and 15-minute prices lower than 5-minute in peak hours, lower in Q2

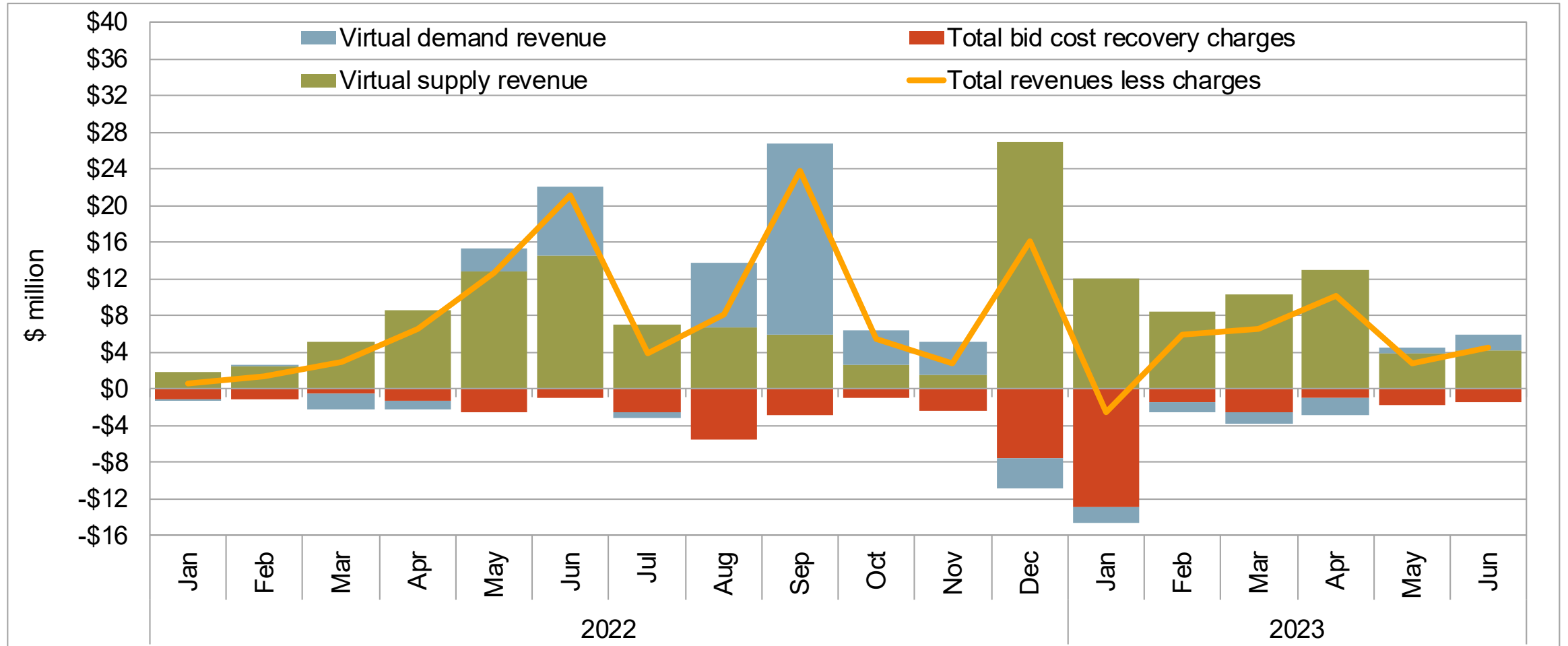
Q1 2023



Q2 2023

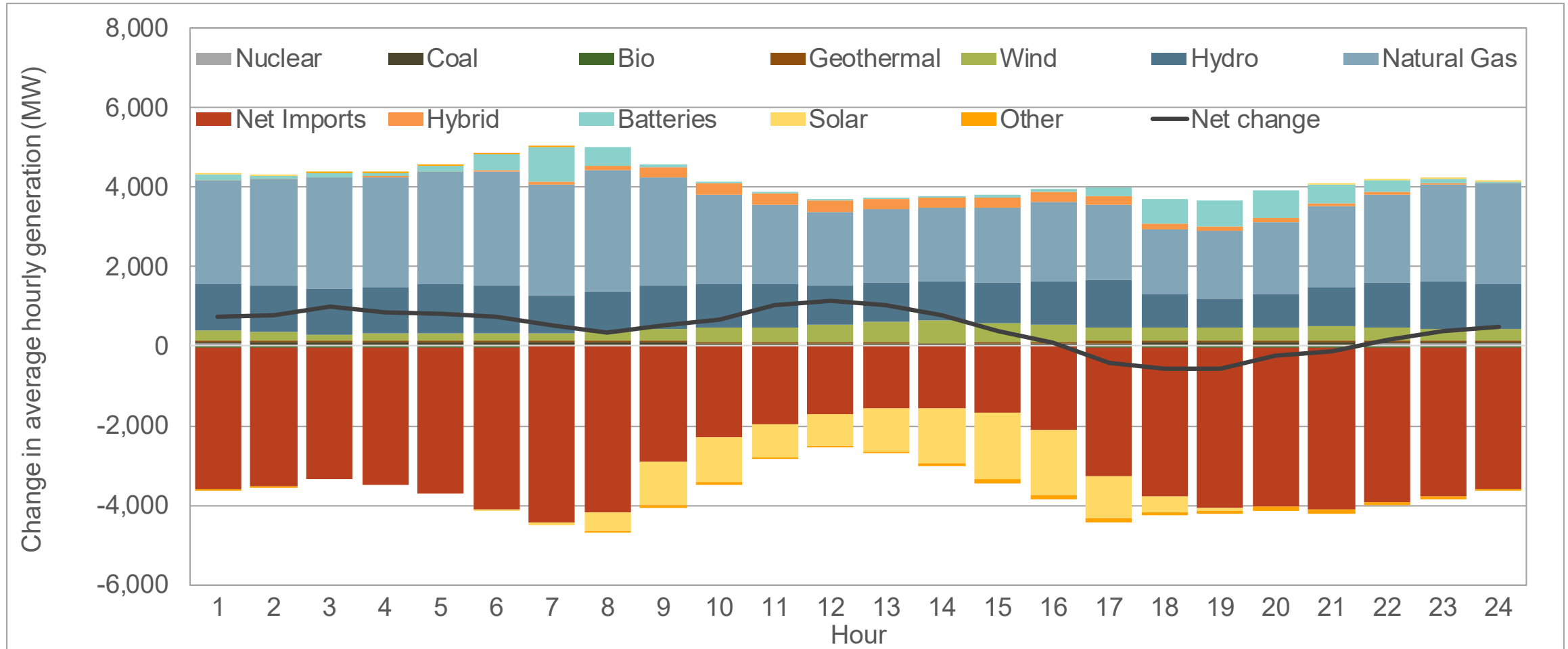


Convergence bidding net profits fell to \$9.9 million in Q1 and \$17.5 million in Q2, from \$106 million in 2022 and \$36 million in 2021



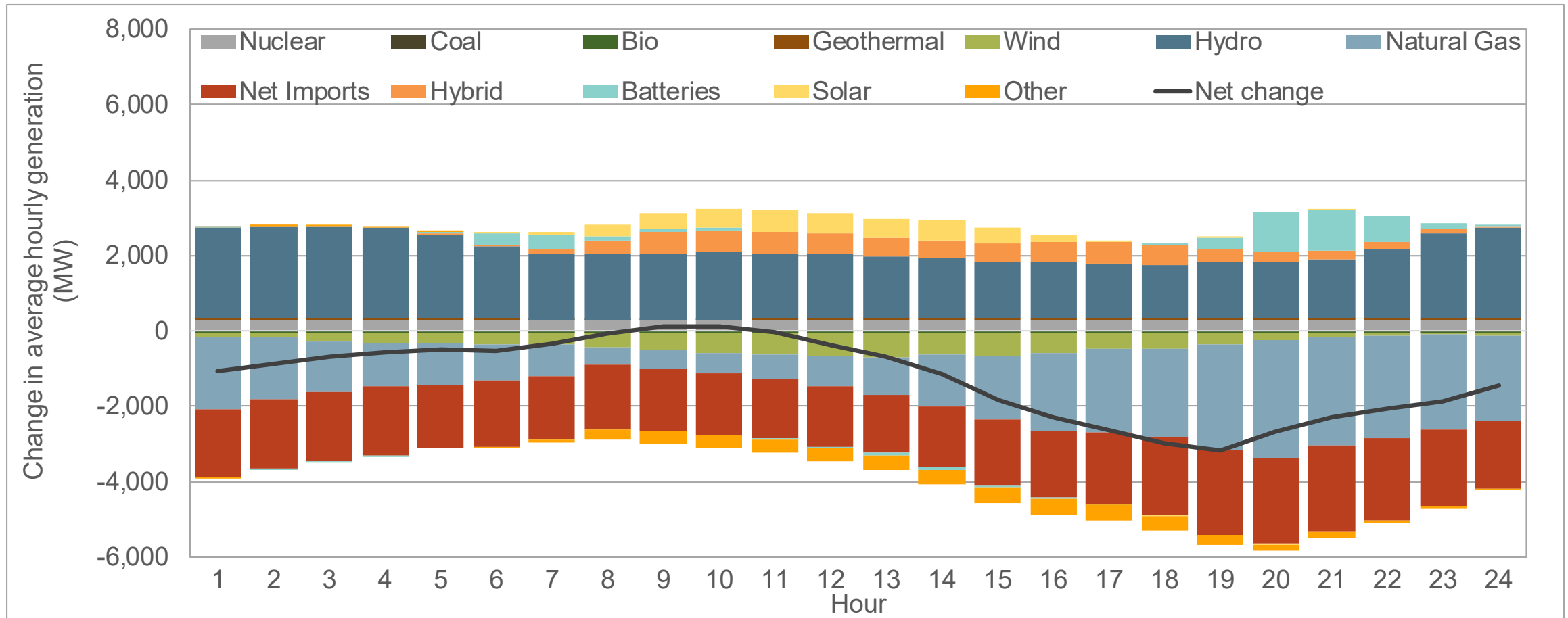
Lower imports replaced by natural gas, solar, and storage

Change in average hourly generation by fuel type (Q1 2022 to Q1 2023)

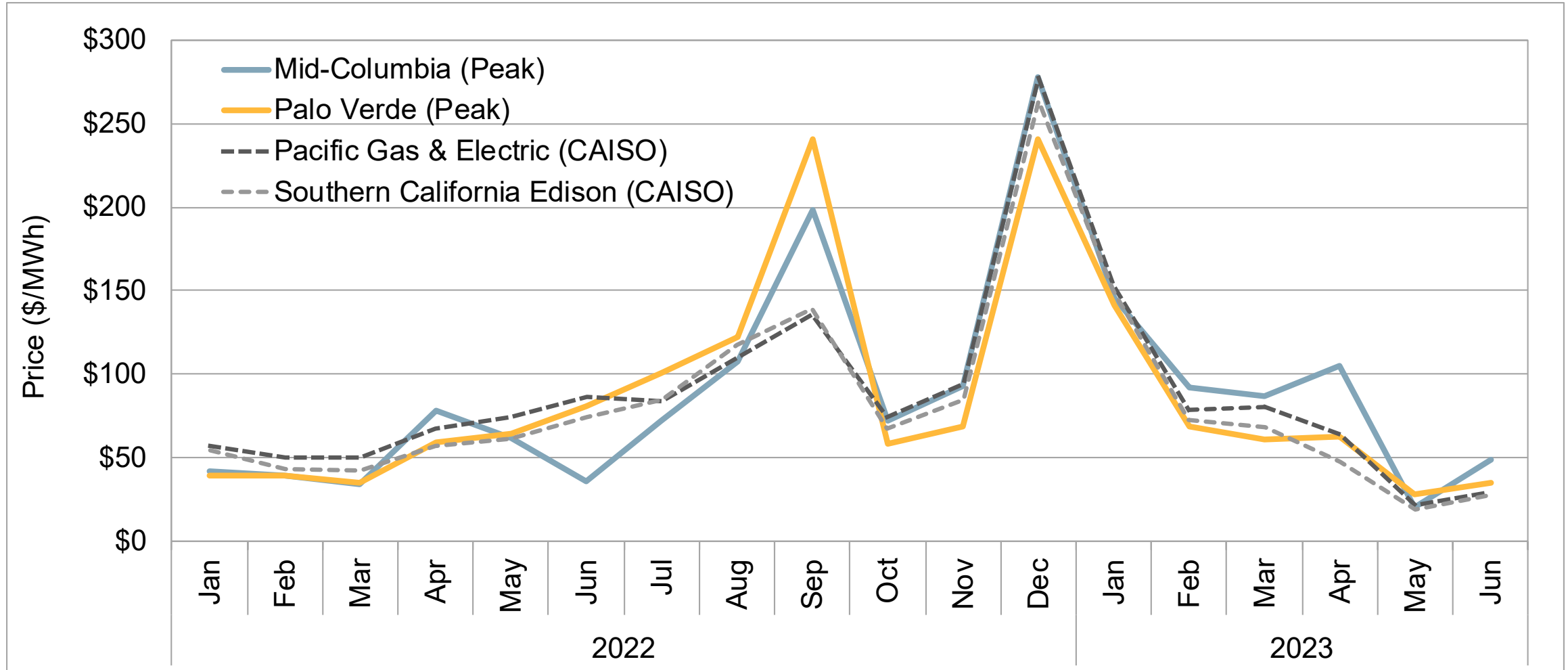


Lower imports and natural gas replaced by hydro, solar, and storage

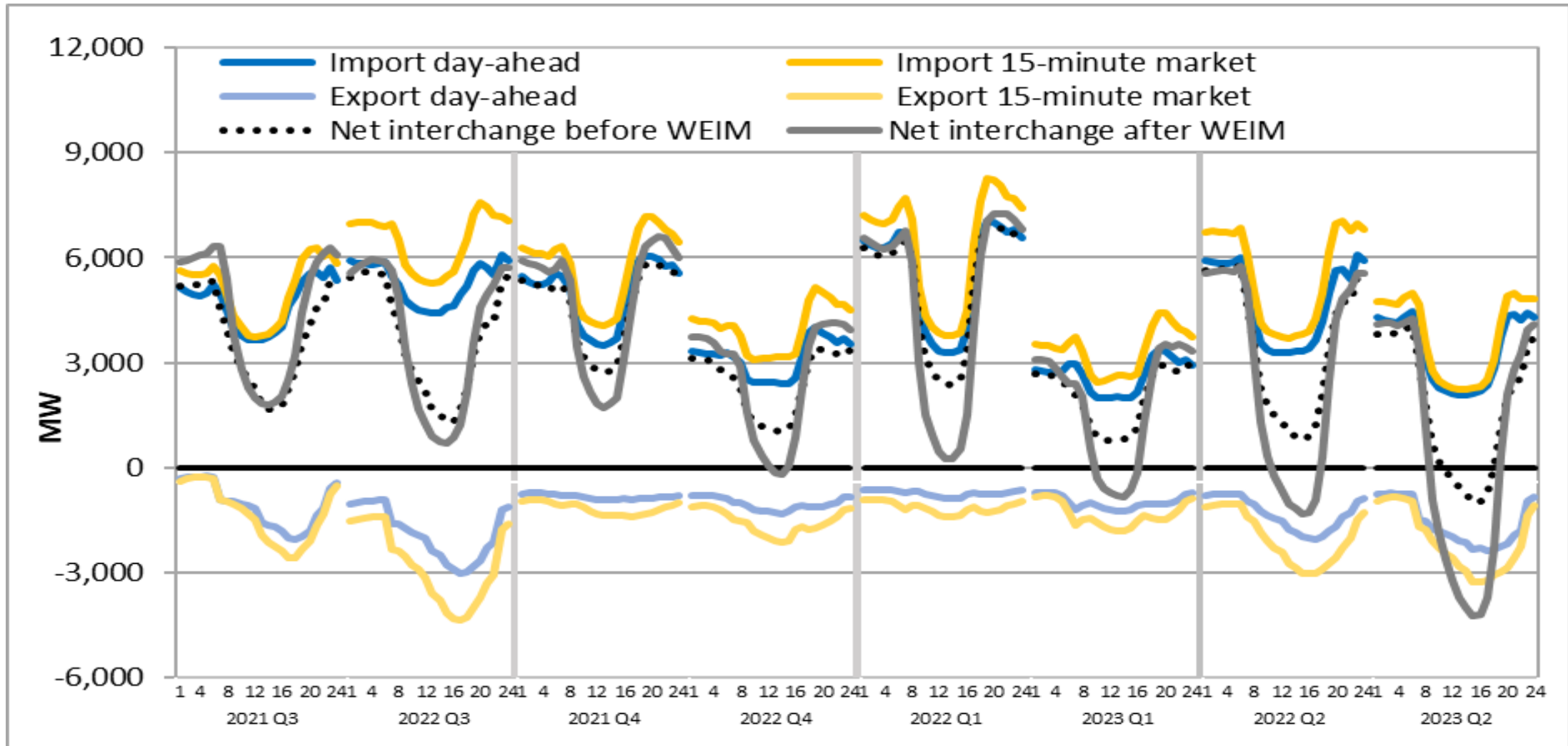
Change in average hourly generation by fuel type (Q2 2022 to Q2 2023)



Day-ahead California ISO and bilateral market prices



Average imports decrease and exports increase in Q1 and Q2



Expansion of the Western Energy Imbalance Market (WEIM) helped improve the overall structure and performance of the real-time market



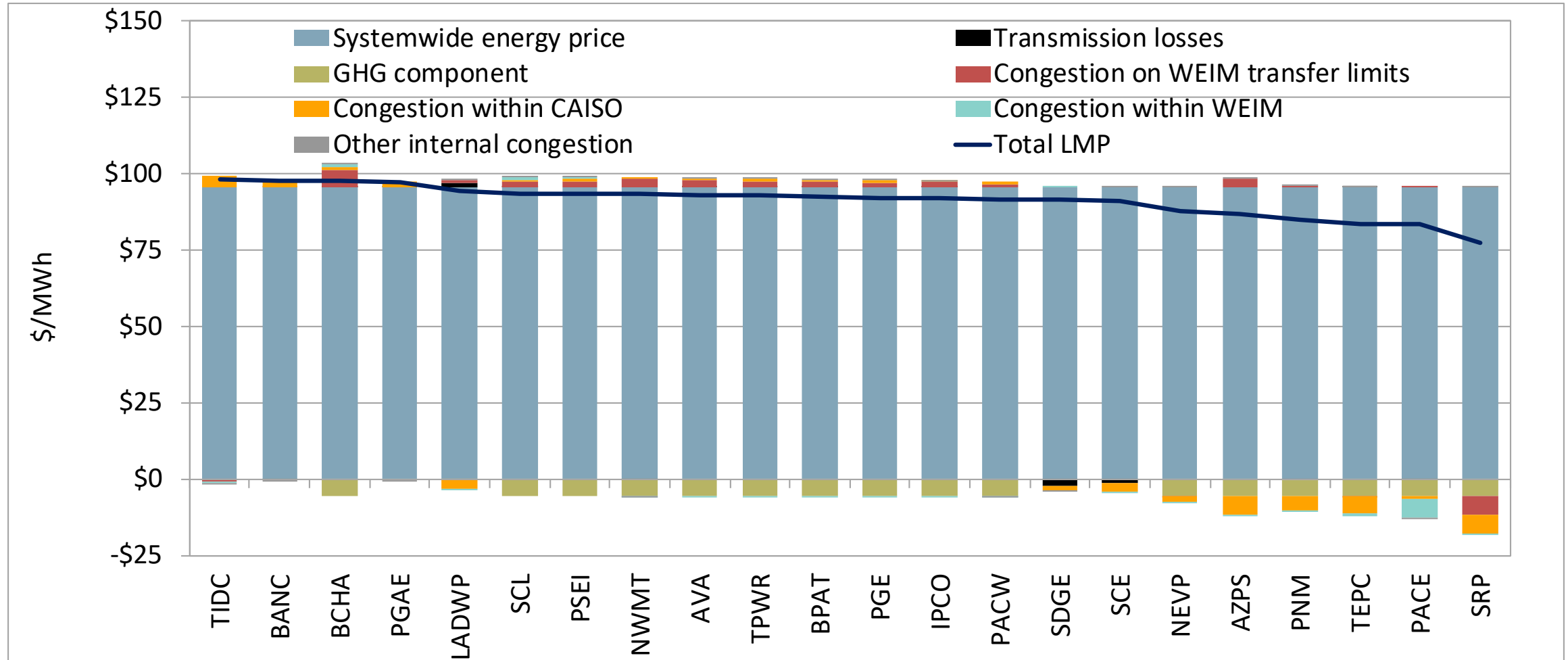
- Two new members of the WEIM in 2020
- Five new members of the WEIM in 2021
- Four new members of the WEIM in 2022
- Three new members in 2023:
 - El Paso Electric
 - WAPA Desert Southwest
 - Avangrid
- Price separation typically due to limited transfer capability into an area
- Peak California area prices exceed other areas due to GHG and congestion

**Avangrid office; generation-only BAA with distribution across multiple states.
Map boundaries are approximate and for illustrative purposes only.*

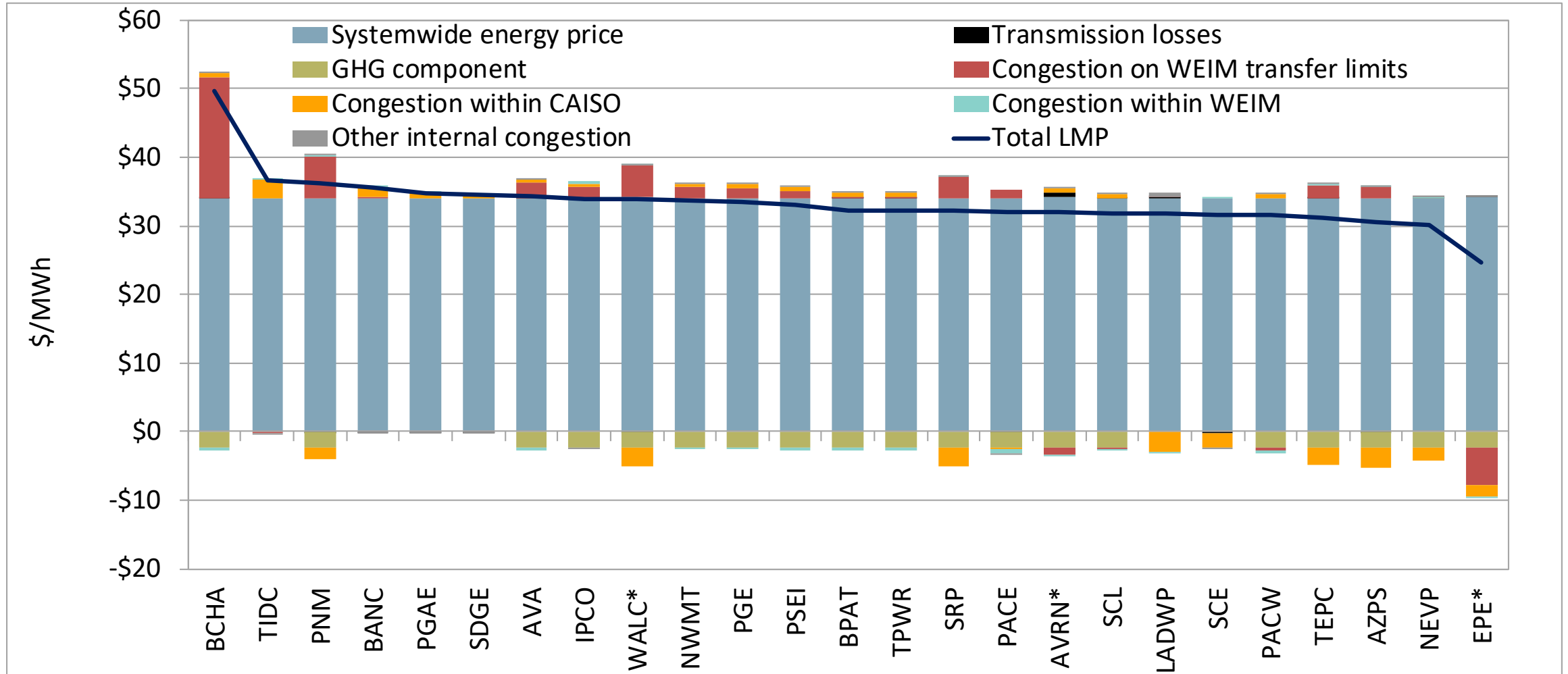
Q2 average 15-minute transfer limit

Region/ balancing area	Total import limit	Total export limit	Out-of-region import limit	Out-of-region export limit
California			26,792	32,684
California ISO	34,764	35,930	23,595	28,250
BANC	3,528	3,449	0	0
LADWP	7,257	11,936	3,197	4,434
Turlock Irrig. District	1,393	1,518	0	0
Desert Southwest			33,589	28,253
Arizona Public Service	36,249	28,335	25,495	19,339
El Paso Electric*	463	415	0	0
NV Energy	4,903	4,818	3,470	3,156
PSC New Mexico	1,001	1,213	0	0
Salt River Project	8,419	9,879	1,775	2,610
Tucson Electric	4,498	5,666	732	874
WAPA - Desert SW*	6,434	6,305	2,116	2,274
Mountain Northwest			2,366	2,637
Avista Utilities	679	967	106	87
Idaho Power	2,443	2,768	691	709
NorthWestern Energy	736	696	25	8
PacifiCorp East	3,307	3,006	1,544	1,833
Pacific Northwest			1,446	618
Avangrid*	679	703	0	0
Powerex	610	50	560	0
BPA	683	915	136	148
PacifiCorp West	1,535	1,348	484	300
Portland General Electric	726	675	137	85
Puget Sound Energy	1,230	1,065	98	56
Seattle City Light	431	420	30	30
Tacoma Power	338	227	0	0

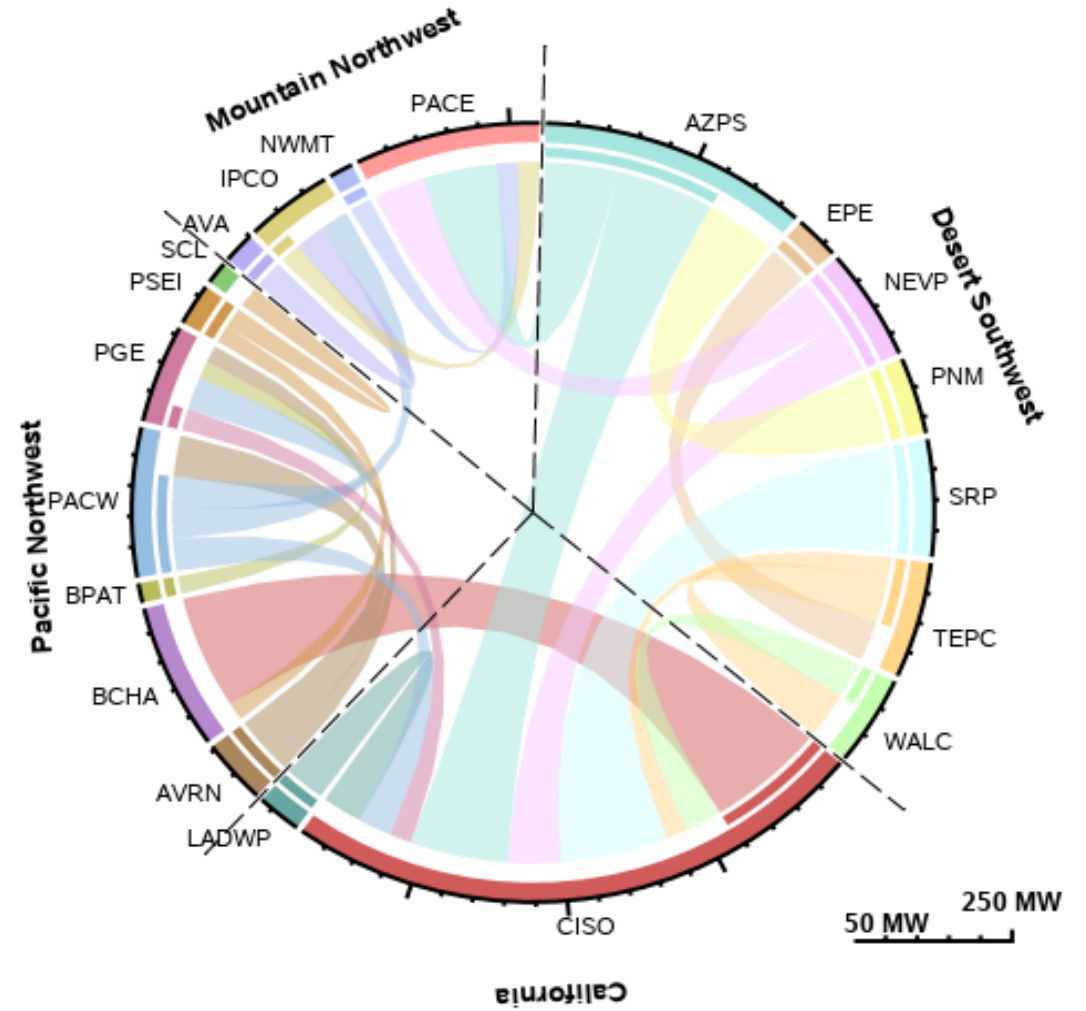
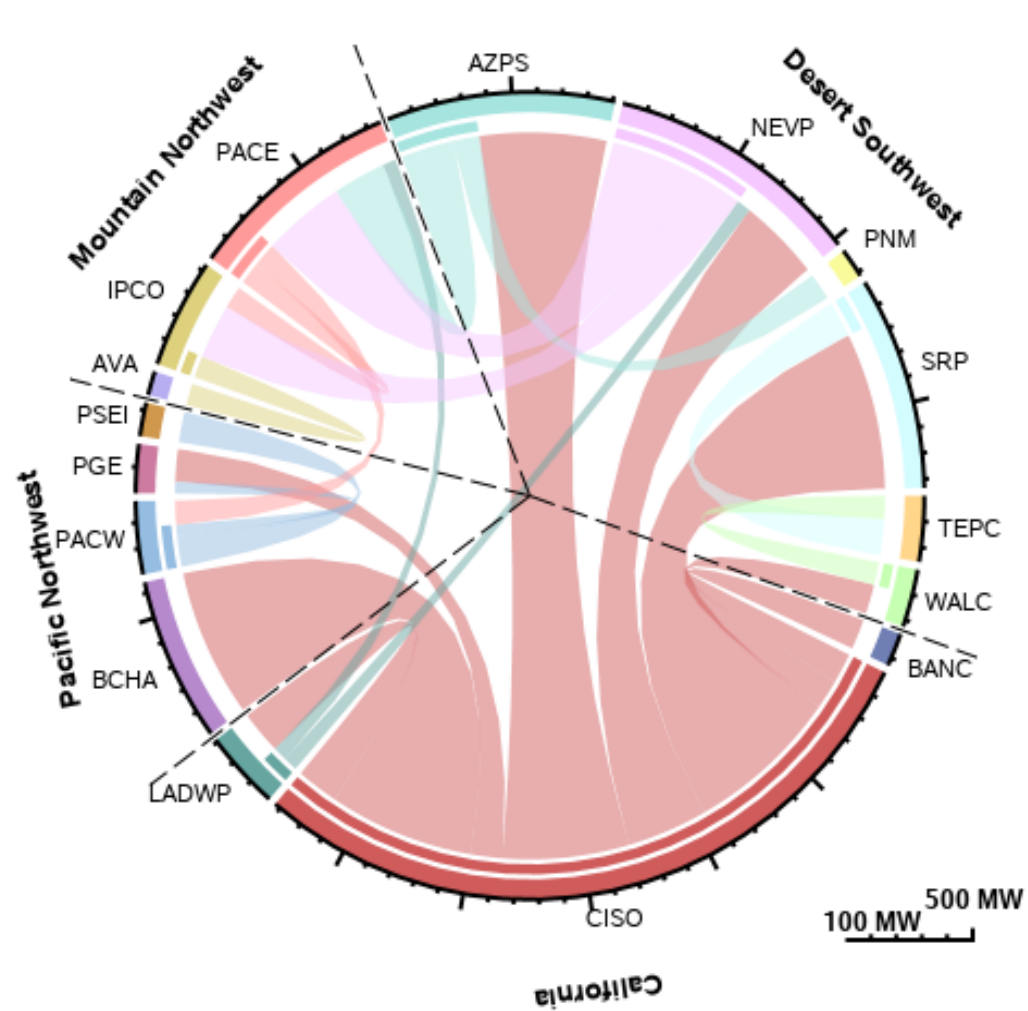
Impact of congestion and greenhouse gas on 15-minute prices (Q1)



Impact of congestion and greenhouse gas on 15-minute prices (Q2)



Average 15-minute WEIM exports mid-day and peak hours Q2 2023

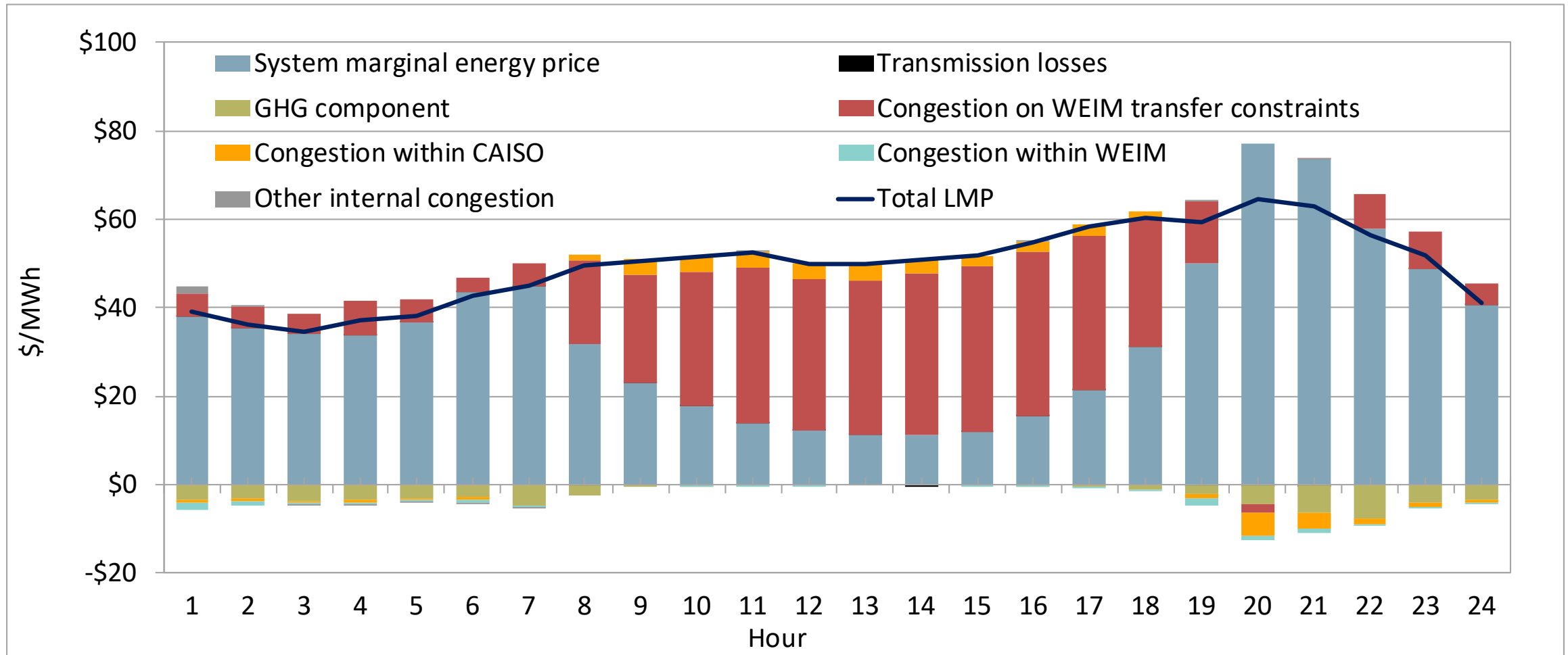


WEIM transfer constraint congestion had greater impact on prices than internal constraint congestion in most areas outside of CAISO, increasing prices in Northwest

	15-minute market				5-minute market			
	Congested from area		Congested into area		Congested from area		Congested into area	
	Congestion Frequency	Price Impact (\$/MWh)	Congestion Frequency	Price Impact (\$/MWh)	Congestion Frequency	Price Impact (\$/MWh)	Congestion Frequency	Price Impact (\$/MWh)
BANC	0.0%	\$0.00	0.0%	\$0.00	0.0%	\$0.00	0.1%	\$0.06
L.A. Dept. of Water and Power	0.1%	-\$0.02	0.0%	\$0.04	0.2%	-\$0.05	0.1%	\$0.13
Turlock Irrigation District	0.5%	-\$0.17	0.0%	\$0.00	0.4%	-\$0.08	0.0%	\$0.01
NV Energy	0.3%	-\$0.28	0.1%	\$0.35	0.3%	-\$0.38	0.2%	\$0.53
Arizona Public Service	0.5%	-\$0.44	0.2%	\$1.76	0.5%	-\$0.57	0.4%	\$2.34
Public Service Company of NM	1.1%	-\$1.08	1.3%	\$7.22	0.8%	-\$0.74	1.2%	\$5.07
PacifiCorp East	0.1%	-\$0.01	10%	\$1.26	0.0%	\$0.00	7.1%	\$1.29
WAPA – Desert Southwest*	3.6%	-\$1.56	7.7%	\$6.10	4.9%	-\$2.10	6.4%	\$4.86
Tucson Electric Power	2.5%	-\$0.34	11%	\$2.36	1.9%	-\$0.17	13%	\$3.48
Idaho Power	6.1%	-\$1.10	11%	\$2.86	4.7%	-\$0.81	9.1%	\$2.97
NorthWestern Energy	8.2%	-\$1.69	13%	\$3.36	6.4%	-\$1.19	12%	\$4.08
Salt River Project	6.9%	-\$1.63	13%	\$4.76	7.9%	-\$1.99	12%	\$8.12
Avista Utilities	8.1%	-\$1.59	14%	\$3.82	6.4%	-\$1.24	13%	\$4.05
Avangrid Renewables*	23%	-\$4.66	16%	\$3.28	17%	-\$3.14	13%	\$3.39
PacifiCorp West	23%	-\$4.40	17%	\$3.83	16%	-\$2.73	14%	\$3.84
Portland General Electric	22%	-\$4.32	18%	\$5.71	16%	-\$2.68	15%	\$5.57
Seattle City Light	23%	-\$4.64	22%	\$4.39	18%	-\$3.31	20%	\$4.56
Puget Sound Energy	23%	-\$4.43	22%	\$5.45	18%	-\$3.17	20%	\$5.16
Tacoma Power	23%	-\$4.44	22%	\$4.47	18%	-\$3.12	20%	\$4.64
Bonneville Power Admin.	23%	-\$5.73	23%	\$5.87	18%	-\$4.00	21%	\$5.50
El Paso Electric Company*	27%	-\$7.07	17%	\$2.14	24%	-\$6.49	20%	\$2.88
Powerex	16%	-\$3.10	50%	\$20.50	20%	-\$3.28	58%	\$22.31

Balancing area WEIM transfer and prices published for each area

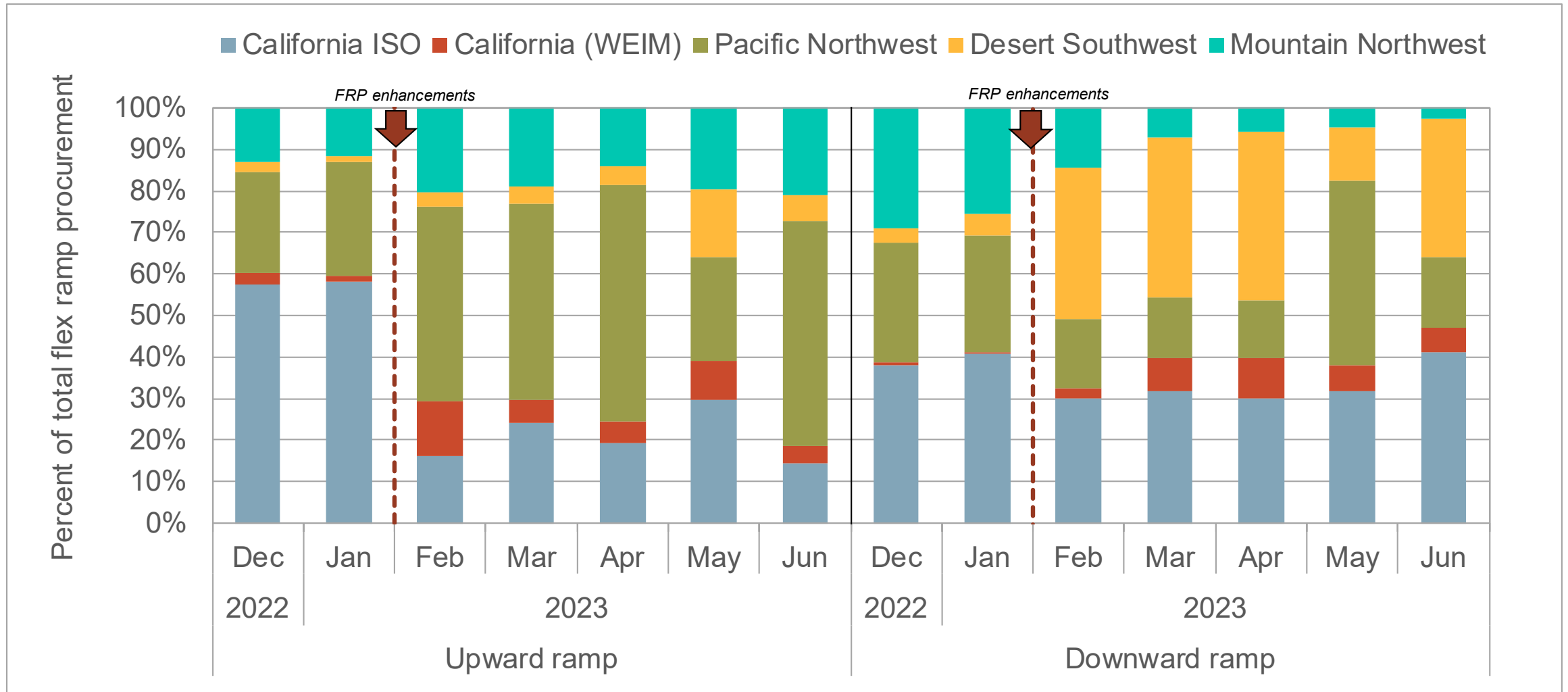
Powerex average hourly 15-minute price by component (Q2 2023)



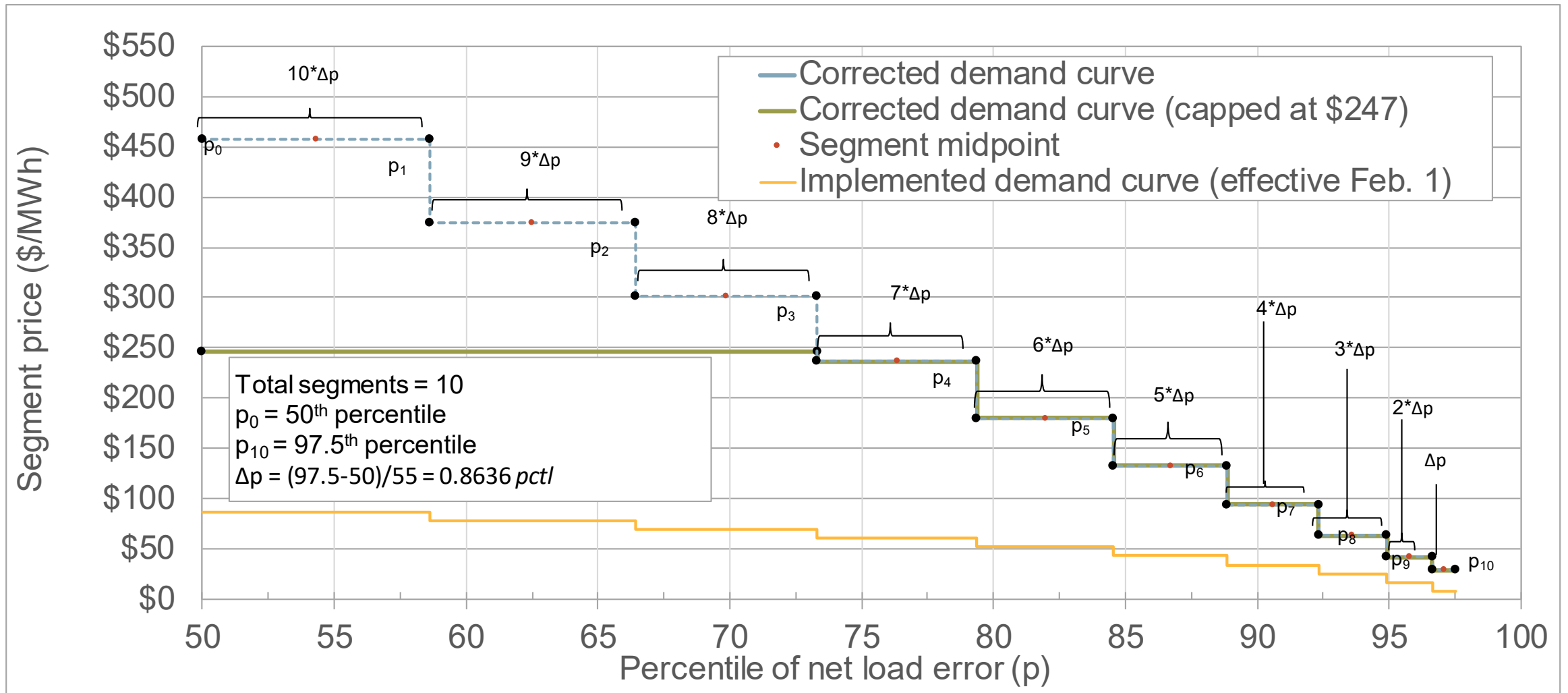
Flexible ramping capacity

- Designed to enhance reliability and market performance by procuring real-time ramping capacity to help manage variability and uncertainty
- Flexible ramping prices were very frequently zero
- DMM supported the ISO's Feb 2023 implementation of (nodal procurement):
 - Reduces procurement of capacity from resources not able to meet system uncertainty because of congestion
 - Demand curve implementation error fixed in October
 - Mosaic quantile regression of net load uncertainty duplicated – further study recommended
- Uncertainty over load and the future availability of resources to meet that load contributes to operators needing to enter systematic and large imbalance conformance adjustments

Percent of system or pass-group flexible capacity procurement by region



Flexible ramping demand curve implementation issue resolved



<http://www.caiso.com/Documents/Flexible-Ramping-Product-Enhancements-Demand-Curve-Implementation-Error-Jul-20-2023.pdf>

Quantile mosaic regression of net load uncertainty

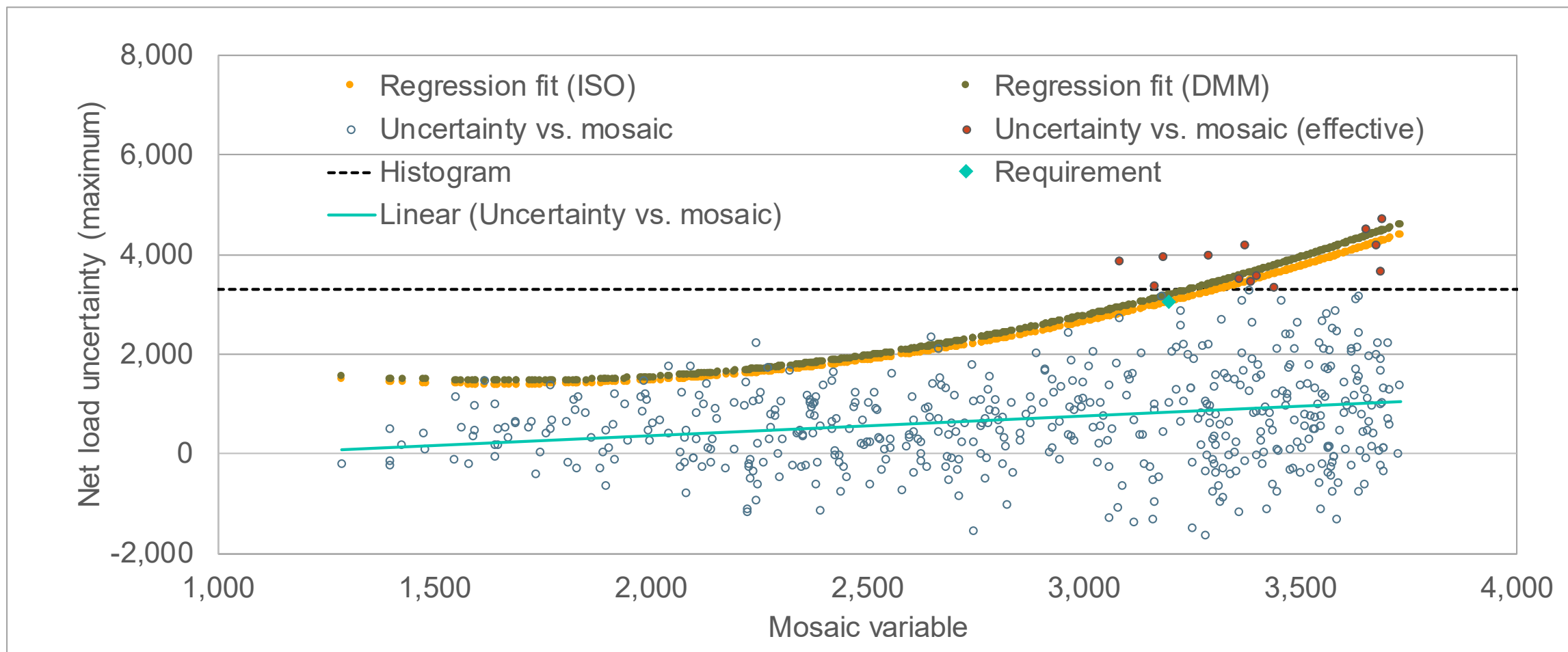
- **The mosaic quantile regression model has limited predictive capability** for forecasting net load uncertainty
- **The results from the mosaic quantile regression closely resemble the histogram model**, highlighting the weak relationship between net load uncertainty and the mosaic variable
- **The quantile regression relies on a limited sample size, which may compromise the validity of the regression model**
- **The performance of the quantile regression and histogram methods is quite similar, with neither method showing clear dominance in accuracy or efficiency**
- **The mosaic quantile regression model has a specification error involving the use of unintended information in forecasting, along with unnecessary steps that do not influence the outcome**

<http://www.caiso.com/Documents/Review-of-the-Mosaic-Quantile-Regression-Nov-20-2023.pdf>

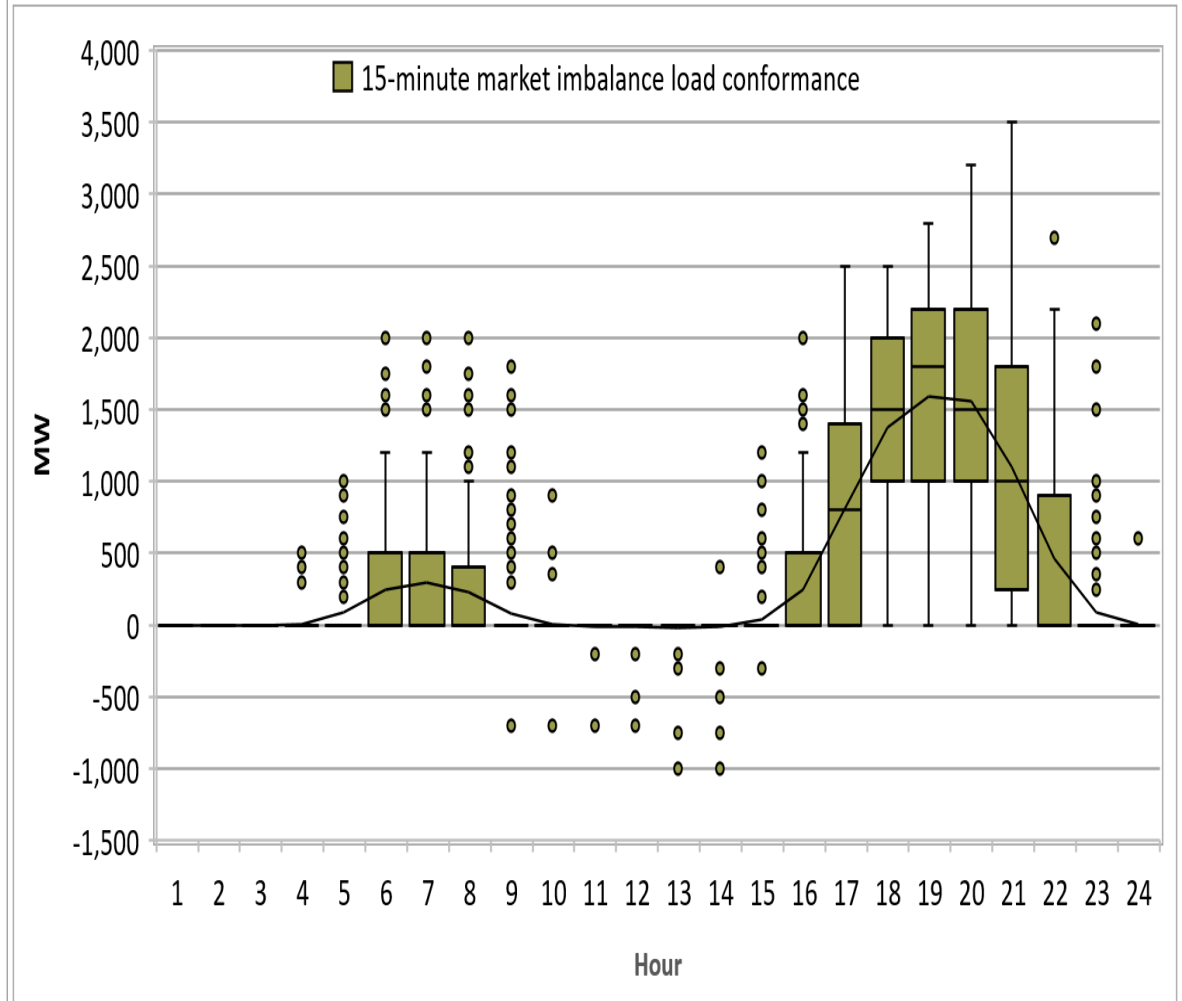
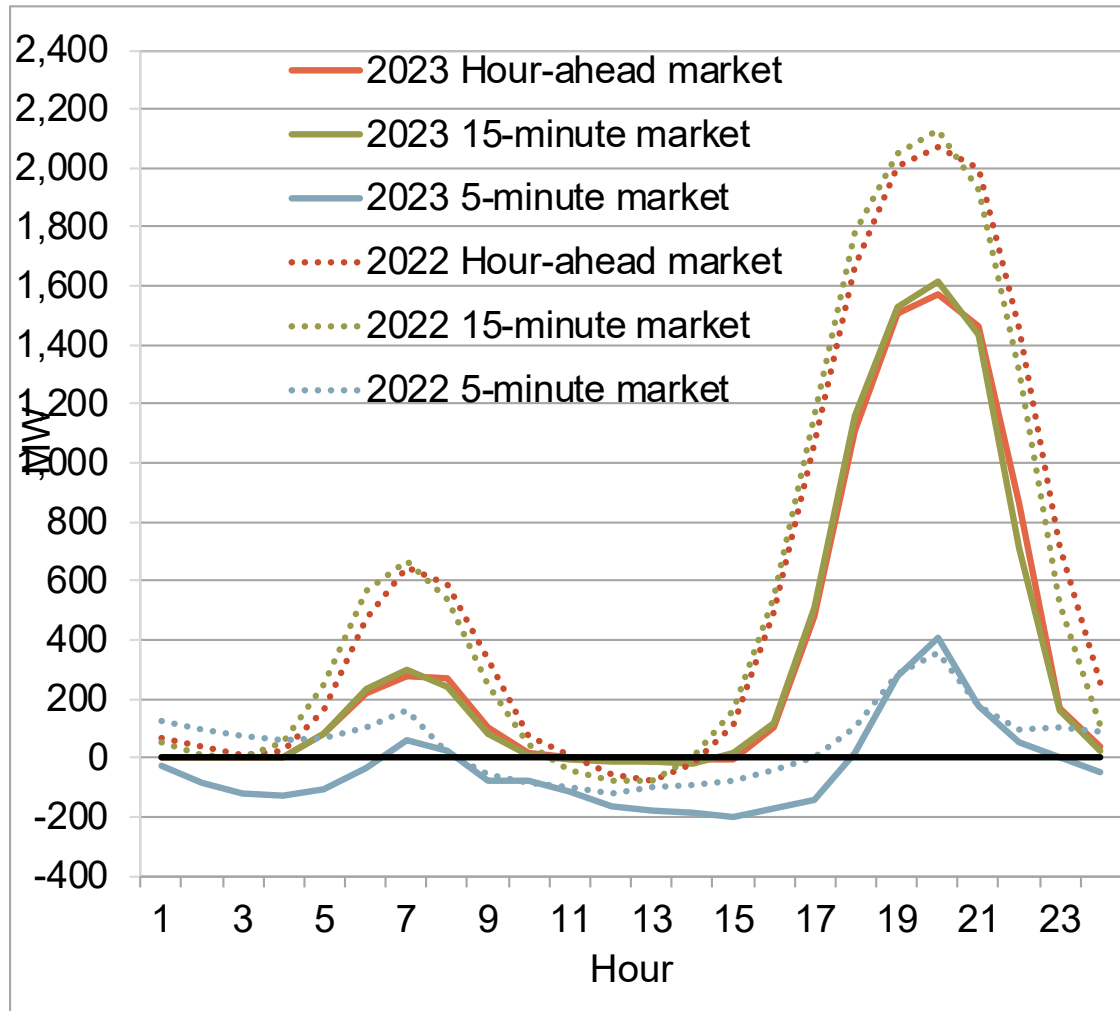
DMM recommendations for net load uncertainty forecasting

- Develop separate models of net load uncertainty for each of the five current and potential future market features in which the ISO incorporates uncertainty
- Review other options
- Consider reverting to the histogram approach for the current flexible ramping product and the resource sufficiency evaluation
- If the ISO retains the existing mosaic quantile regression, the limited sample size and technical errors in the formulation should be resolved
- DMM recommends that a much more simplified approach be considered for incorporating uncertainty into resource sufficiency evaluations
 - requirements could be based on a very simplified approach based on the amount of load, wind, and solar each hour within each balancing area

Mosaic quantile regression fit for upward pass-group uncertainty (hour-ending 9, February 15, 2023)

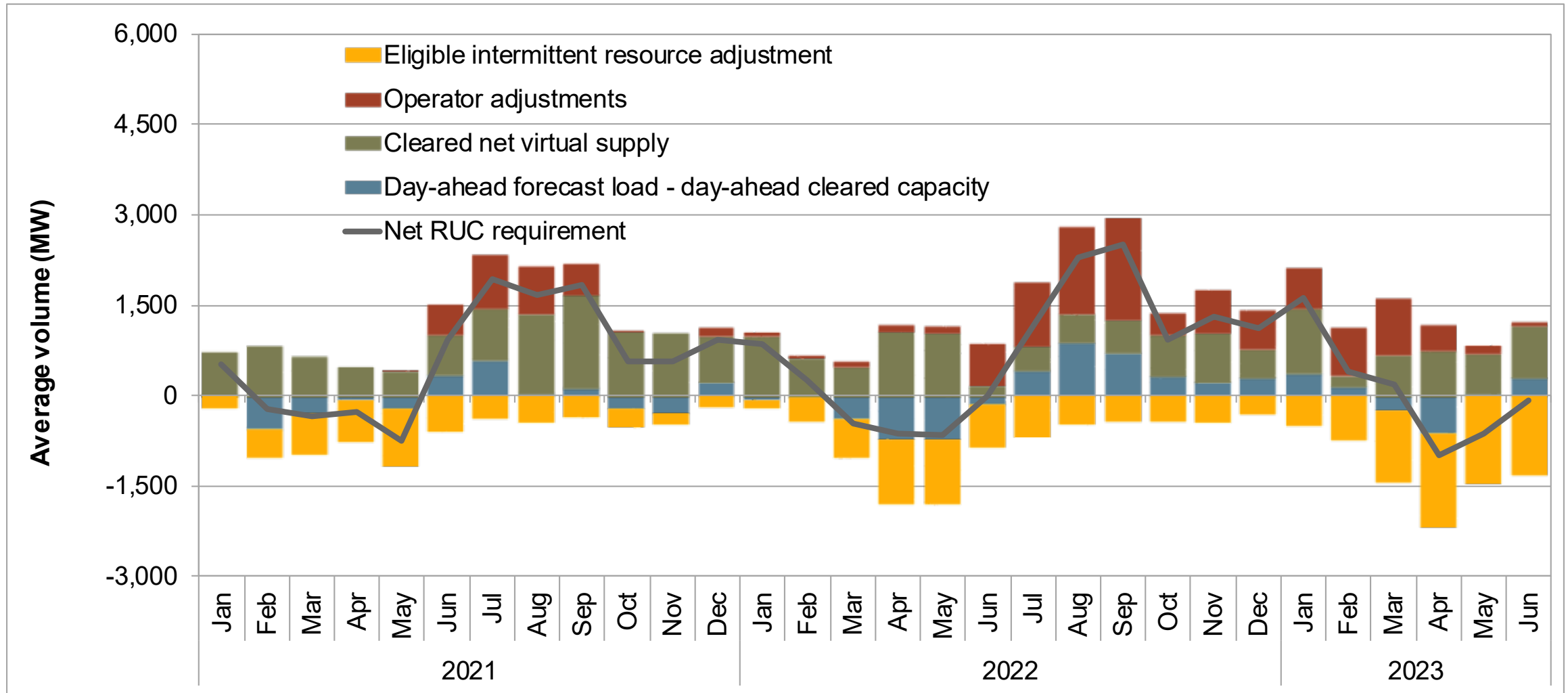


Load adjustment by grid operators decreased in Q2

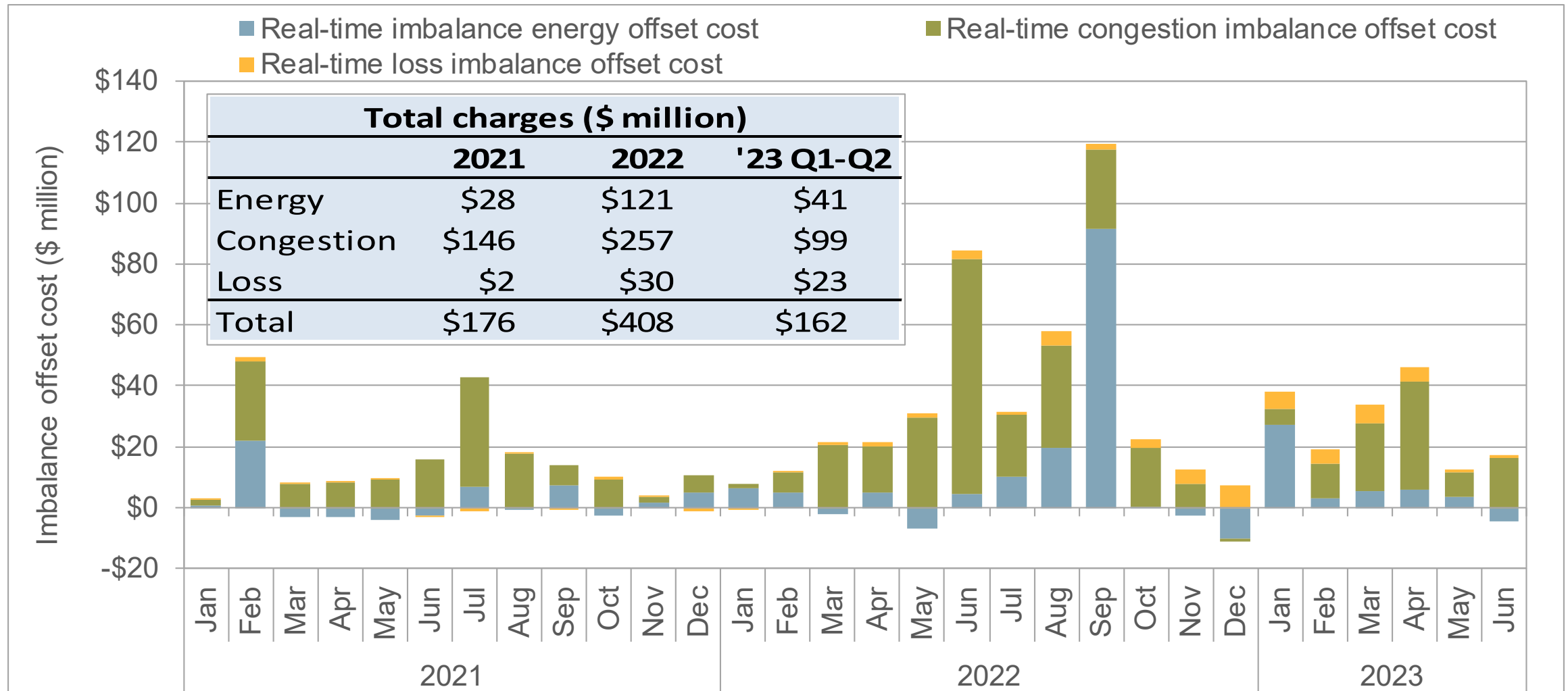


[Analysis-LoadConformanceImpactonResourceSufficiencyEvaluation.pdf \(caiso.com\)](#)

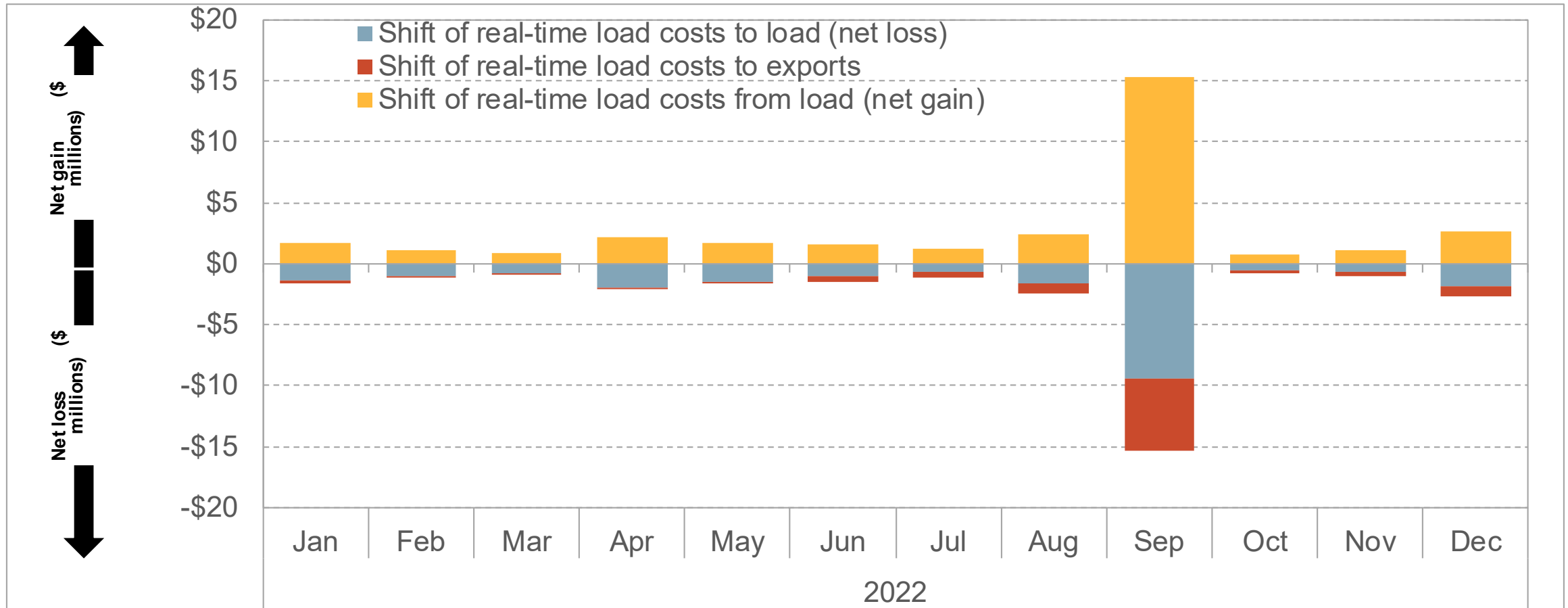
Determinants of residual unit commitment procurement



Real-time imbalance offset costs increased to \$162 million in first half of 2023

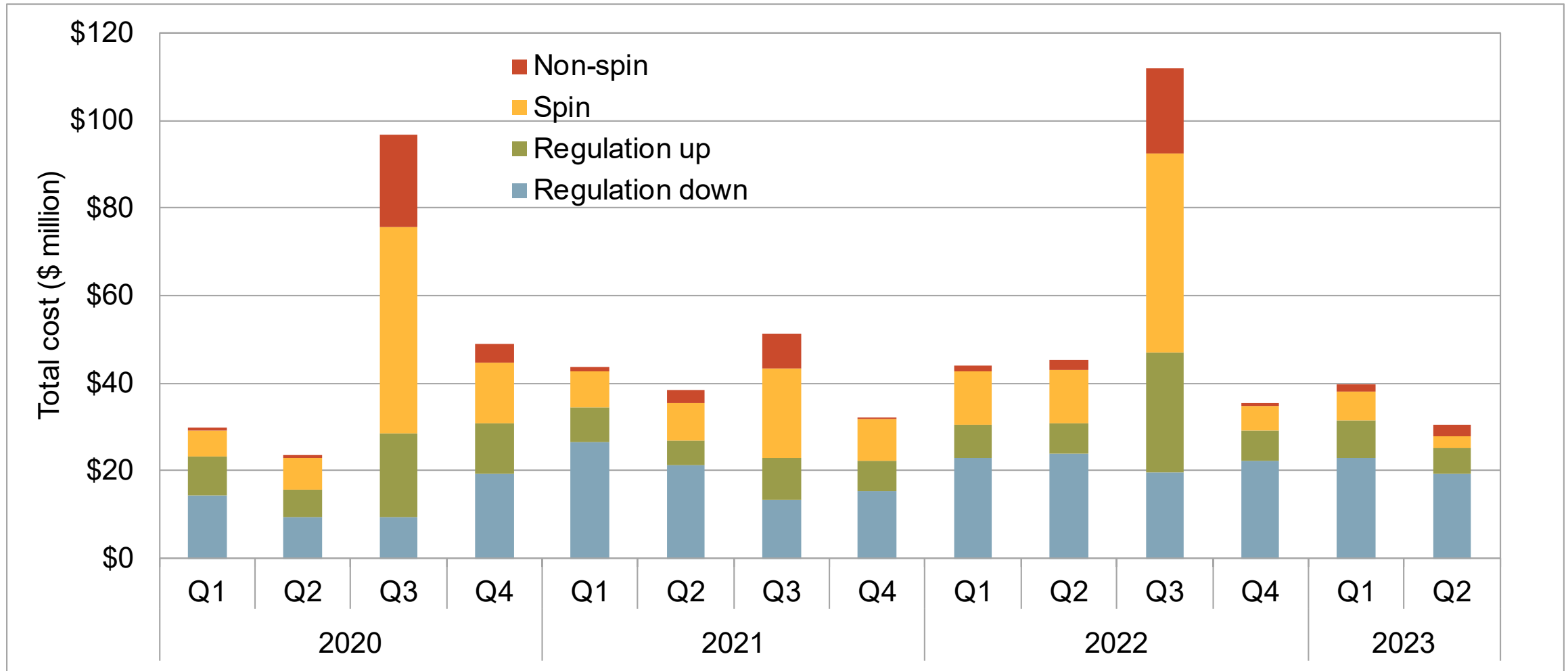


Settling load incrementally, as generation is settled, would change the distribution of real-time energy costs between exporters and load serving entities with metered load

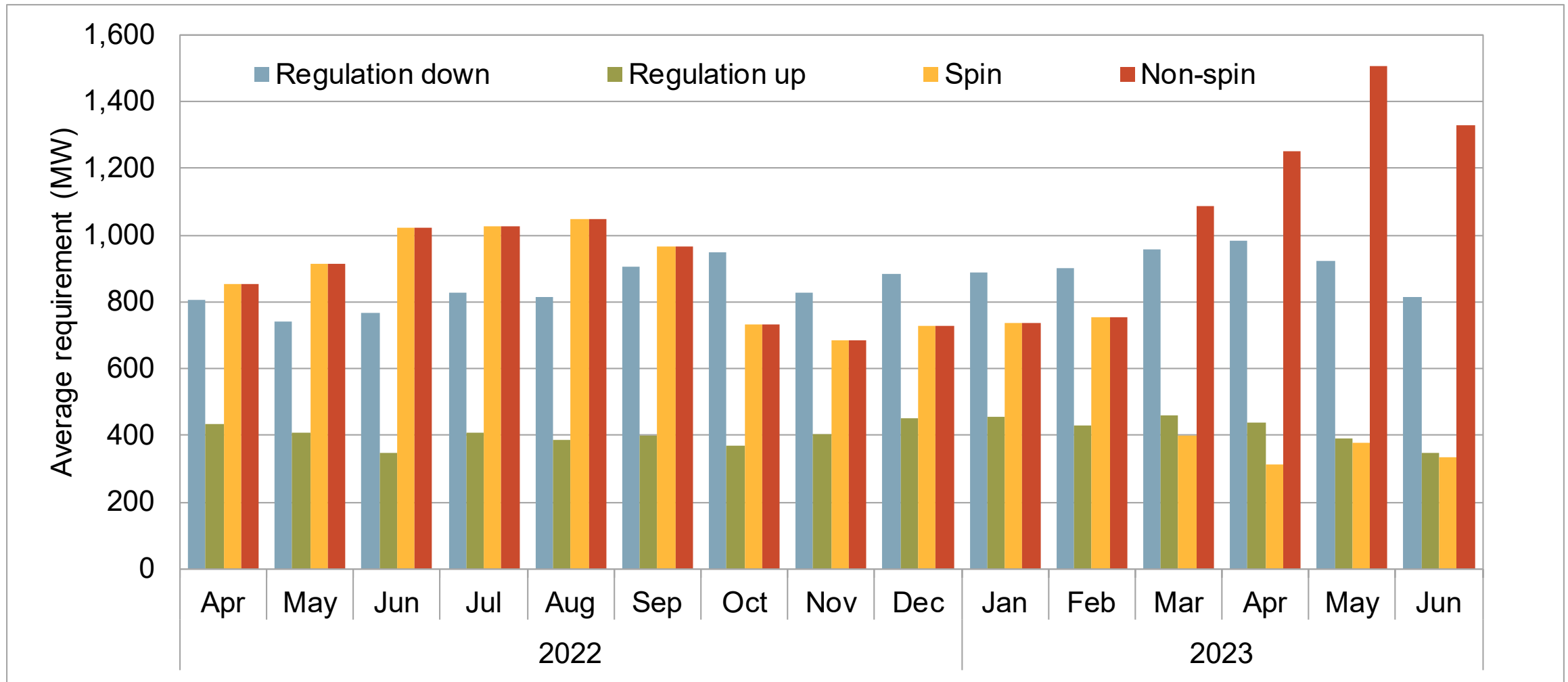


<http://www.caiso.com/Documents/Real-Time-Load-Settlements-and-Revenue-Imbalances-Aug-30-2023.pdf>

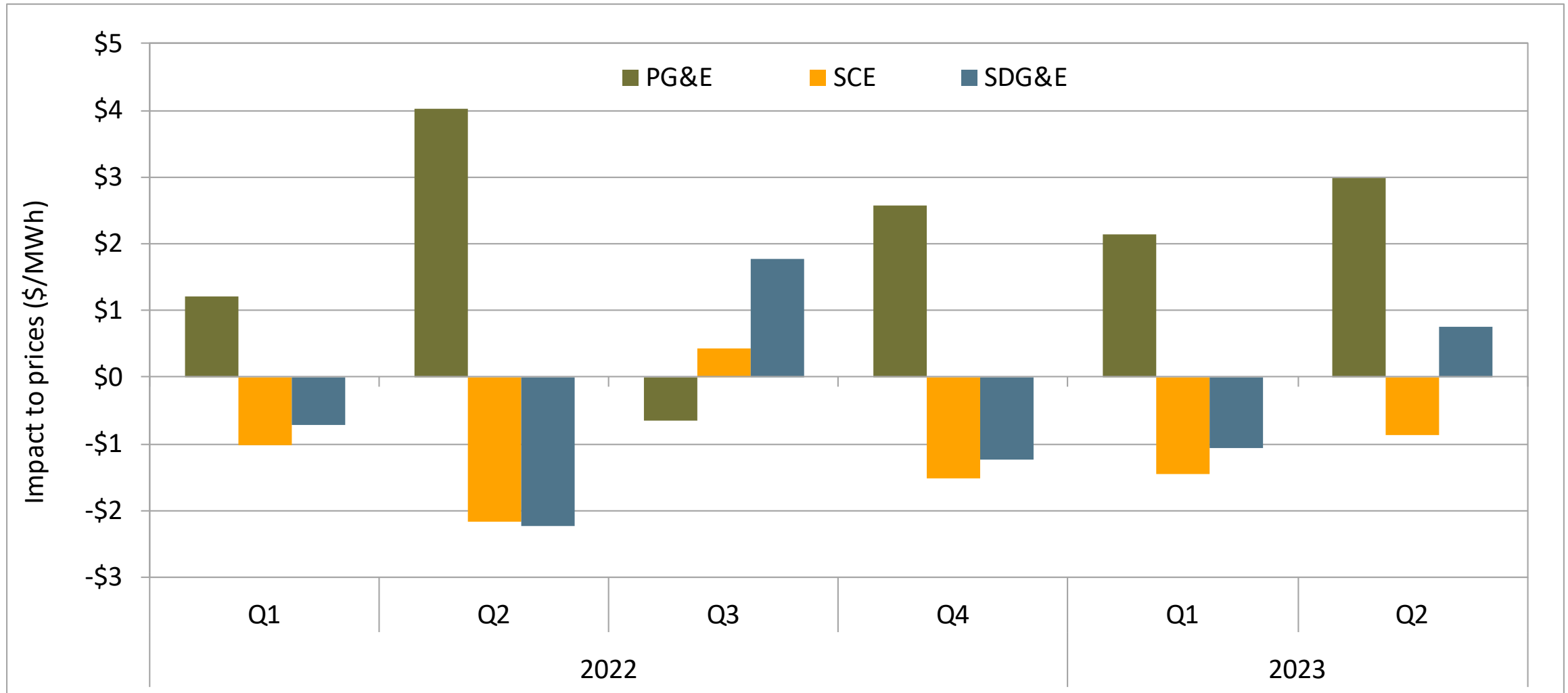
Ancillary service costs \$39.7 million in Q1, \$30.7 million in Q2



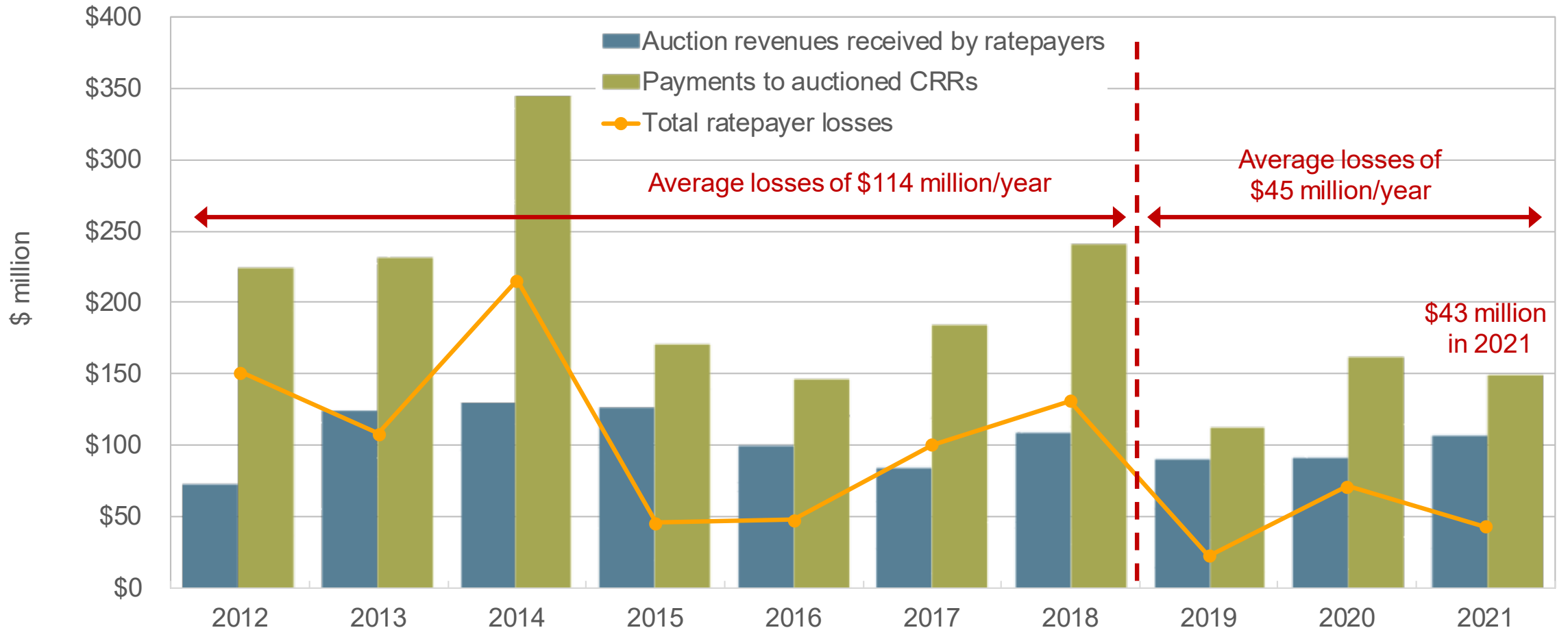
Average monthly day-ahead ancillary service requirements



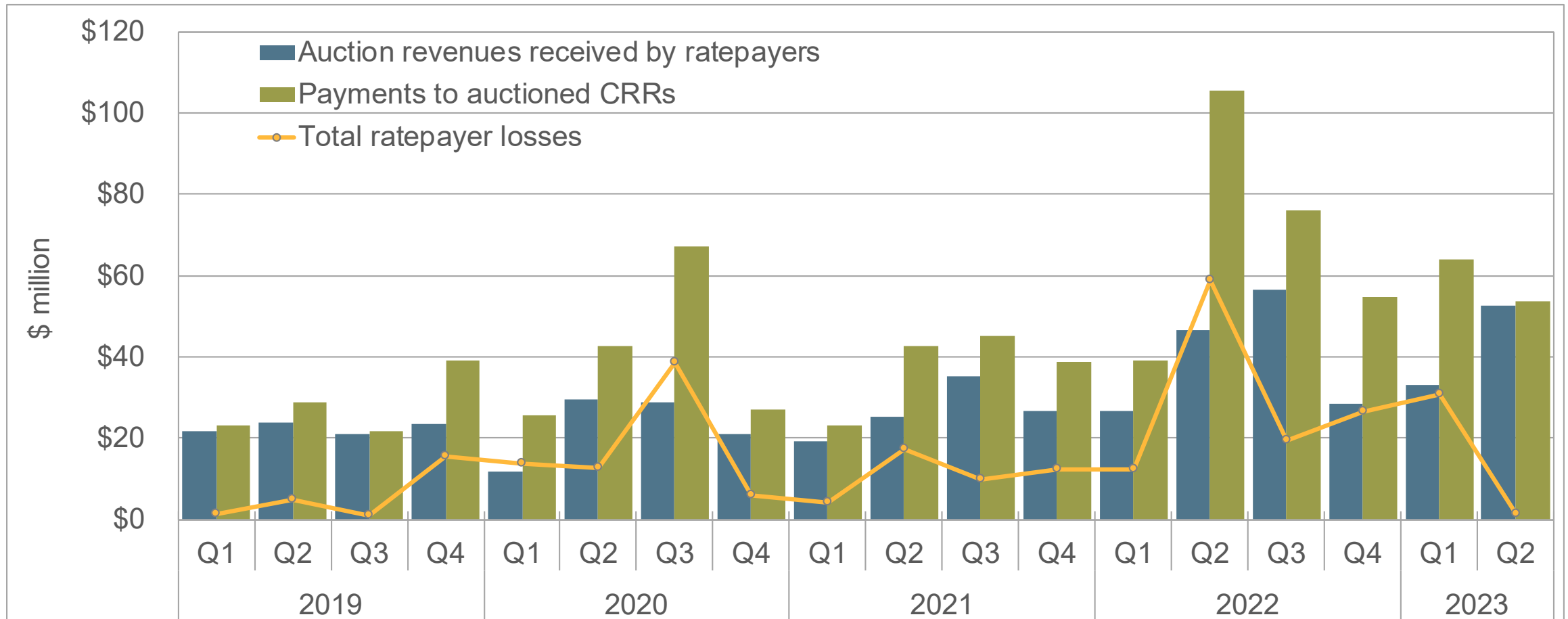
Day-ahead congestion rent fell to \$280 million (Q1) and \$151 million (Q2)



Transmission ratepayer losses from auctioned CRRs have been reduced by changes made in 2019, but still averaging \$45 million per year through 2021



Payouts to congestion revenue rights sold in the California ISO auction exceeded auction revenues by \$31 million in Q1, \$1 million in Q2



Bid cost recovery payments \$84 million in Q1 and \$32 million in Q2 (CAISO)
and \$13 million in Q1 and \$4 million in Q2 (WEIM)

