2023 Annual Report on Market Issues and Performance

Ryan Kurlinski
Senior Manager, Monitoring and Reporting
Department of Market Monitoring

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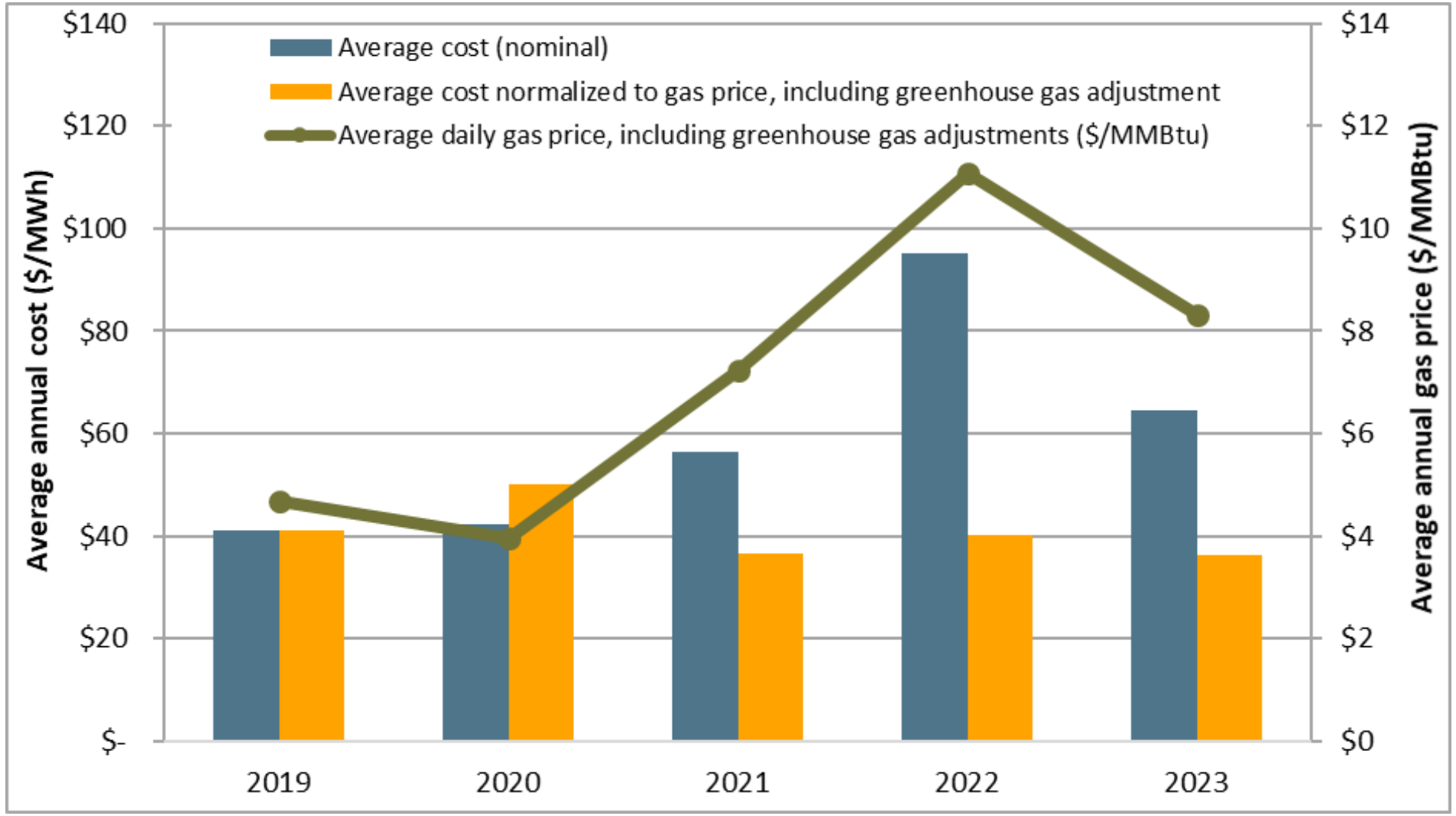
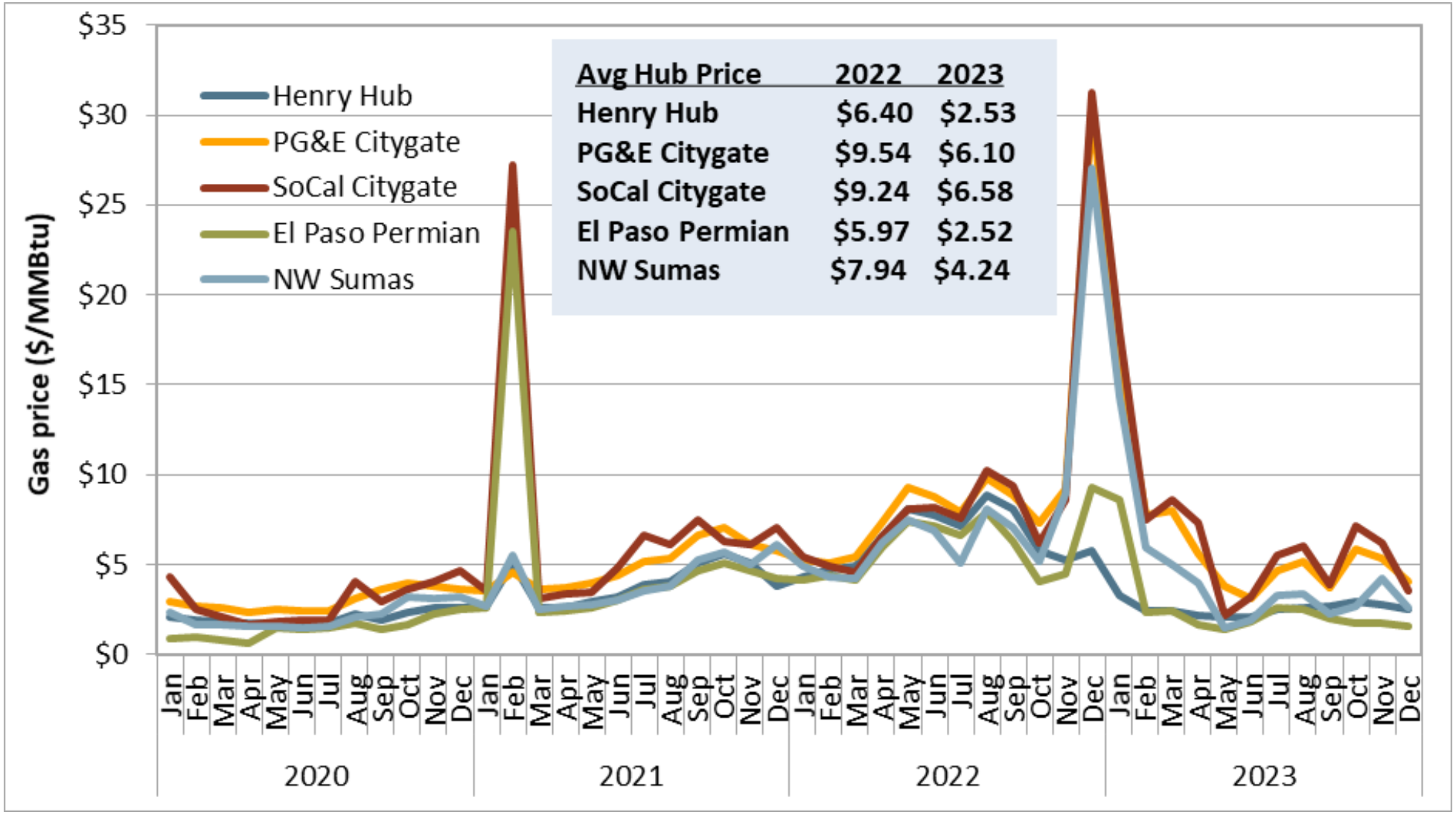
https://www.caiso.com/documents/2023-annual-report-on-market-issues-and-performance.pdf
https://www.caiso.com/market-operations/market-monitoring

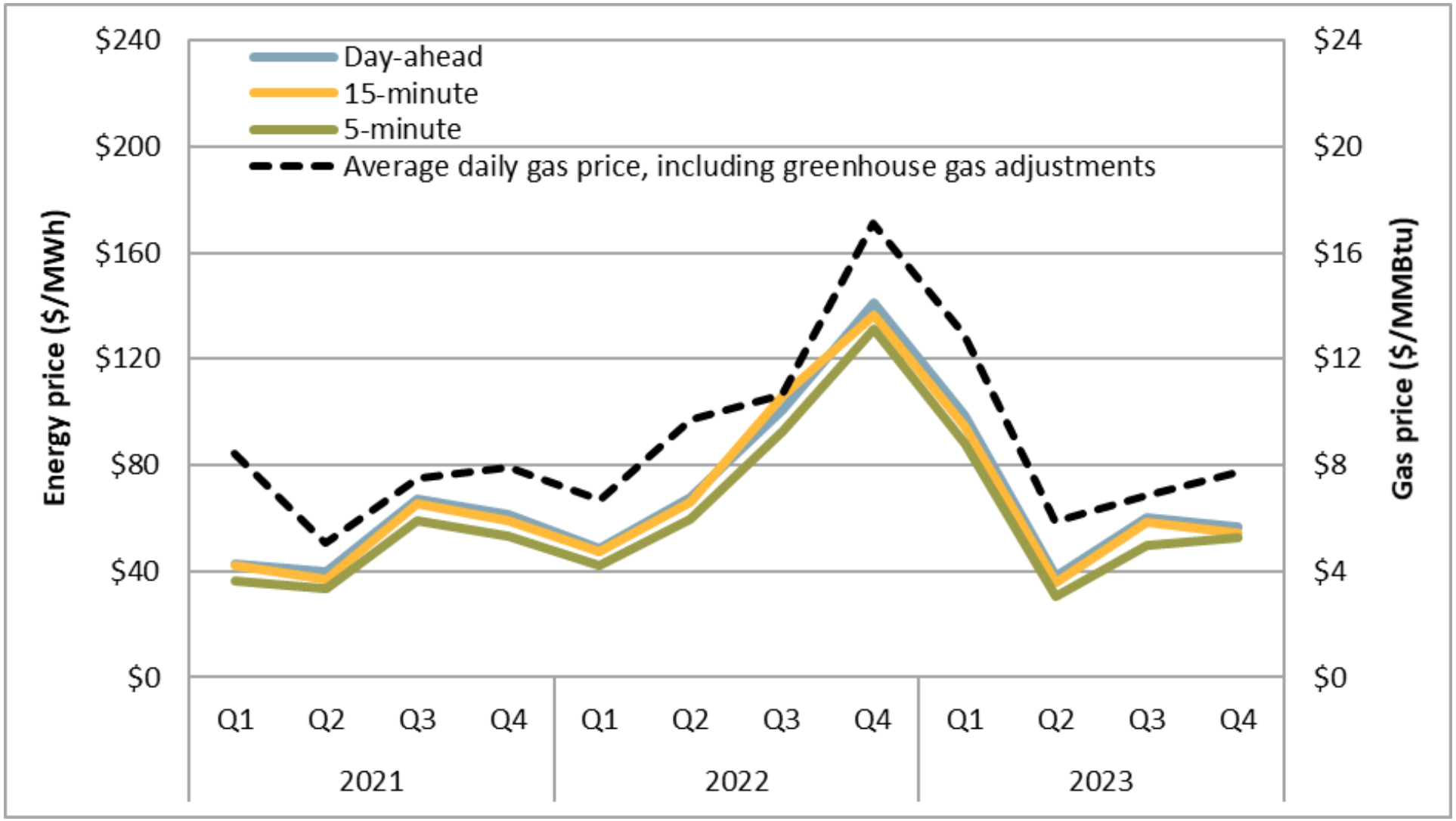
Total CAISO wholesale costs decreased about 32% – or 10% after accounting for lower gas costs



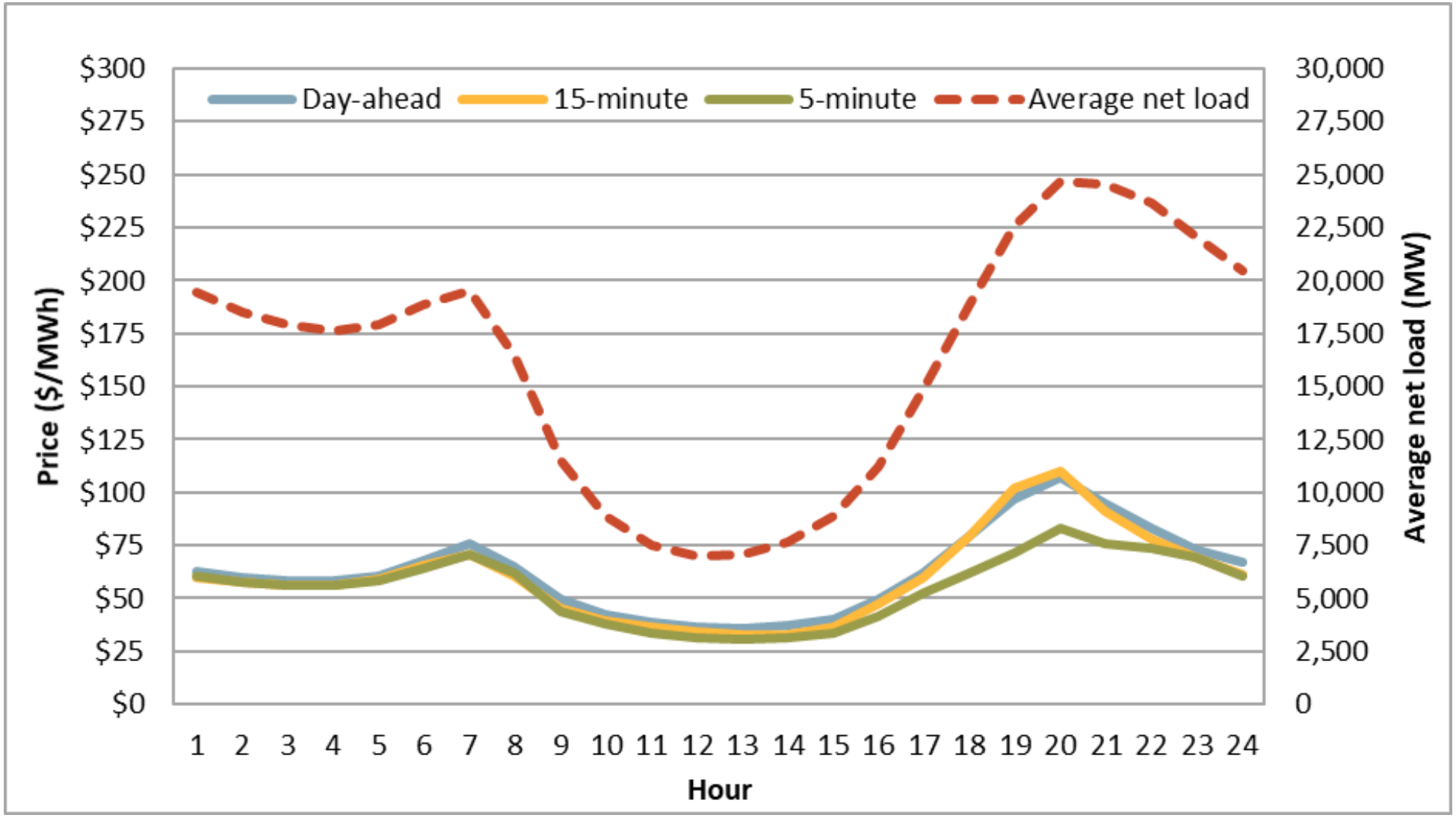
Natural gas prices decreased across the West and in California



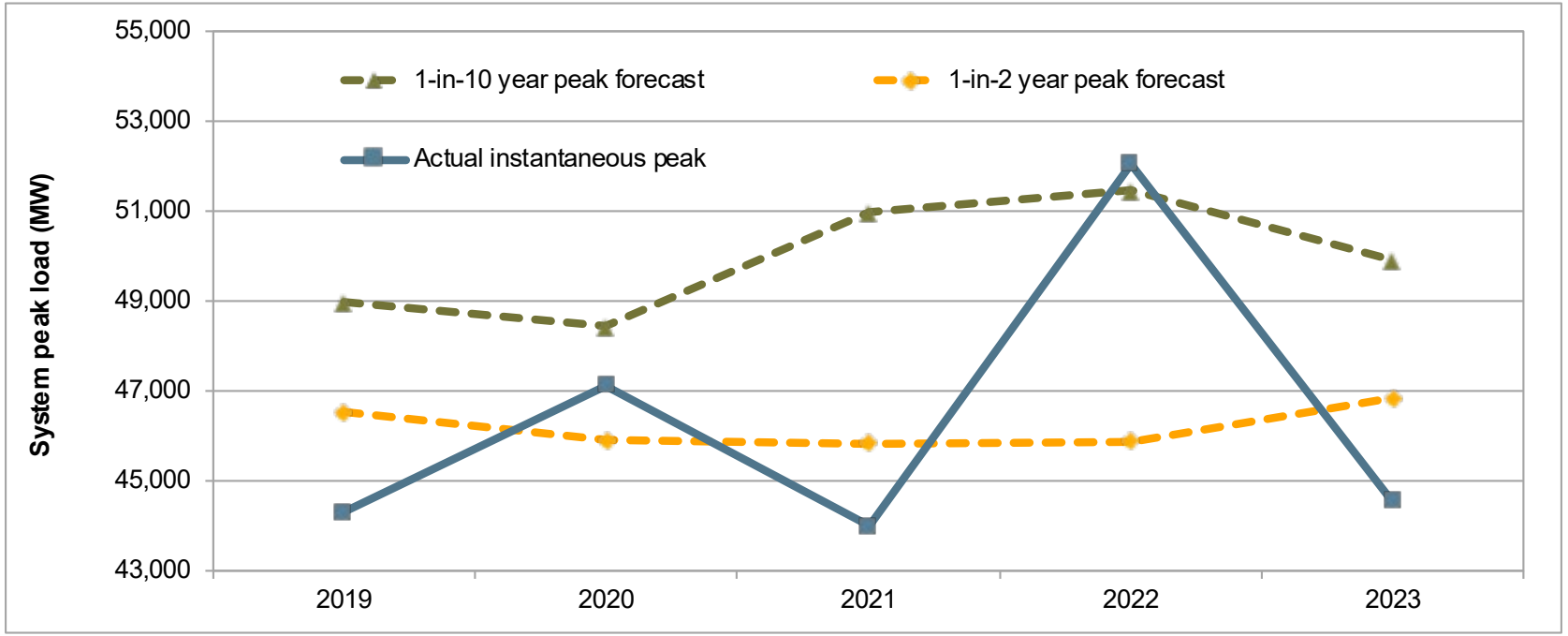
Electricity prices continue to track closely with gas price changes, day-ahead and 15-minute market prices greater than 5-minute market



CAISO 15-minute prices > 5-minute prices over net load peak

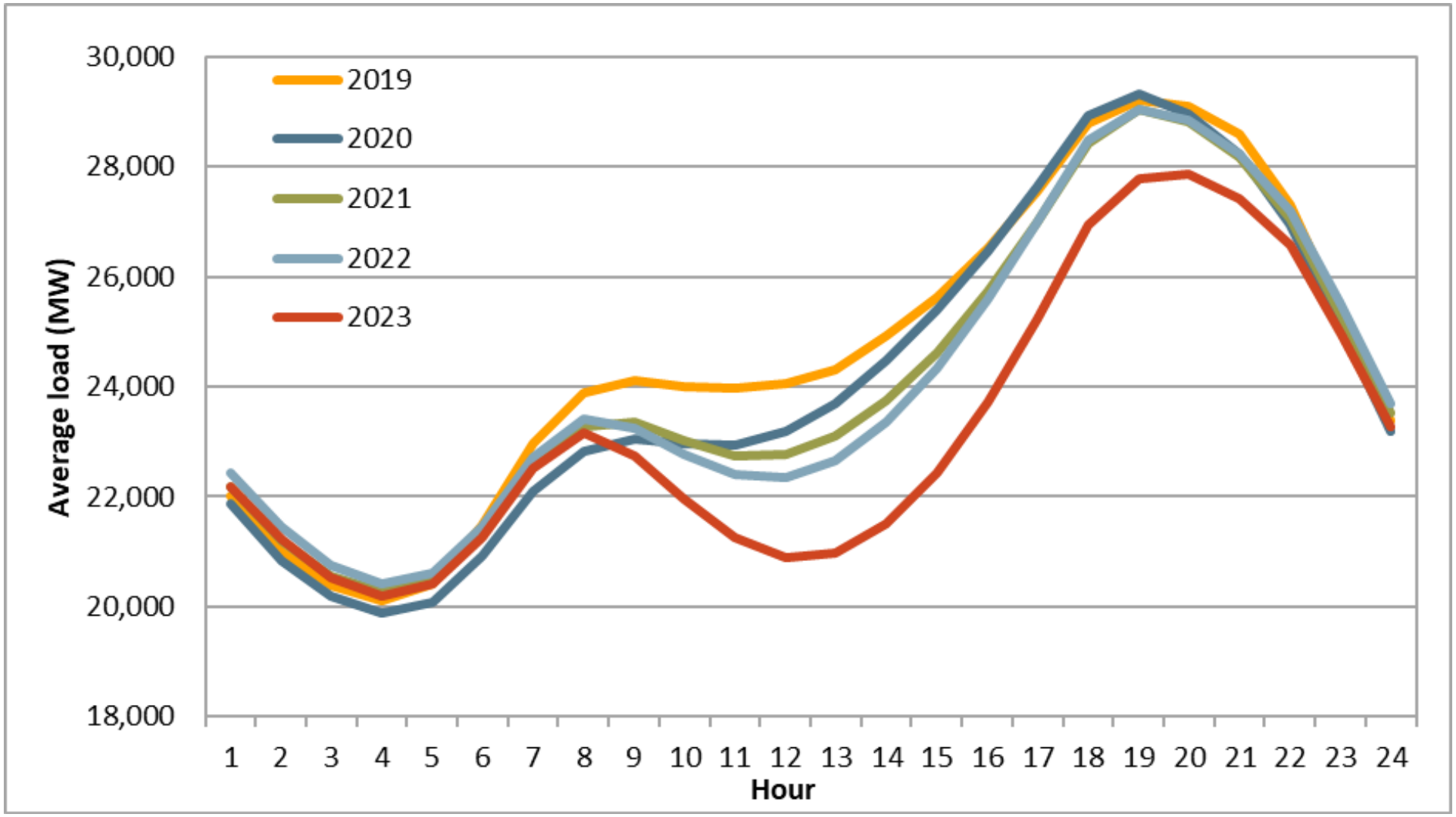


CAISO peak and average load down significantly

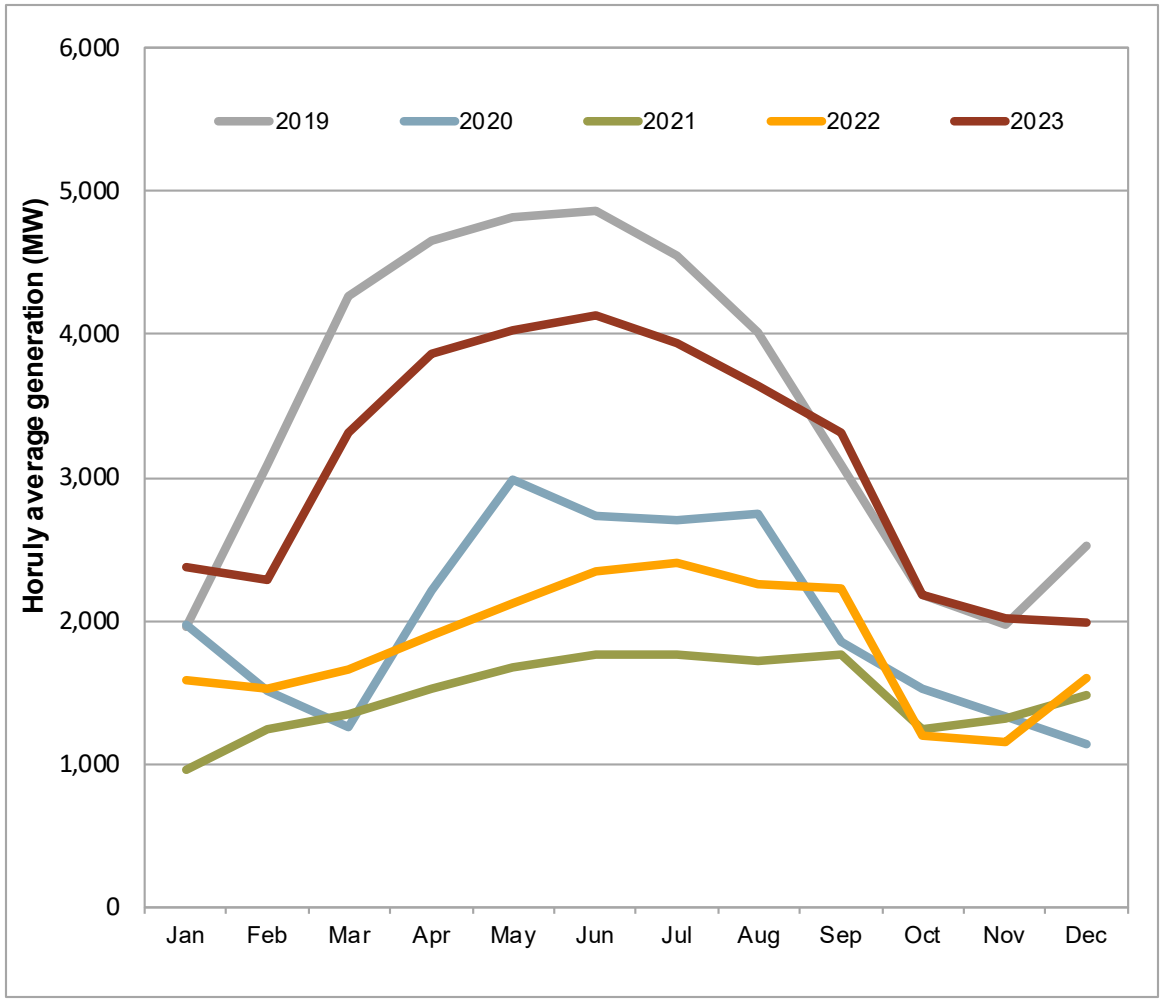


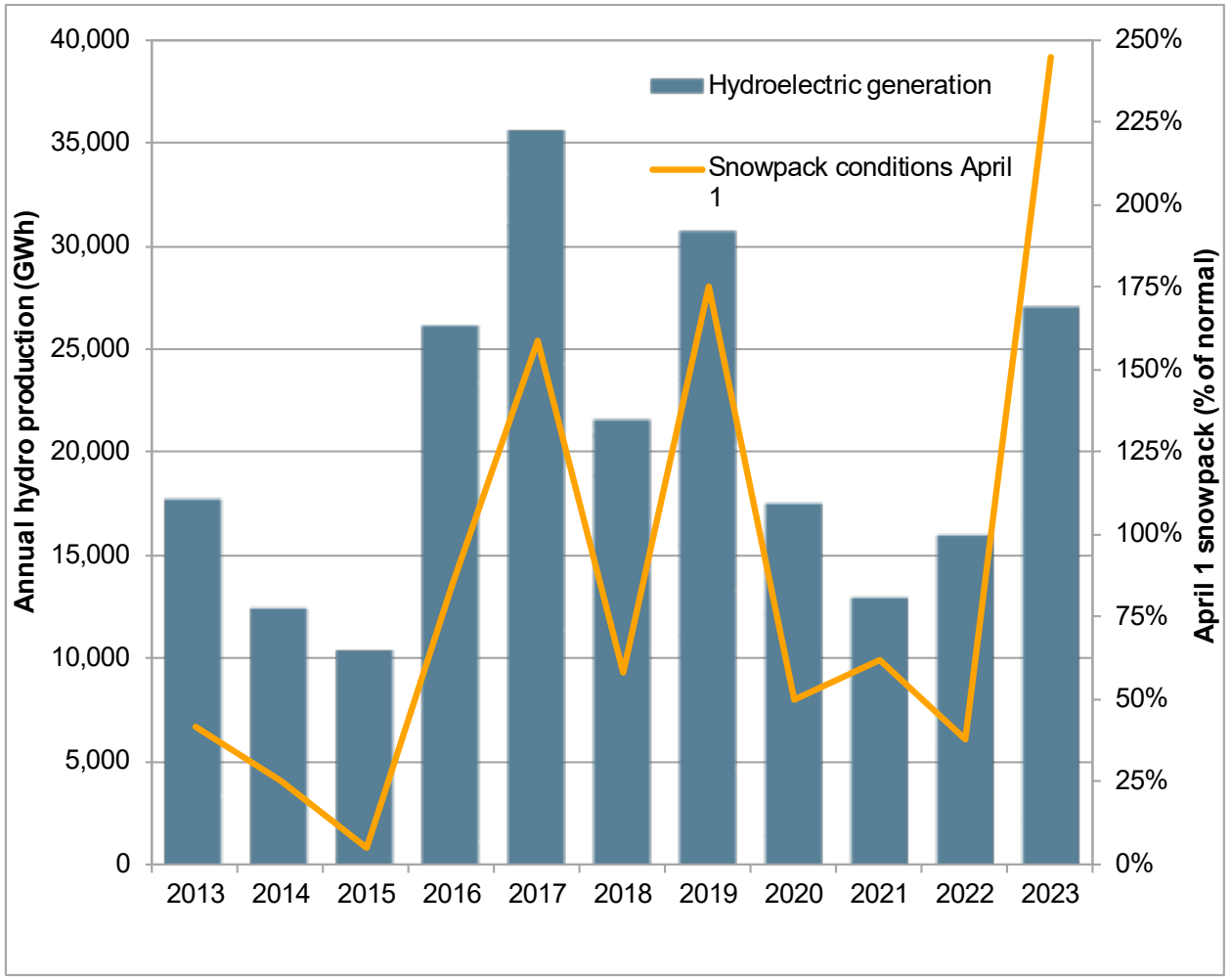
Year	Annual total energy (GWh)	Average load (MW)	% change	Annual peak load (MW)	% change
2019	214,955	24,541	-3.9%	44,301	-11.6%
2020	211,919	24,128	-1.7%	47,121	6.4%
2021	211,020	24,092	-0.1%	43,982	-6.7%
2022	210,879	24,059	-0.1%	52,061	6.4%
2023	203,268	23,207	-3.5%	44,534	-14.5%

Significantly lower CAISO system load from sunrise to sunset

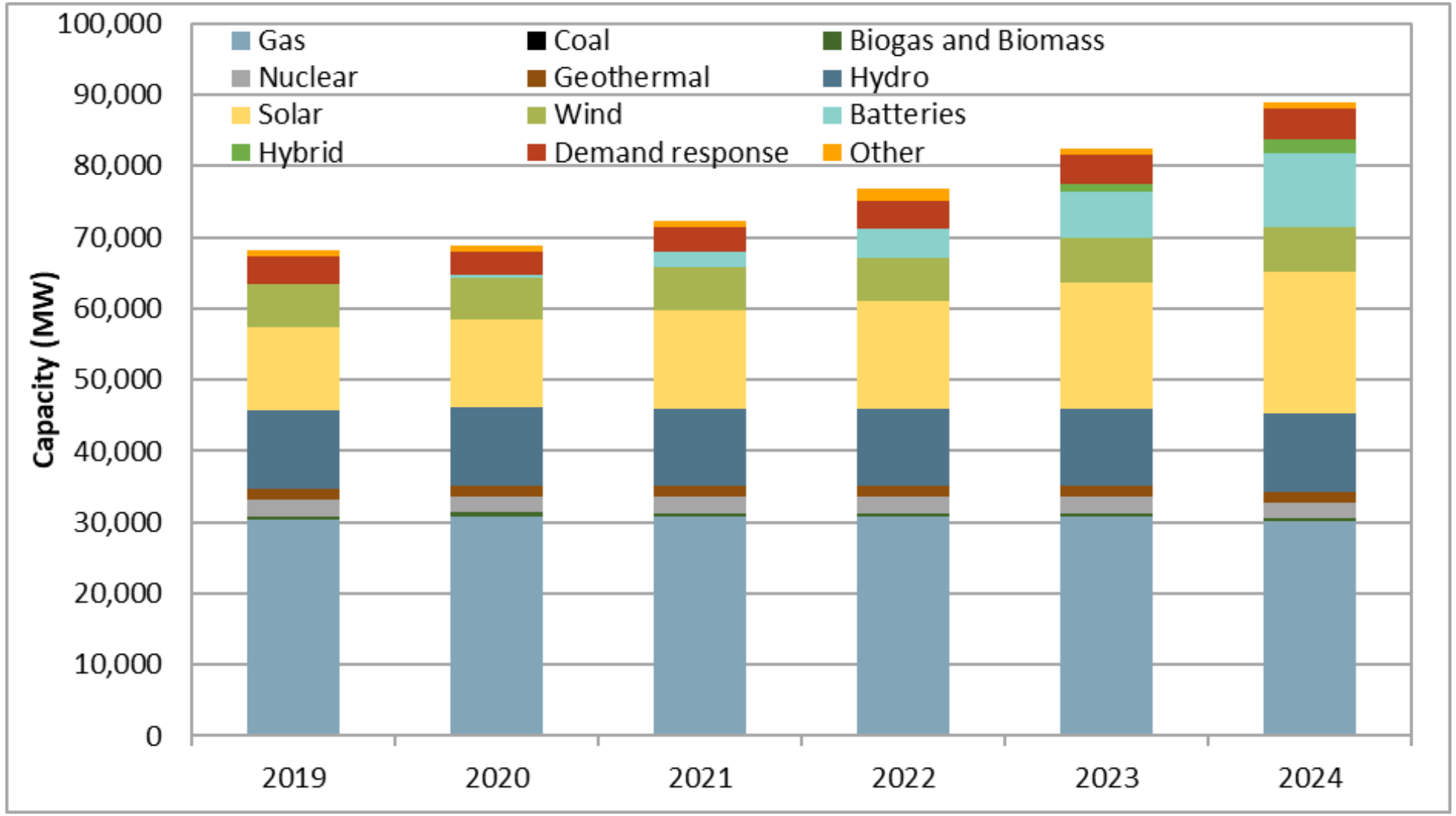


CAISO hydro production and snowpack up significantly, despite tight hydro conditions in the Pacific Northwest

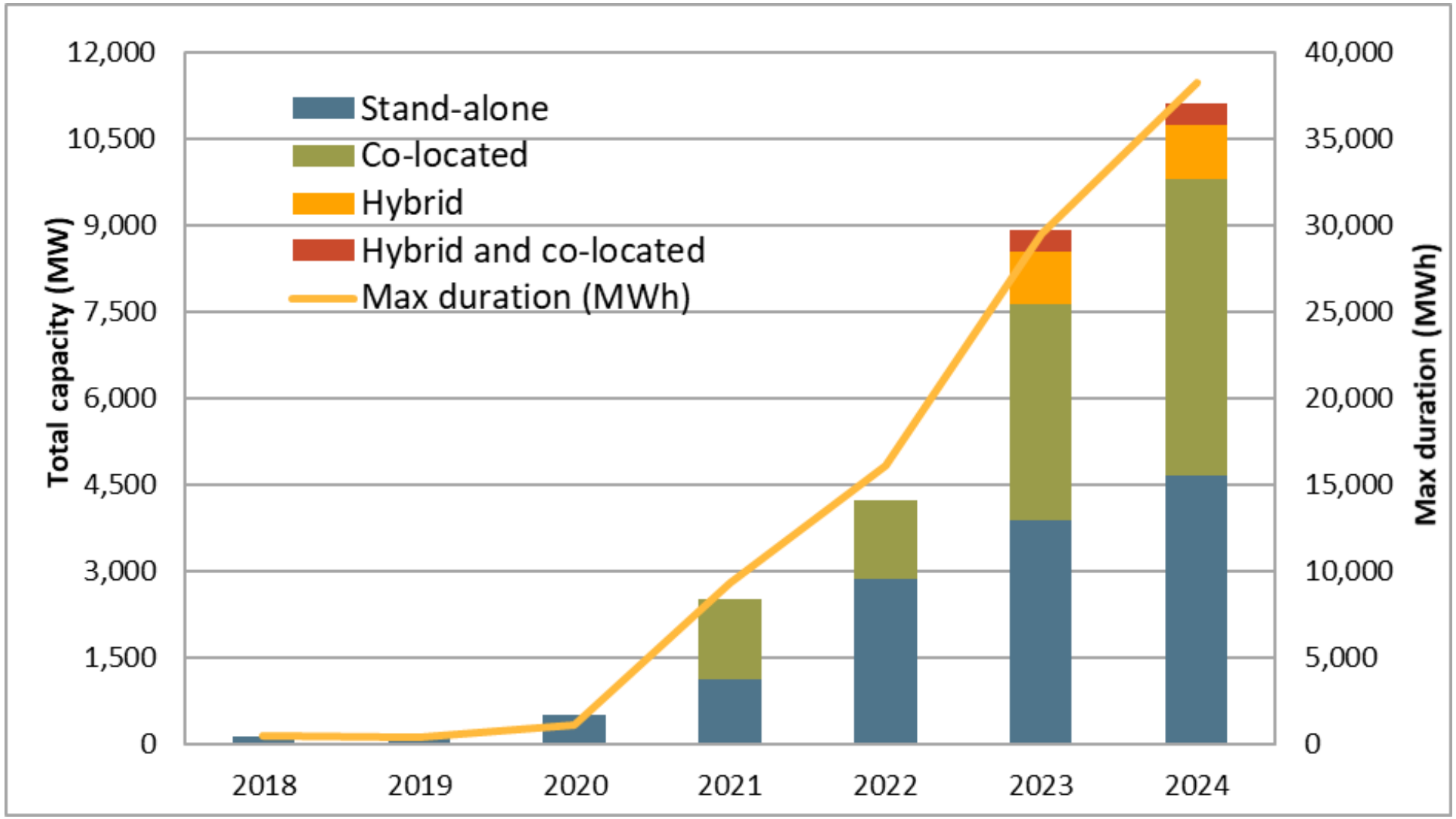




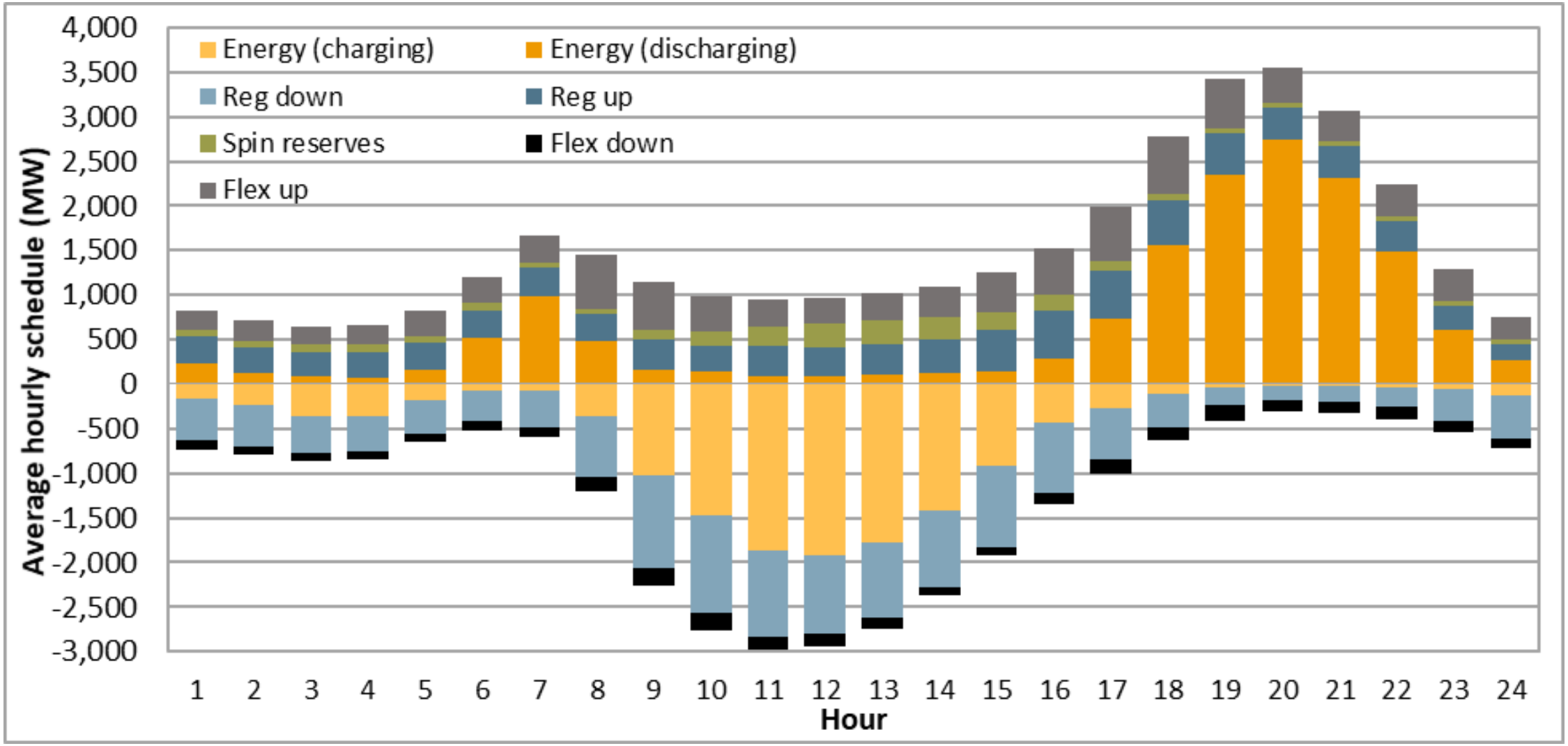
CAISO participating capacity increased 6.4 GW, mainly from battery and solar



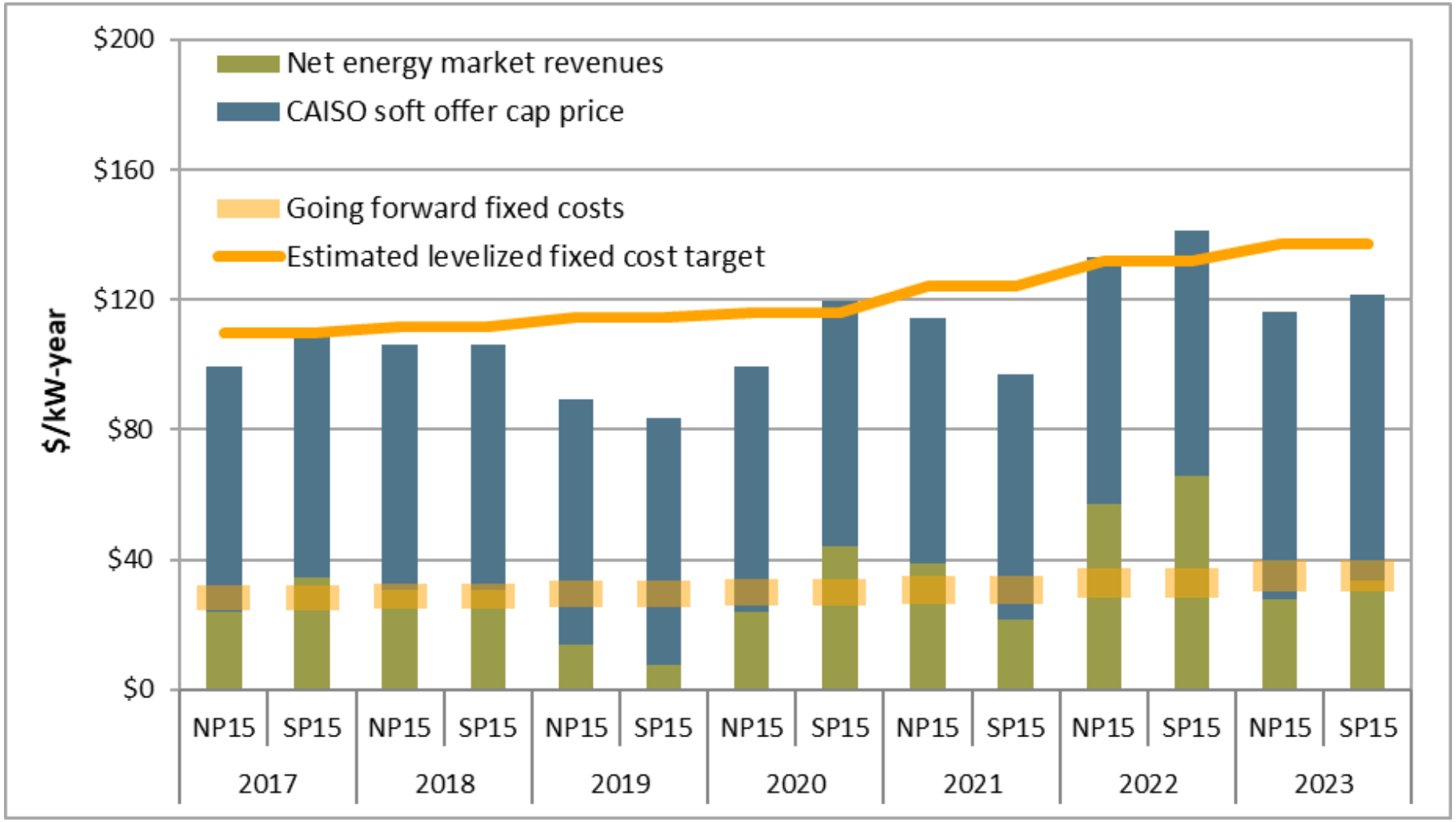
Active battery capacity totaled 11,100 MW in June 2024, almost 7,000 MW more than December 2022



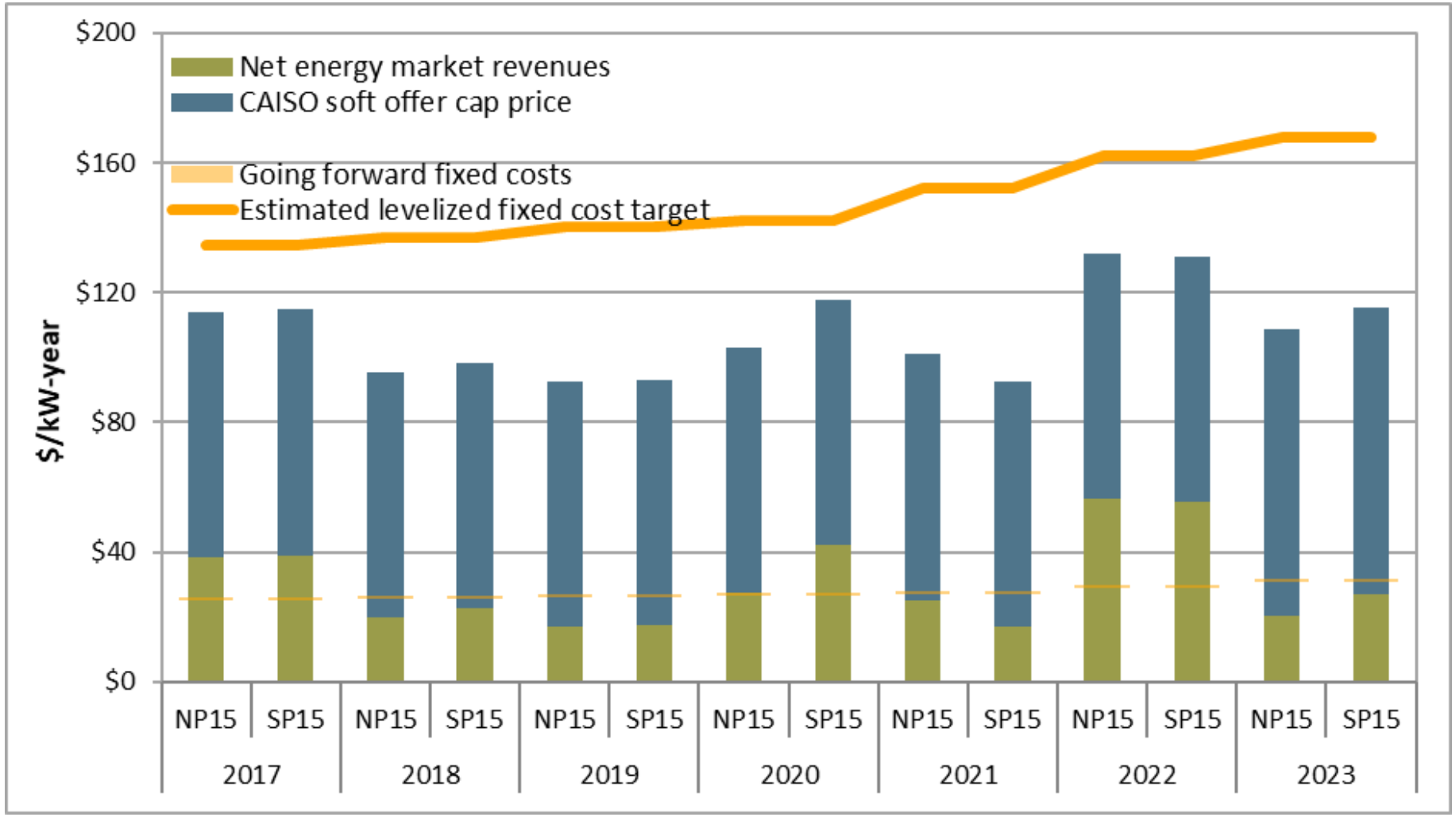
Battery schedules increasingly shifting to energy from regulation



Estimated net revenue of hypothetical combined cycle unit fell to $28/kW-year in NP15 and $33/kW-year in SP15, below going forward fixed costs

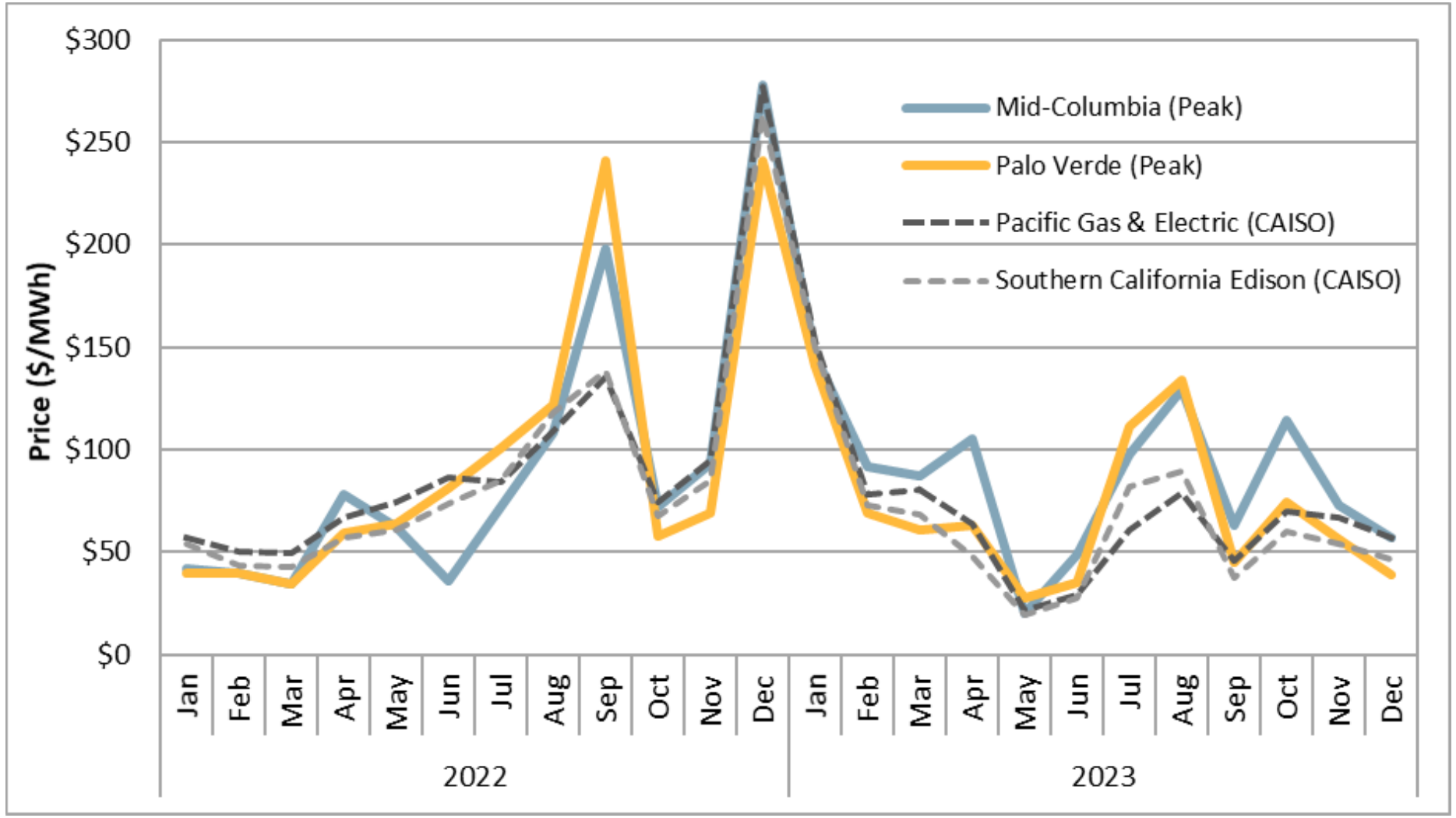


Estimated net revenue of hypothetical combustion turbine fell to $20/kW-year in NP15 and $27/kW-year in SP15, below going forward fixed costs

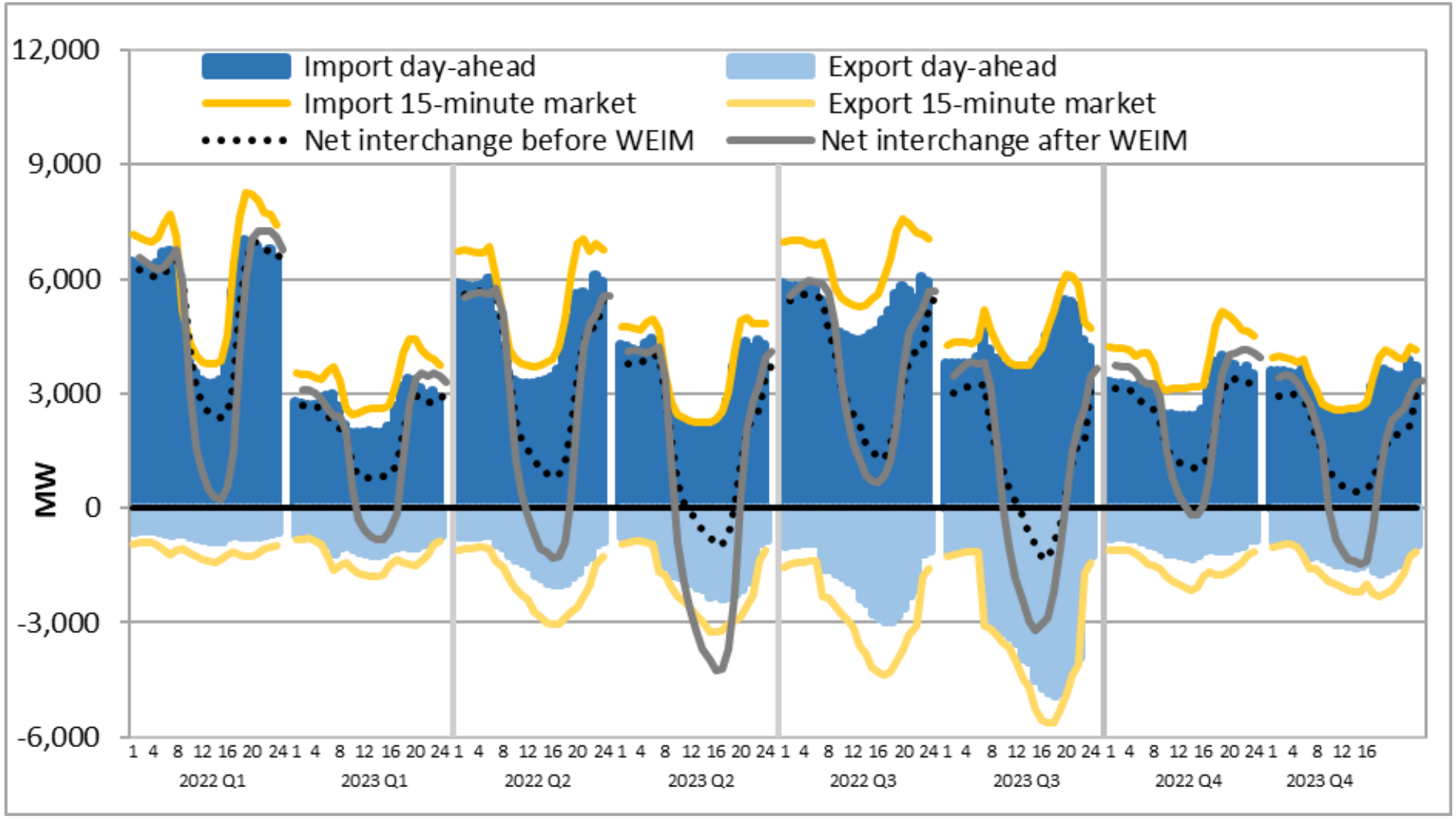


Pacific Northwest prices exceed CAISO prices most of year

Monthly average day-ahead and bilateral market prices

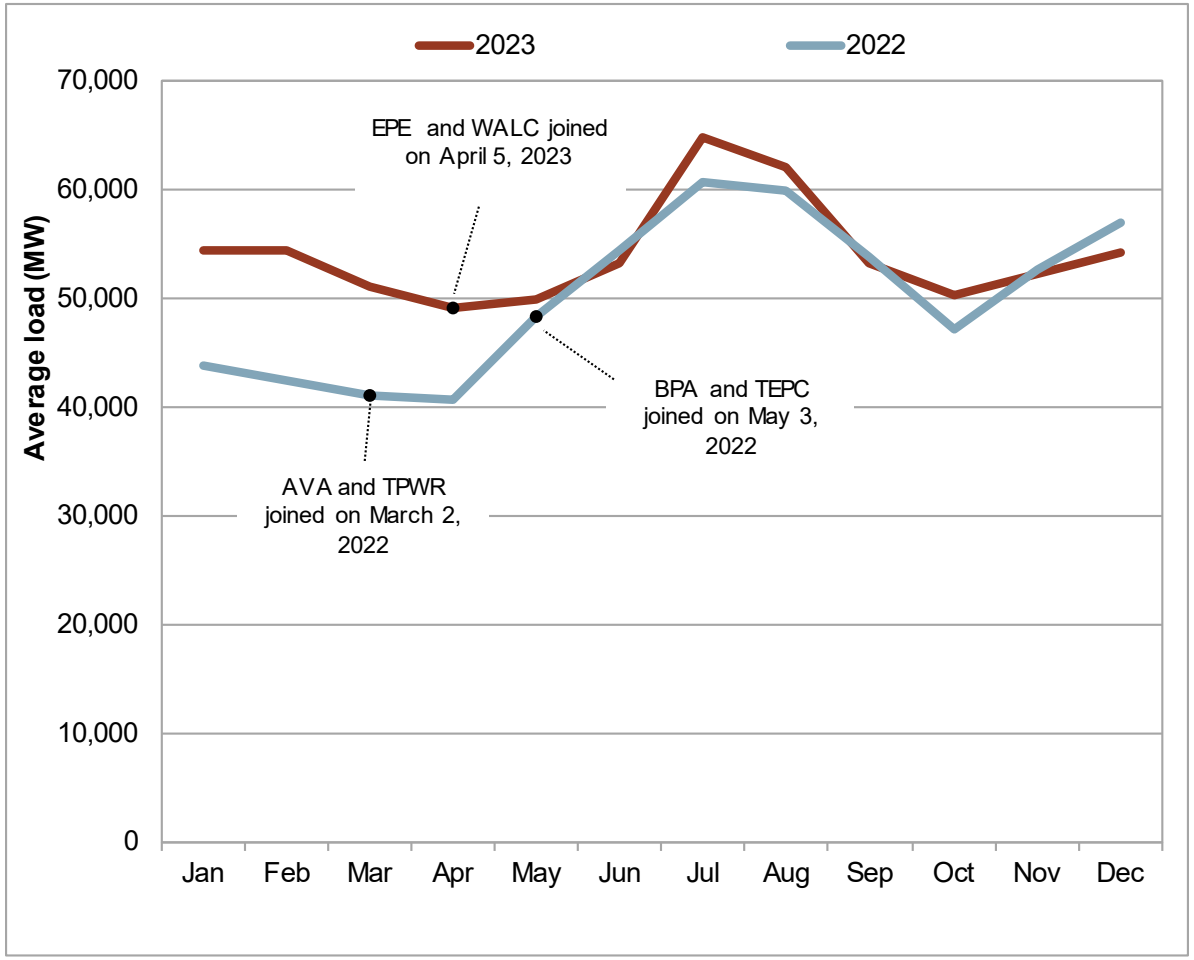


Net imports decreasing each quarter, continuing multi-year trend



Western energy imbalance market expands, improving structure of the real-time market

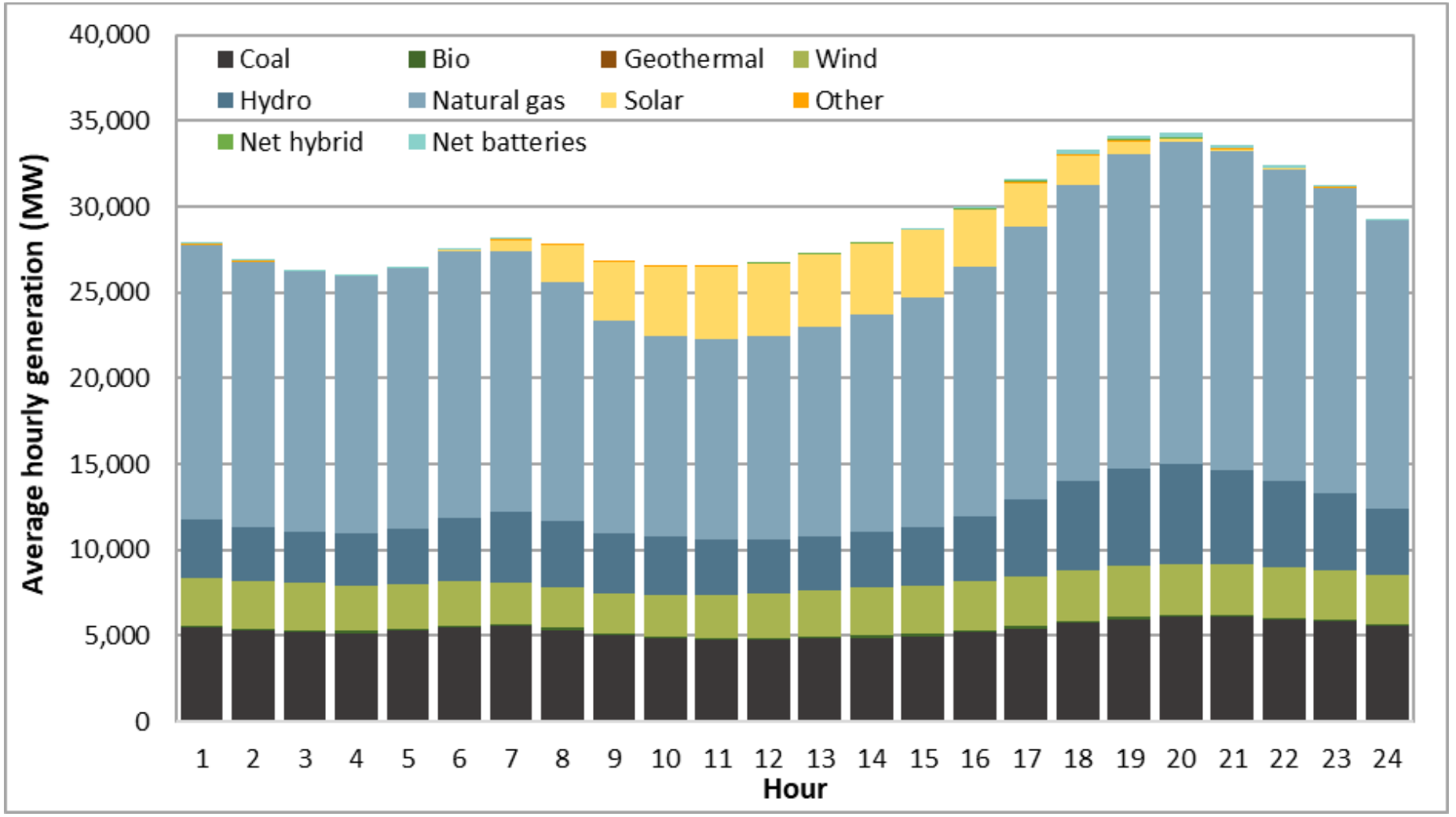
Non-CAISO WEIM load



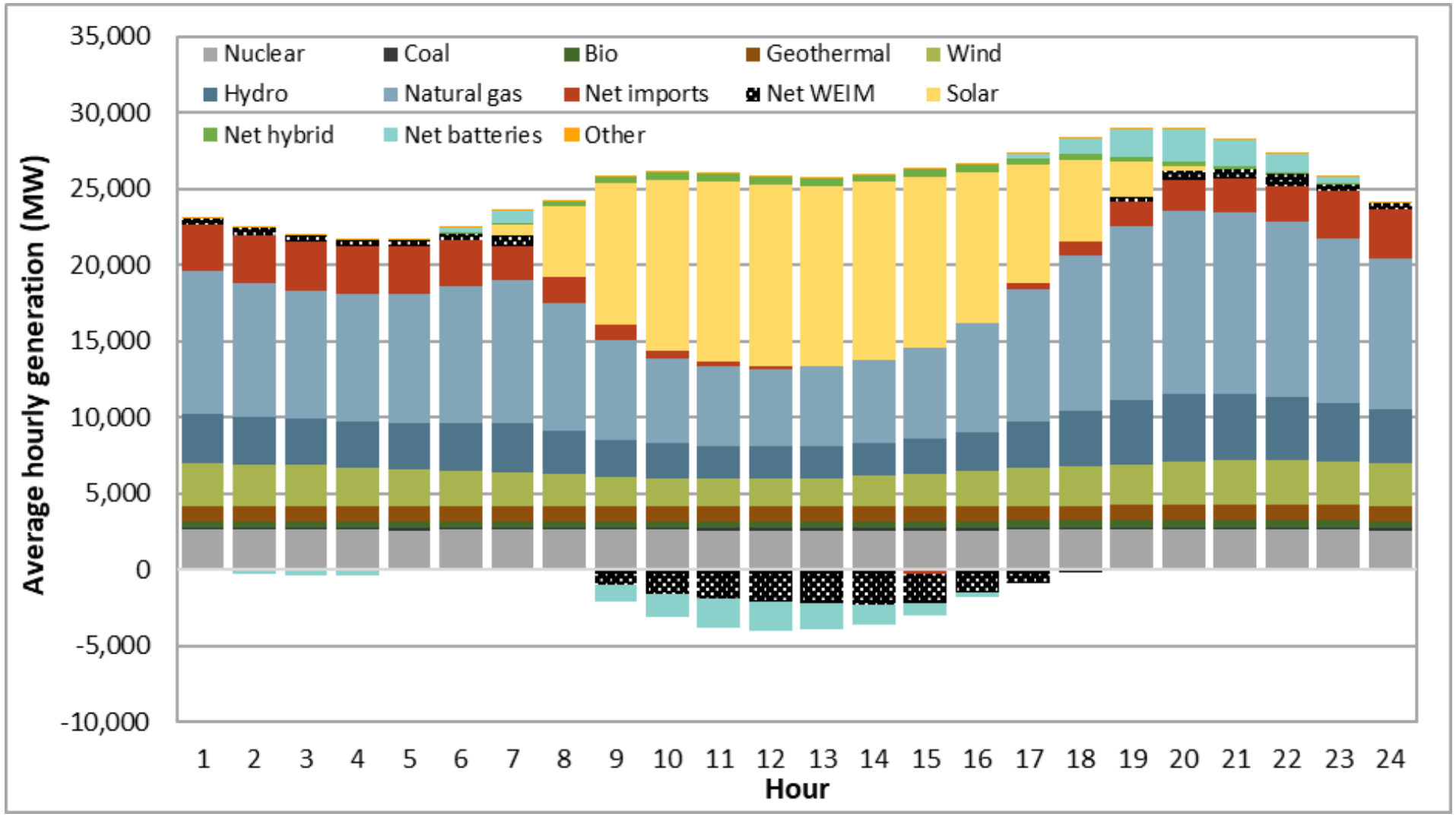
2023 Peak load measures

	Peak load		Load during WEIM system peak (16-Aug-23)	
BAA	Date	Load (MW)	Load (MW)	Percentage
AVA	15-Aug-23	2,093	2,061	1.6%
AZPS	15-Jul-23	8,081	7,192	5.5%
BANC	16-Aug-23	4,438	4,389	3.4%
BCHA	24-Feb-23	10,761	9,201	7.1%
BPAT	30-Jan-23	10,637	8,936	6.9%
CISO	16-Aug-23	41,730	41,730	32.0%
EPE	19-Jul-23	2,375	1,950	1.5%
IPCO	20-Jul-23	3,770	3,645	2.8%
LADWP	29-Aug-23	5,191	4,737	3.6%
NEVP	21-Jul-23	9,122	7,618	5.8%
NWMT	22-Feb-23	1,939	1,684	1.3%
PACE	17-Jul-23	9,343	8,877	6.8%
PACW	30-Jan-23	3,981	3,894	3.0%
PGE	16-Aug-23	4,524	4,453	3.4%
PNM	18-Jul-23	2,685	2,253	1.7%
PSEI	30-Jan-23	4,567	4,025	3.1%
SCL	30-Jan-23	1,693	1,400	1.1%
SRP	25-Jul-23	8,081	7,038	5.4%
TEPC	19-Jul-23	3,118	2,668	2.0%
TIDC	17-Aug-23	687	674	0.5%
TPWR	30-Jan-23	872	678	0.5%
WALC	26-Jul-23	1,621	1,345	1.0%
Total			**130,448**	

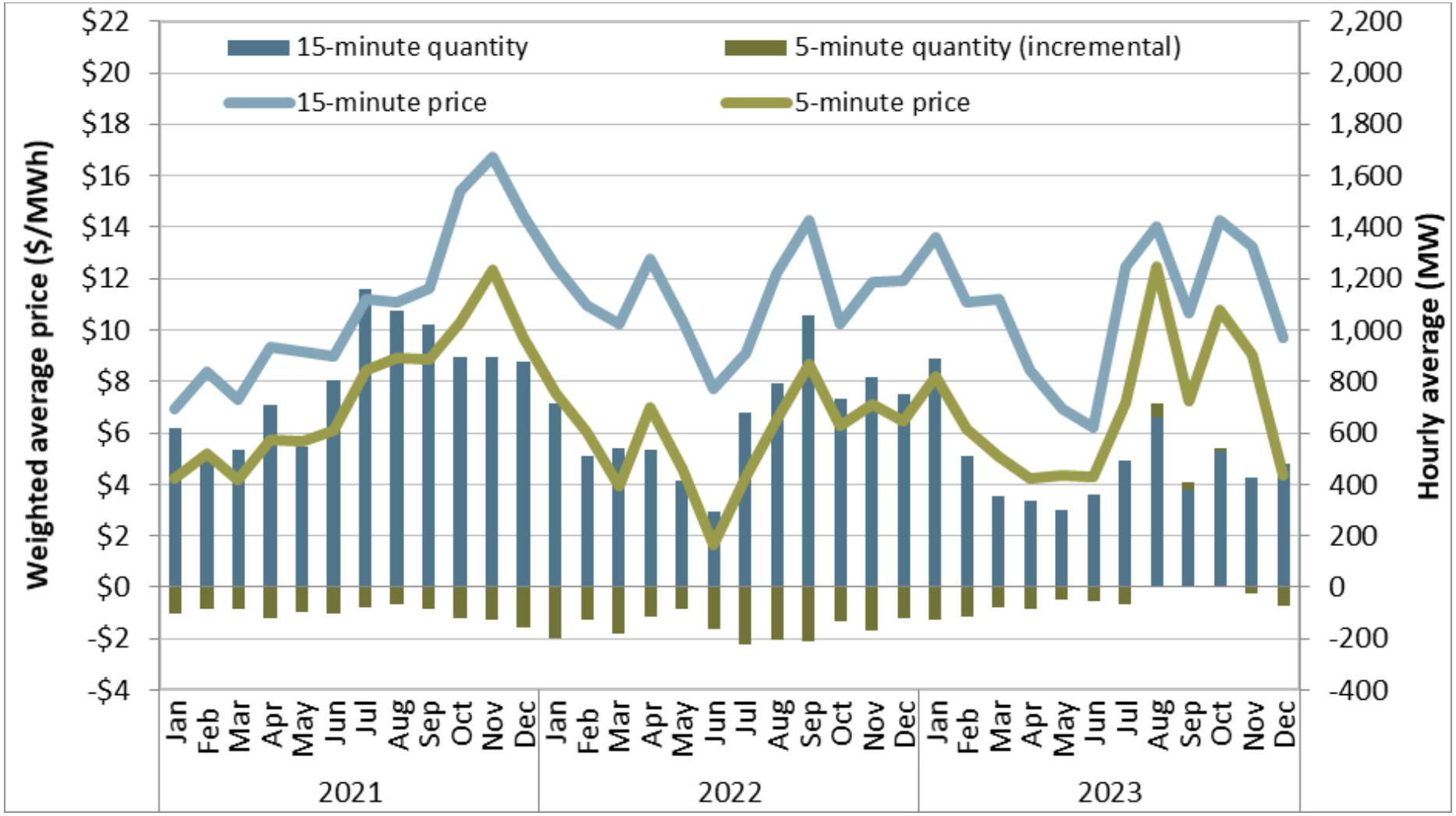
Average hourly participating non-CAISO WEIM generation by fuel type, 2023



Average hourly generation in CAISO by fuel type (2023)



WEIM greenhouse gas price and cleared quantity



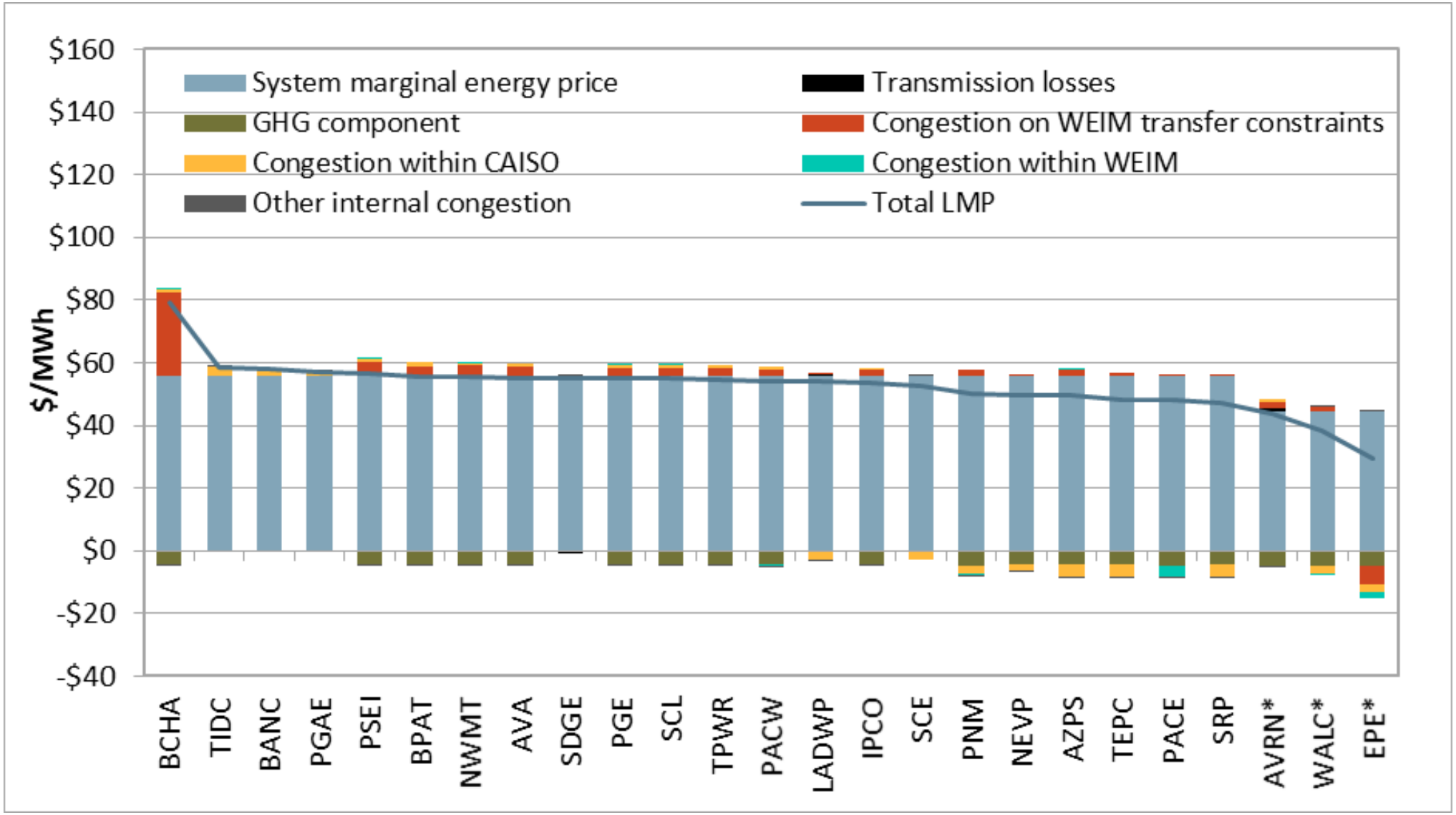
Power flowing from south to north during solar hours

Average hourly 5-minute market prices

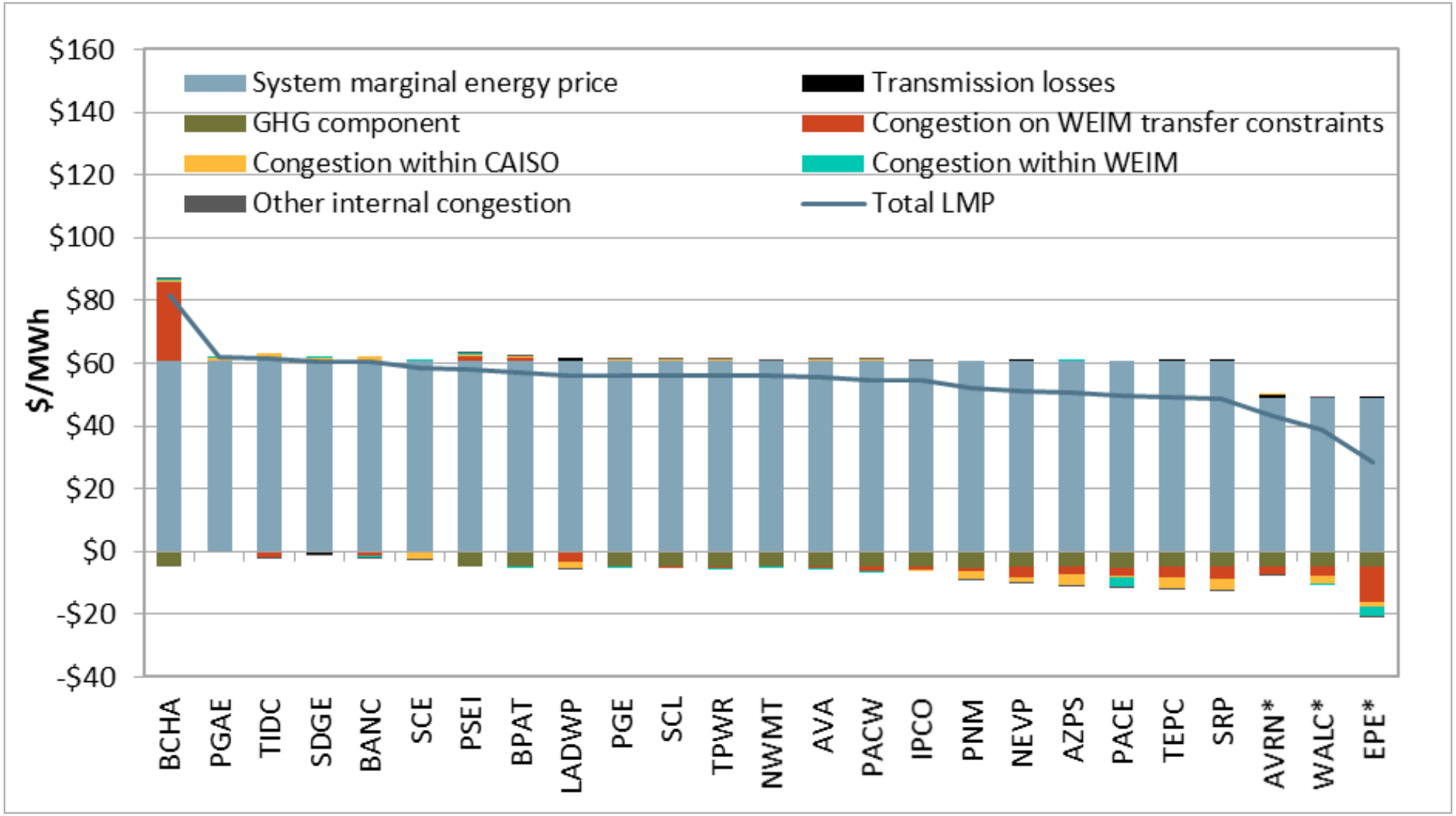
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
SMEC	$60	$57	$56	$56	$58	$64	$70	$62	$45	$41	$38	$35	$35	$35	$37	$44	$53	$61	$70	$81	$75	$73	$69	$60
PG&E (CAISO)	$60	$57	$56	$56	$58	$64	$70	$65	$51	$48	$43	$41	$40	$40	$41	$47	$55	$61	$68	$78	$72	$71	$68	$60
SCE (CAISO)	$60	$57	$56	$56	$58	$64	$71	$59	$36	$29	$26	$23	$23	$24	$27	$38	$50	$62	$73	$86	$79	$75	$70	$61
BANC	$60	$57	$55	$55	$58	$63	$71	$65	$52	$50	$45	$44	$43	$42	$43	$48	$55	$61	$68	$79	$73	$71	$68	$60
Turlock ID	$60	$57	$55	$55	$58	$63	$70	$64	$54	$53	$48	$46	$45	$45	$46	$50	$56	$62	$68	$78	$72	$71	$68	$60
LADWP	$63	$58	$56	$56	$59	$65	$72	$61	$39	$30	$27	$24	$25	$25	$29	$39	$54	$64	$73	$85	$79	$75	$72	$64
NV Energy	$52	$49	$48	$49	$53	$59	$63	$55	$37	$33	$31	$29	$29	$30	$31	$40	$52	$59	$67	$78	$69	$63	$63	$54
Arizona PS	$53	$48	$48	$50	$55	$63	$64	$62	$43	$29	$25	$20	$21	$23	$28	$42	$48	$58	$68	$79	$73	$69	$63	$56
Tucson Electric	$52	$48	$47	$48	$51	$58	$61	$52	$32	$28	$25	$24	$26	$27	$32	$42	$51	$62	$68	$77	$70	$63	$63	$52
Salt River Project	$48	$44	$42	$42	$47	$57	$58	$48	$33	$27	$30	$35	$33	$28	$30	$41	$50	$56	$71	$75	$67	$59	$67	$50
PSC New Mexico	$54	$52	$49	$53	$53	$62	$65	$63	$35	$29	$26	$24	$24	$25	$28	$37	$53	$64	$74	$82	$71	$66	$63	$57
WAPA - Desert SW*	$45	$39	$37	$38	$39	$46	$50	$34	$18	$17	$16	$17	$21	$23	$24	$34	$40	$49	$56	$70	$59	$52	$54	$44
El Paso Electric*	$28	$25	$24	$24	$26	$33	$29	$24	$18	$17	$18	$21	$21	$23	$25	$31	$35	$39	$46	$53	$44	$34	$35	$28
PacifiCorp East	$50	$47	$45	$46	$49	$57	$61	$52	$39	$36	$34	$33	$32	$32	$34	$40	$48	$55	$62	$71	$64	$59	$59	$52
Idaho Power	$53	$50	$49	$50	$53	$60	$65	$59	$48	$46	$43	$42	$41	$41	$42	$46	$53	$60	$66	$74	$68	$63	$62	$54
NorthWestern	$57	$50	$49	$50	$54	$62	$64	$60	$53	$48	$46	$45	$45	$44	$45	$51	$56	$60	$66	$74	$67	$62	$63	$57
Avista Utilities	$55	$50	$49	$50	$54	$61	$64	$60	$52	$50	$48	$47	$46	$45	$46	$50	$56	$59	$64	$71	$66	$62	$63	$55
Avangrid*	$40	$37	$36	$37	$40	$45	$46	$41	$39	$40	$39	$39	$40	$41	$41	$43	$47	$49	$52	$58	$53	$49	$50	$42
BPA	$53	$51	$49	$49	$53	$59	$62	$58	$53	$52	$51	$49	$49	$49	$49	$54	$55	$60	$65	$70	$66	$61	$62	$54
Tacoma Power	$53	$49	$48	$50	$53	$59	$61	$57	$52	$51	$50	$48	$49	$48	$48	$50	$54	$58	$65	$69	$63	$60	$63	$54
PacifiCorp West	$53	$50	$49	$50	$53	$59	$62	$57	$52	$50	$48	$47	$46	$46	$46	$49	$54	$59	$63	$69	$64	$61	$61	$53
Portland GE	$53	$50	$49	$50	$53	$59	$62	$57	$52	$50	$49	$47	$47	$46	$47	$50	$55	$62	$68	$72	$65	$61	$61	$53
Puget Sound Energy	$53	$49	$48	$50	$53	$59	$61	$57	$55	$55	$51	$48	$49	$52	$48	$51	$57	$68	$73	$77	$68	$61	$63	$55
Seattle City Light	$54	$50	$48	$50	$52	$59	$62	$57	$52	$51	$50	$48	$50	$50	$49	$51	$54	$58	$64	$69	$64	$61	$60	$52
Powerex	$71	$66	$65	$66	$70	$73	$81	$80	$81	$81	$81	$80	$81	$80	$80	$82	$85	$87	$90	$93	$90	$86	$81	$73

Hour

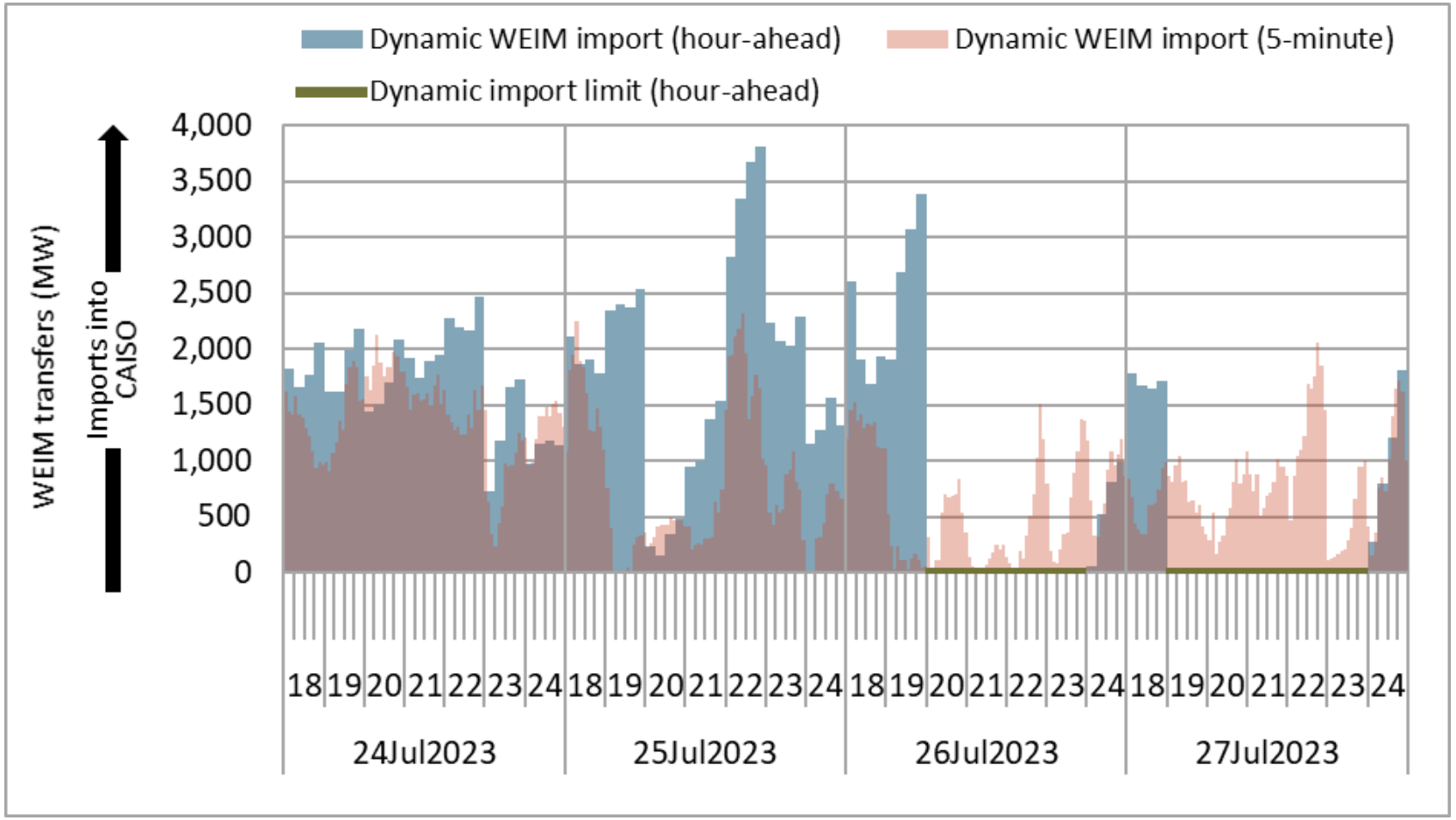
Impact of congestion and greenhouse gas on 5-minute prices (2023)



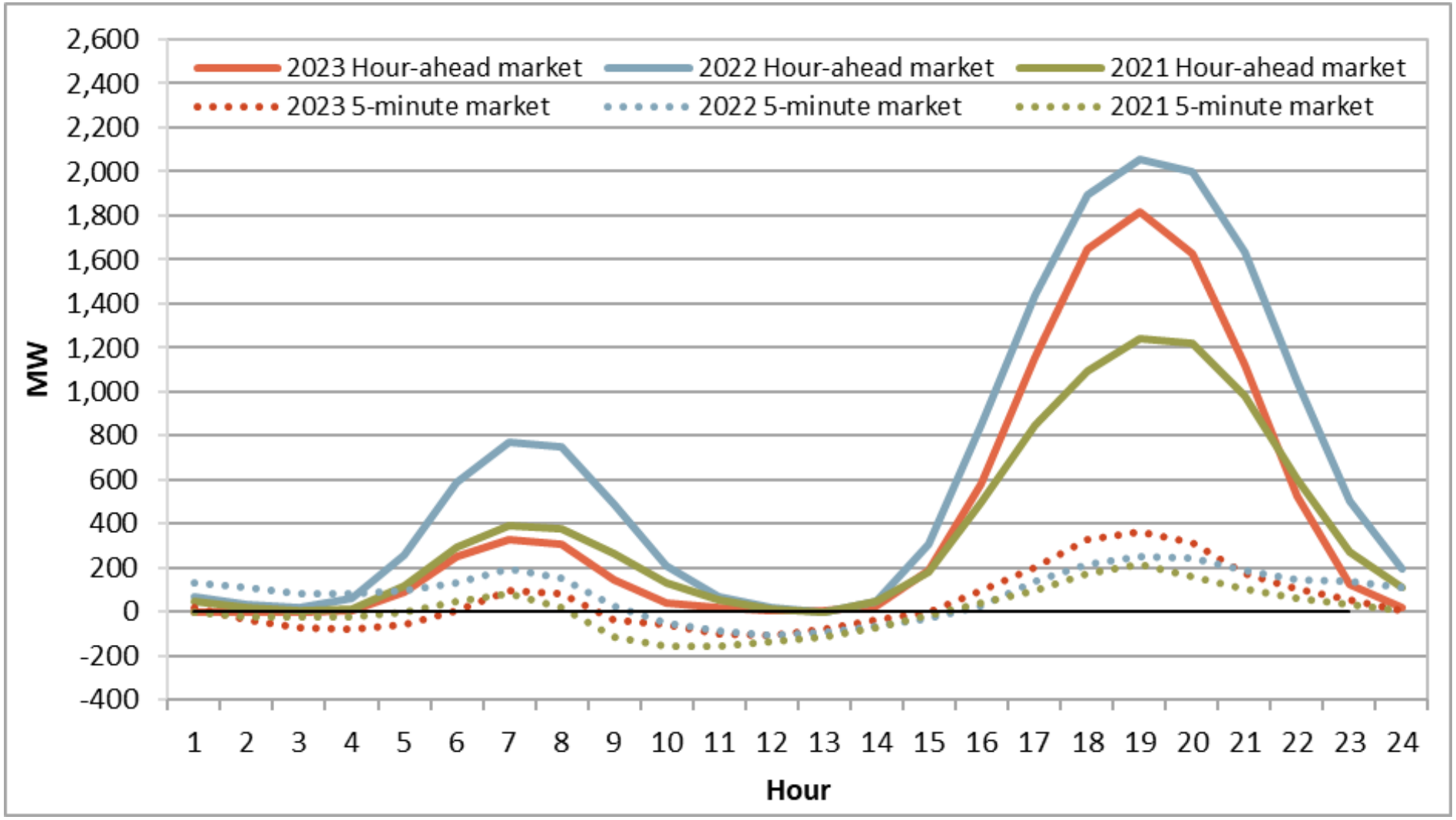
Impact of congestion and greenhouse gas on 15-minute prices (2023)



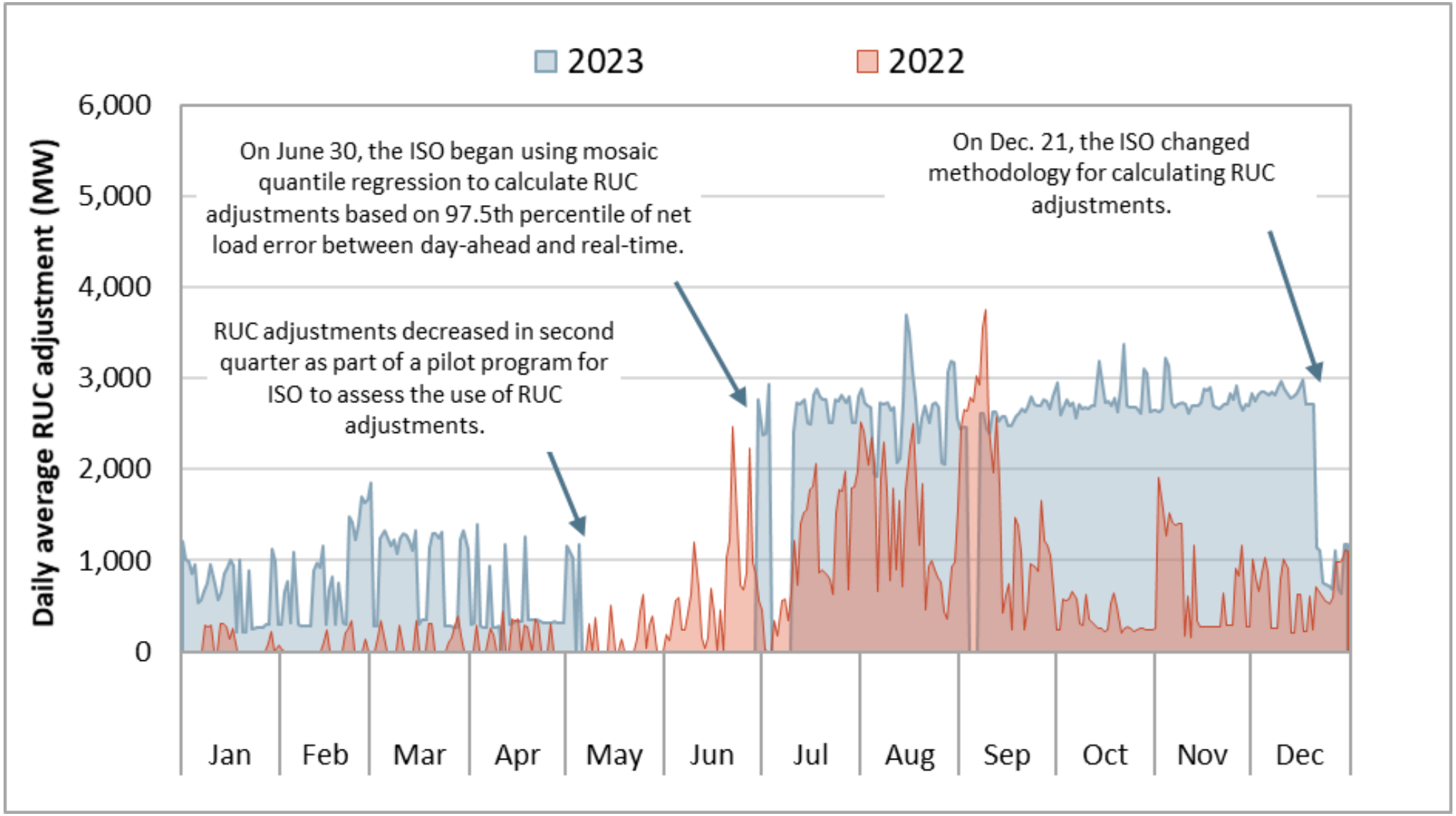
CAISO limited WEIM transfers into CAISO in hour-ahead and 15-minute markets, but not 5-minute market, during peak net load hours July 26 – November 15, 2023.



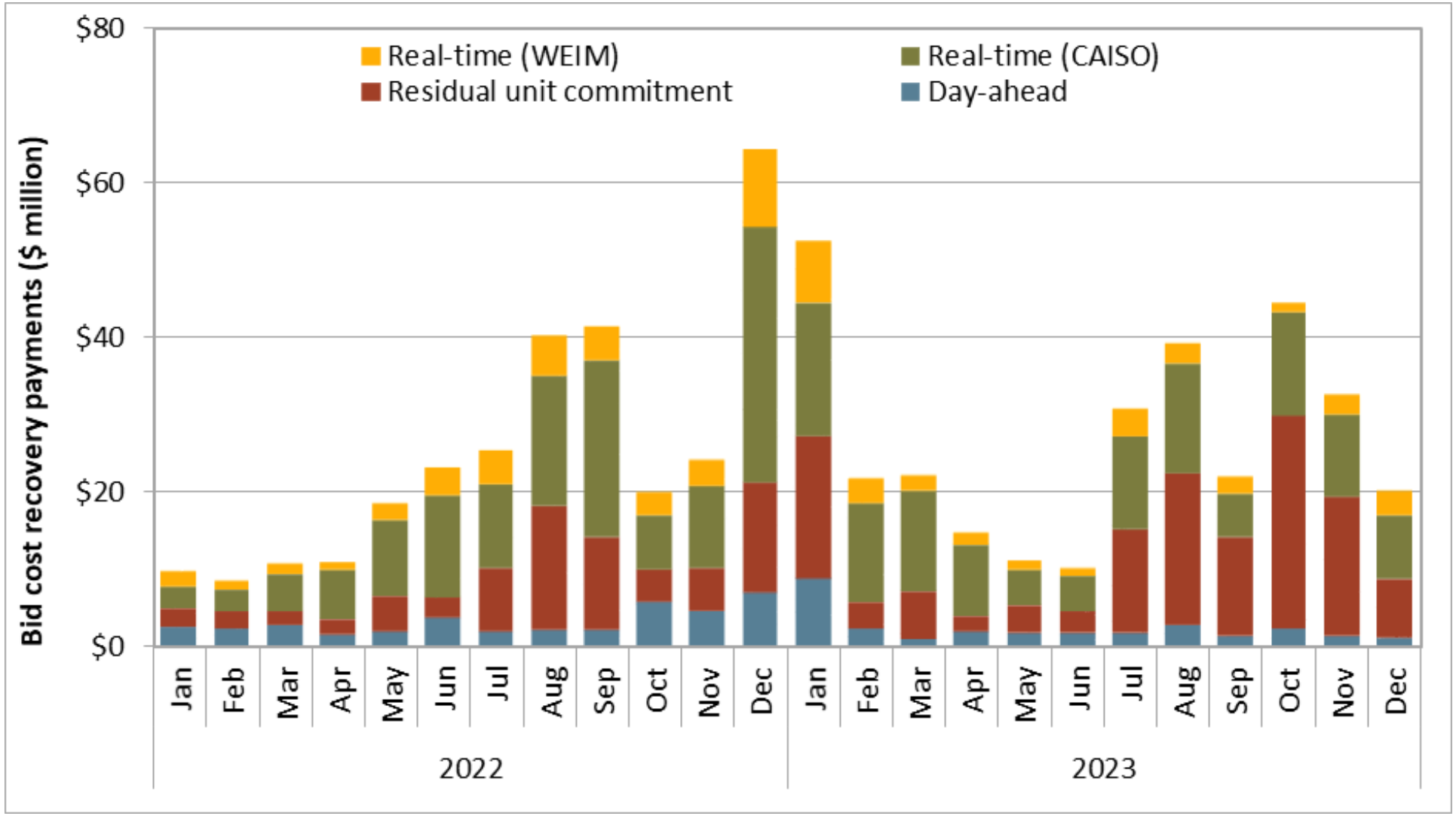
Continued high load adjustment in hour-ahead and 15-minute markets compared to 5-minute market during evening ramp hours



RUC load adjustments significantly higher in second half of year

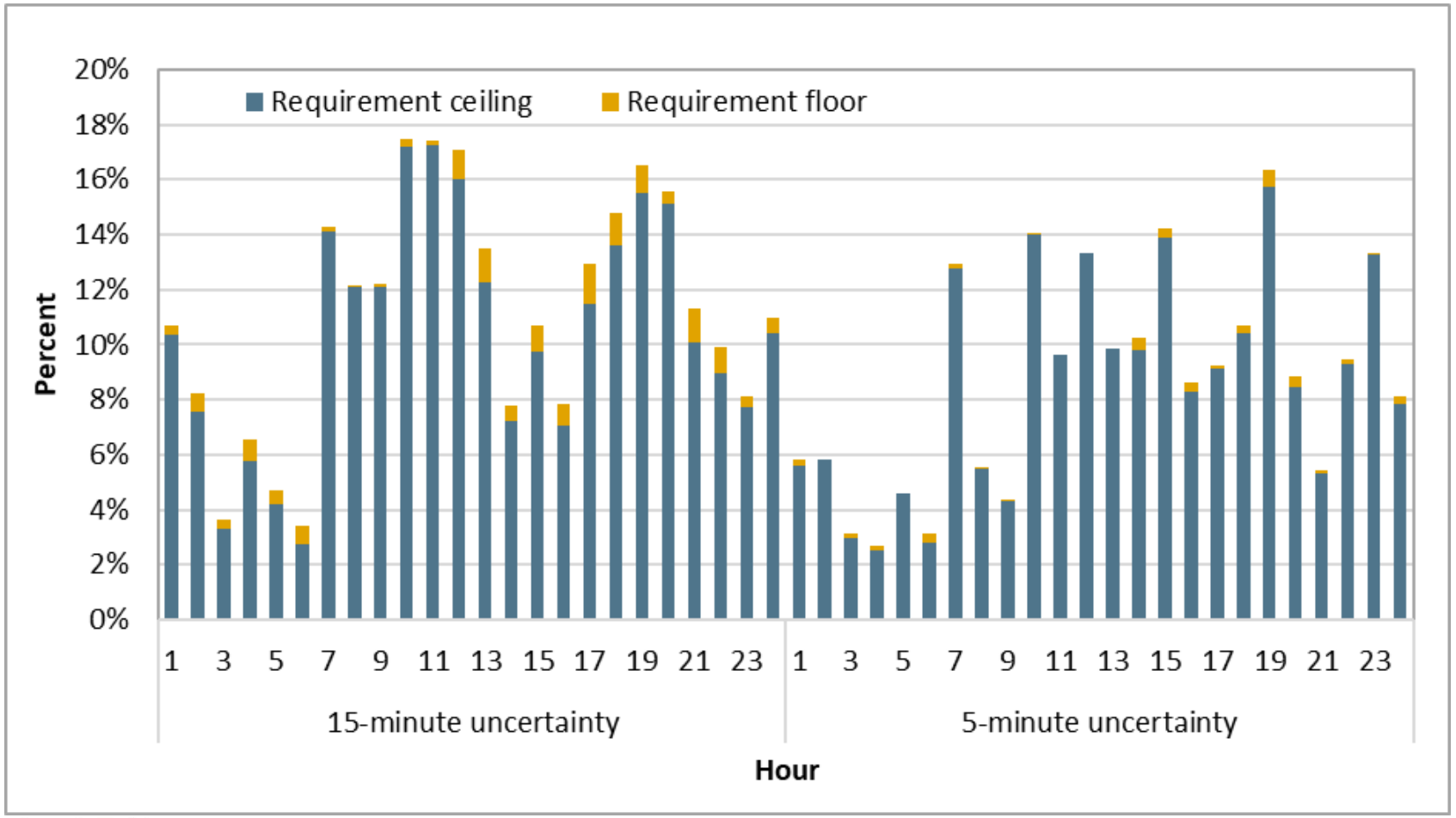


Bid cost recovery for CAISO was $289 million – highest value since 2011. BCR for WEIM fell to $33 million

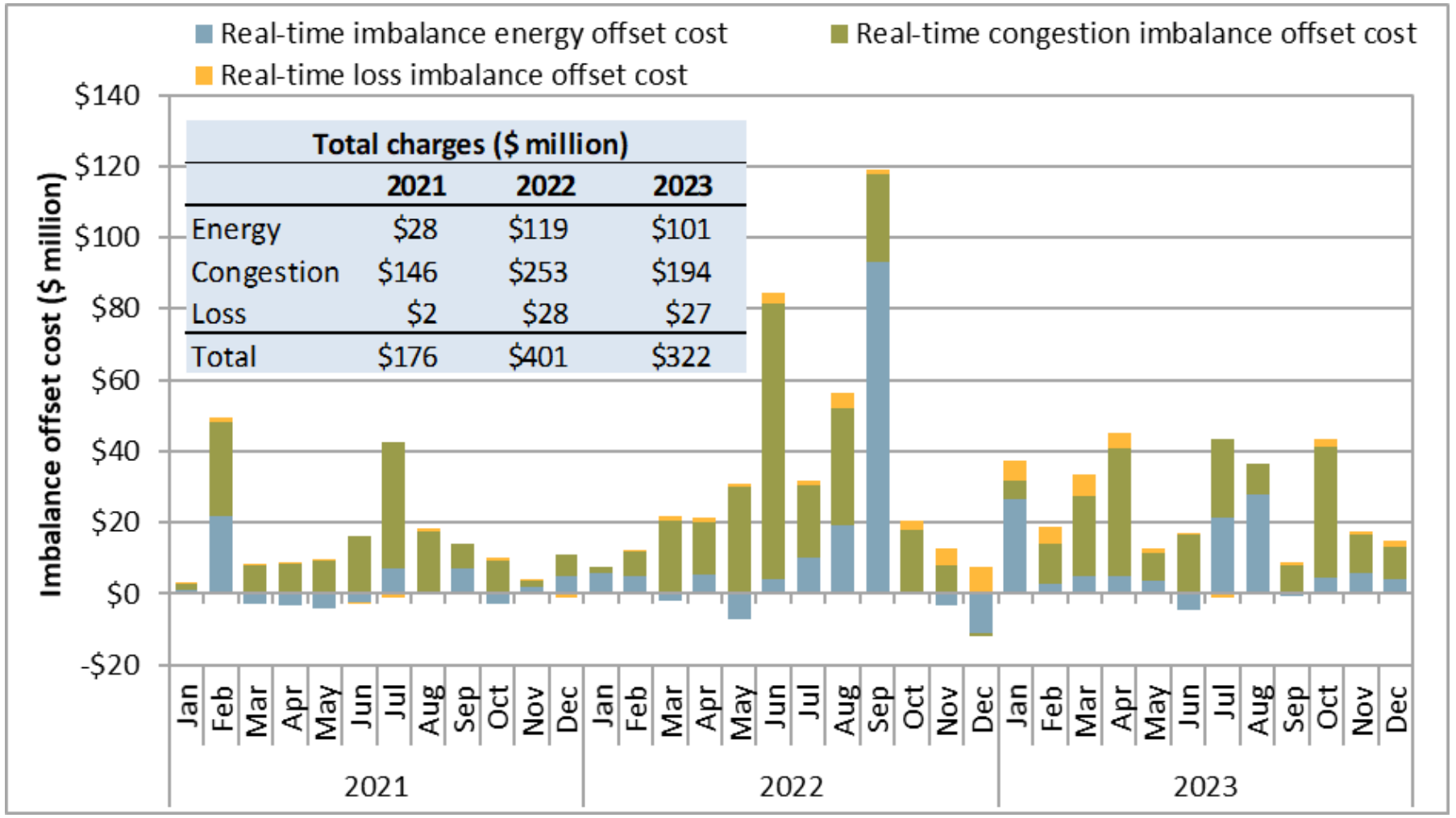


Mosaic quantile regression method implemented for estimating uncertainty for flexible ramping product, resource sufficiency evaluation, and RUC load adjustments

Frequency that thresholds were applied to FRP pass-group uncertainty requirement

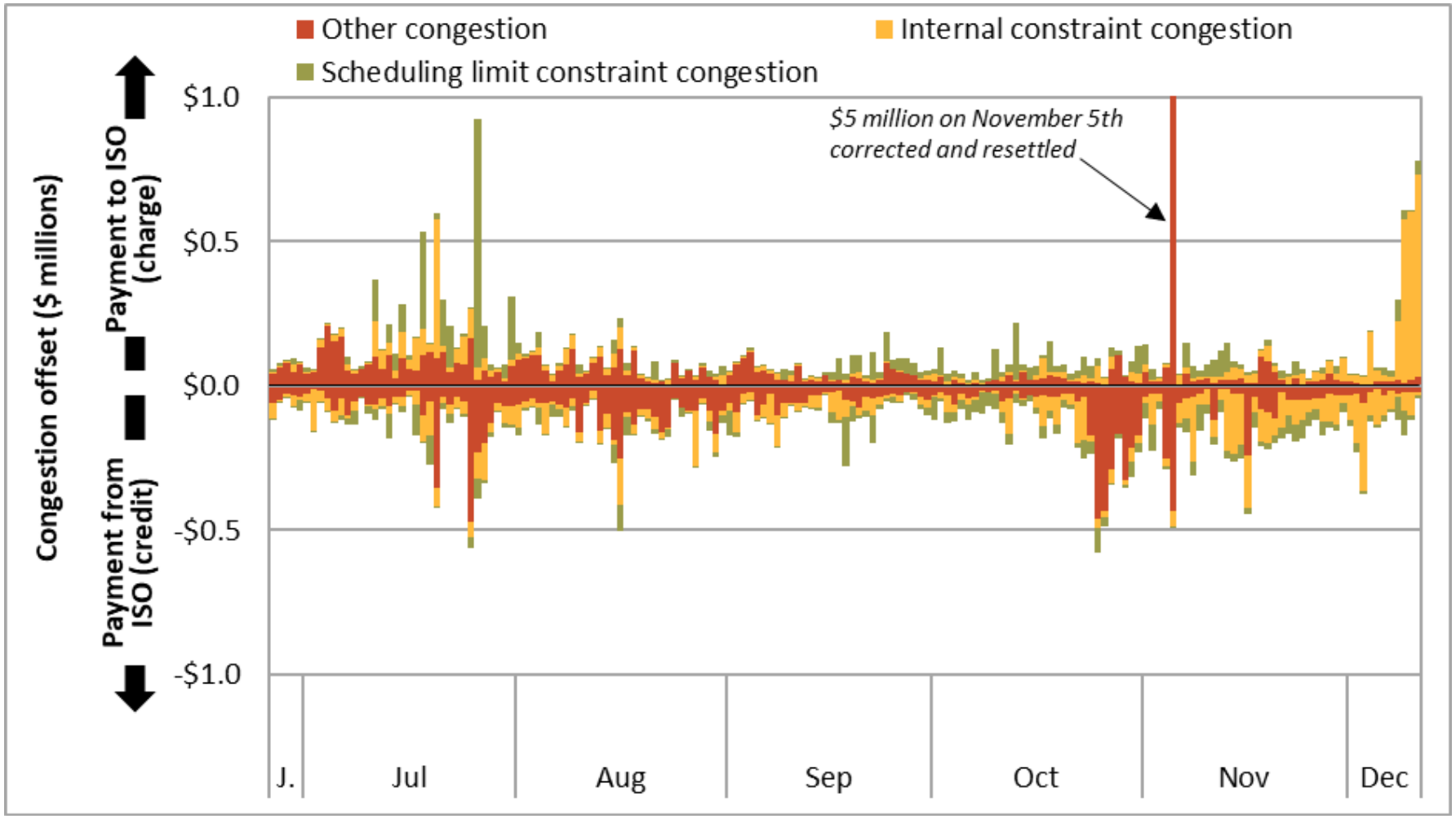


Real-time imbalance energy costs caused by 1) difference between price paid to generation and price paid by load, and 2) error in settlement price used for CAISO load

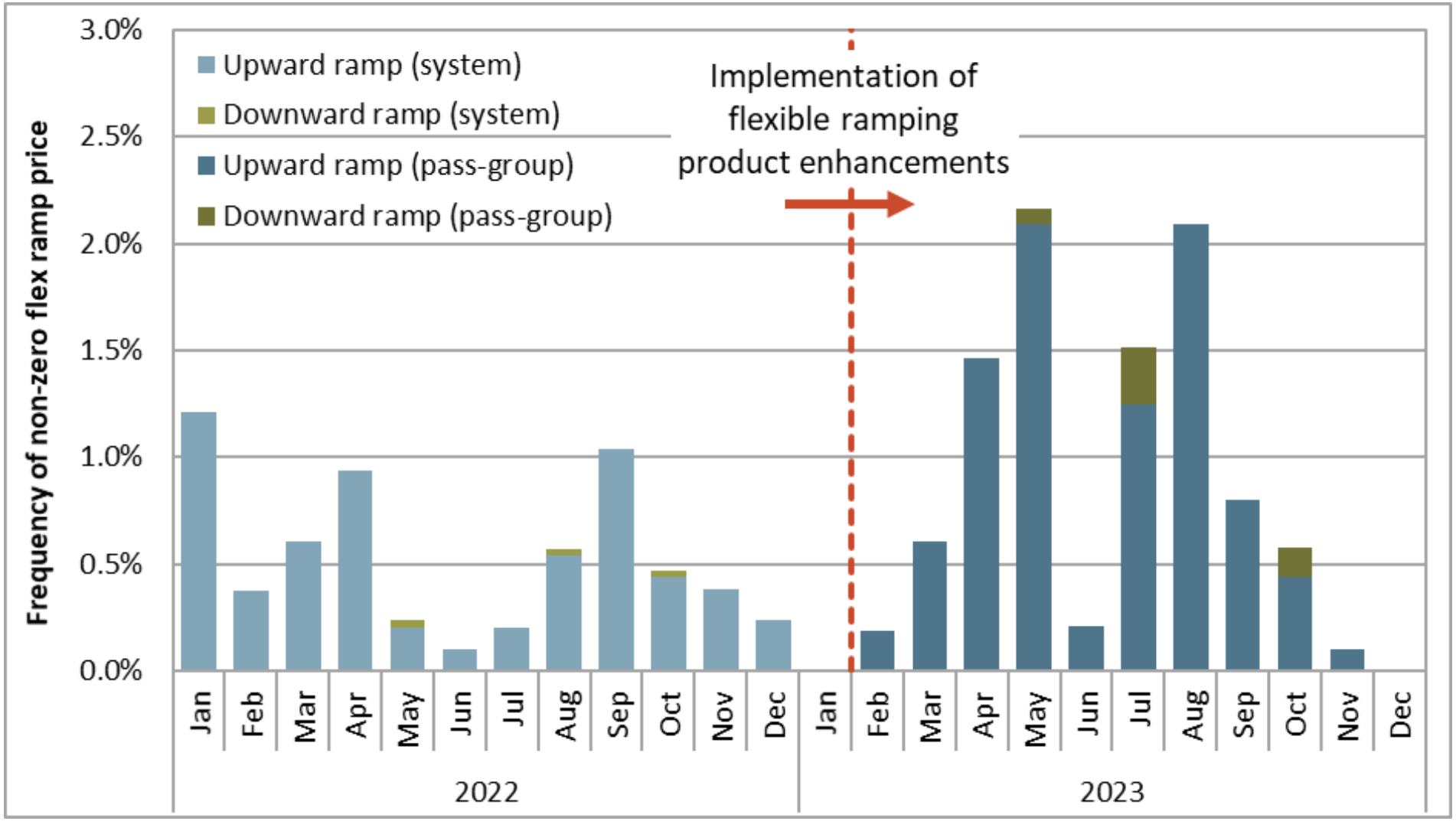


Total charges ($ million)	2021	2022	2023
Energy	$28	$119	$101
Congestion	$146	$253	$194
Loss	$2	$28	$27
Total	$176	$401	$322

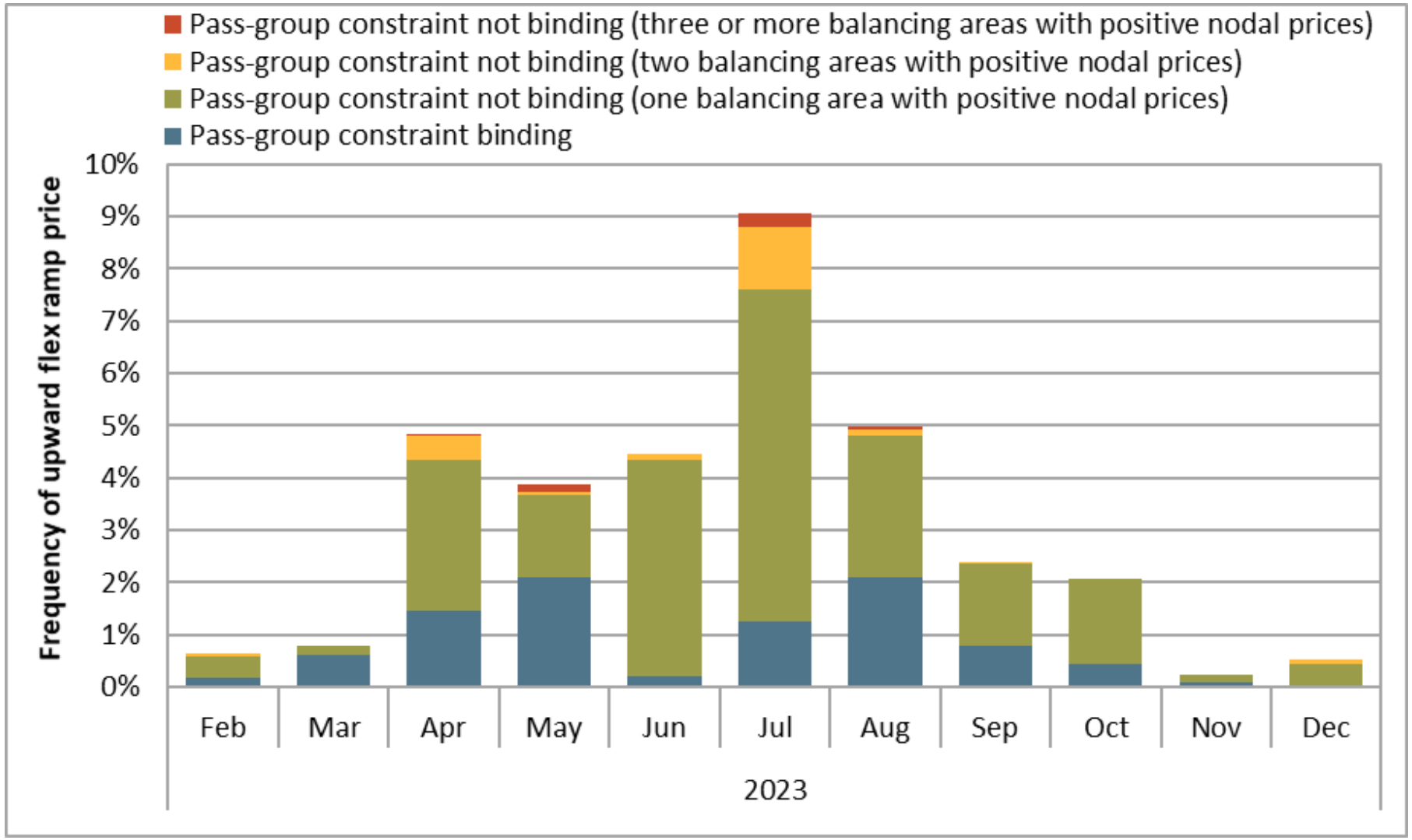
WEIM daily 5-minute market component of congestion offset calculation by congestion type – some misallocation of "other" from June 26 to December 11, 2023



With nodal flexible ramping product procurement, frequency of non-zero upward system prices in 15-minute market has increased slightly

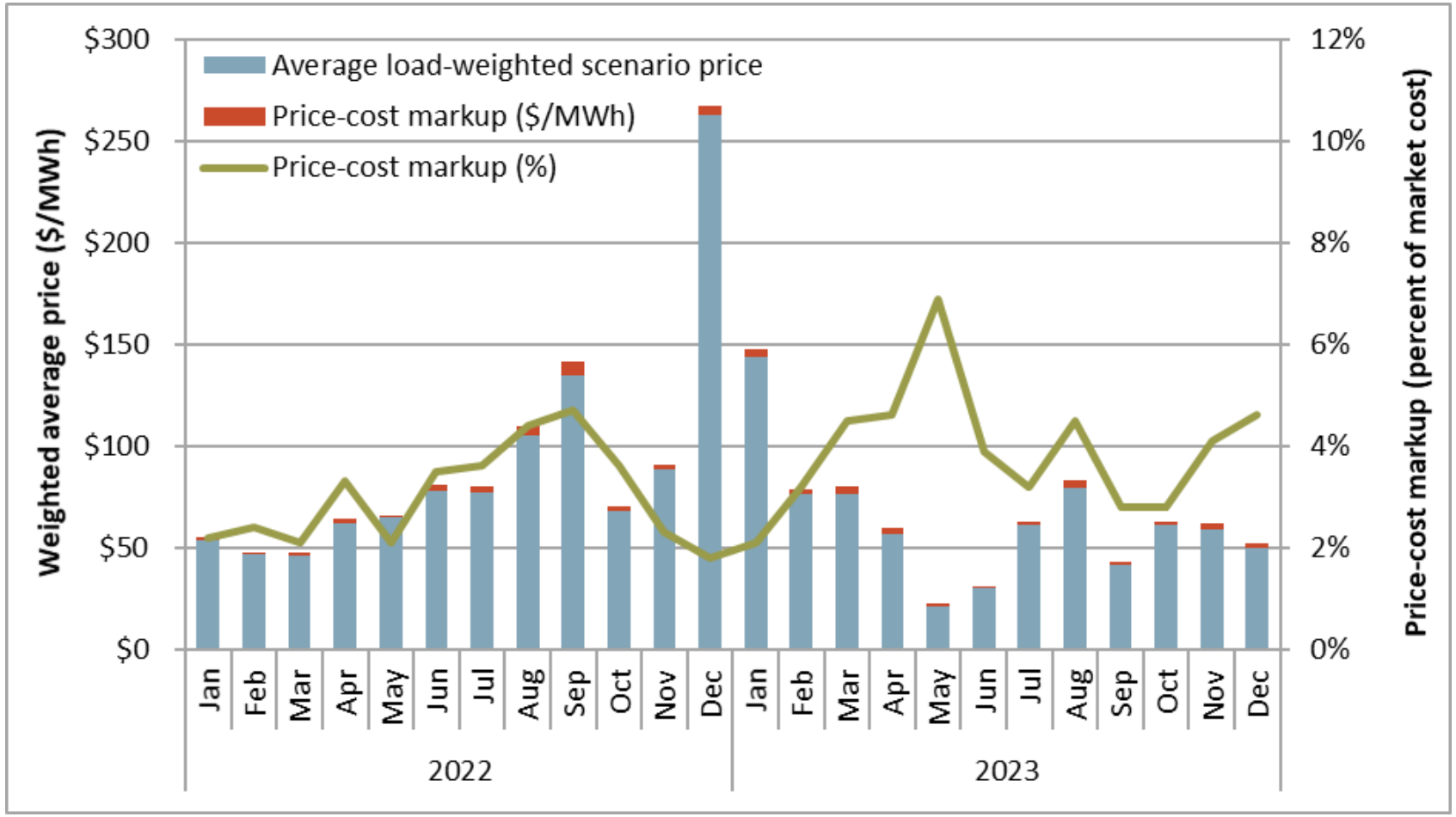


Frequency of 15-minute market upward flexible ramping price at any node in pass-group

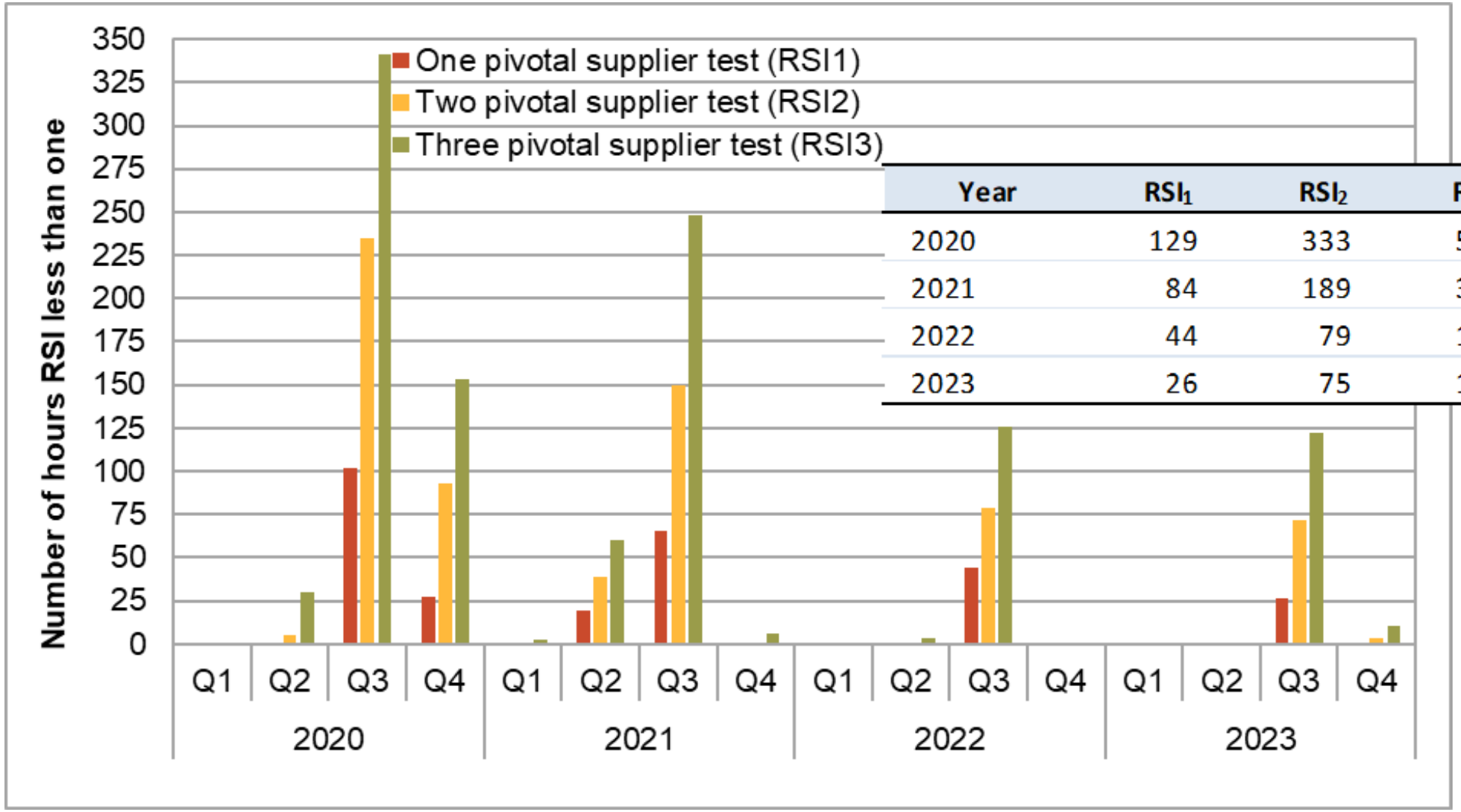


The ISO's energy markets were competitive in 2023, with energy prices about equal to competitive baseline prices calculated by DMM

Total markup about $2.68 or about 3.6% compared to $3.04/MWh or about 3.1% in 2022

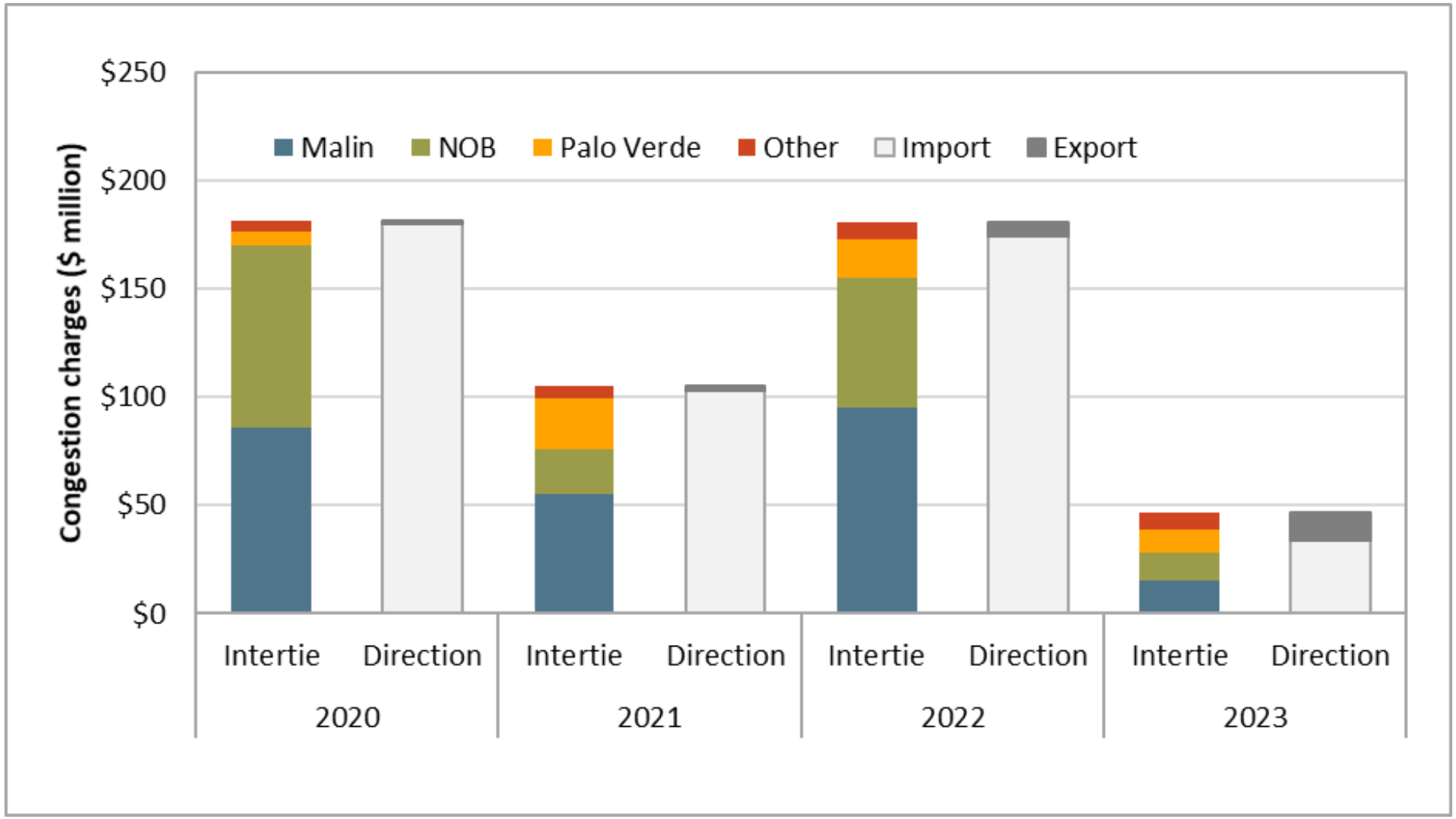


Day-ahead market structural competitiveness similar to 2022

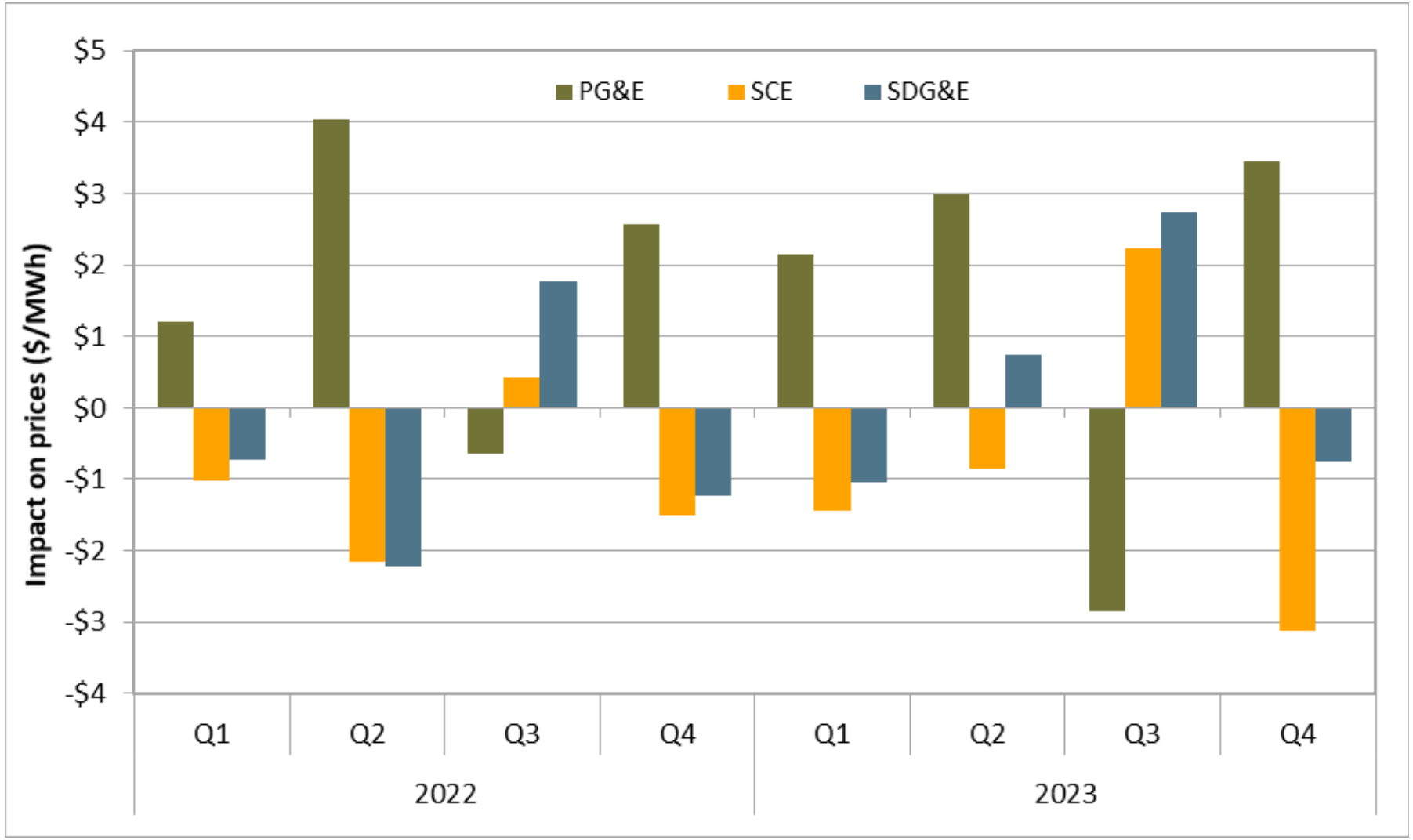


Year	RSI_1	RSI_2	RSI_3
2020	129	333	524
2021	84	189	316
2022	44	79	130
2023	26	75	132

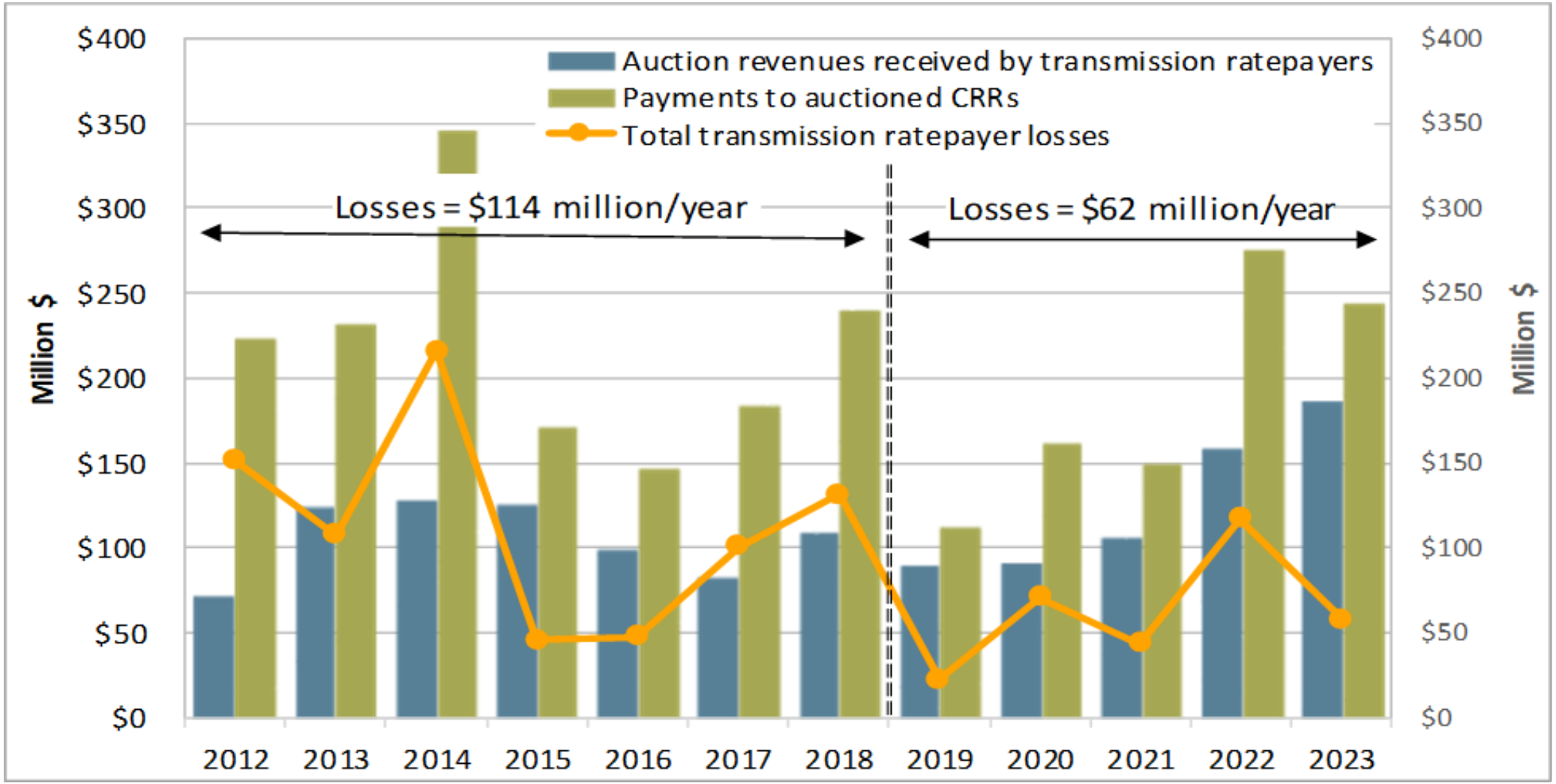
Day-ahead congestion rent on interties decreased overall, but export congestion rent increased



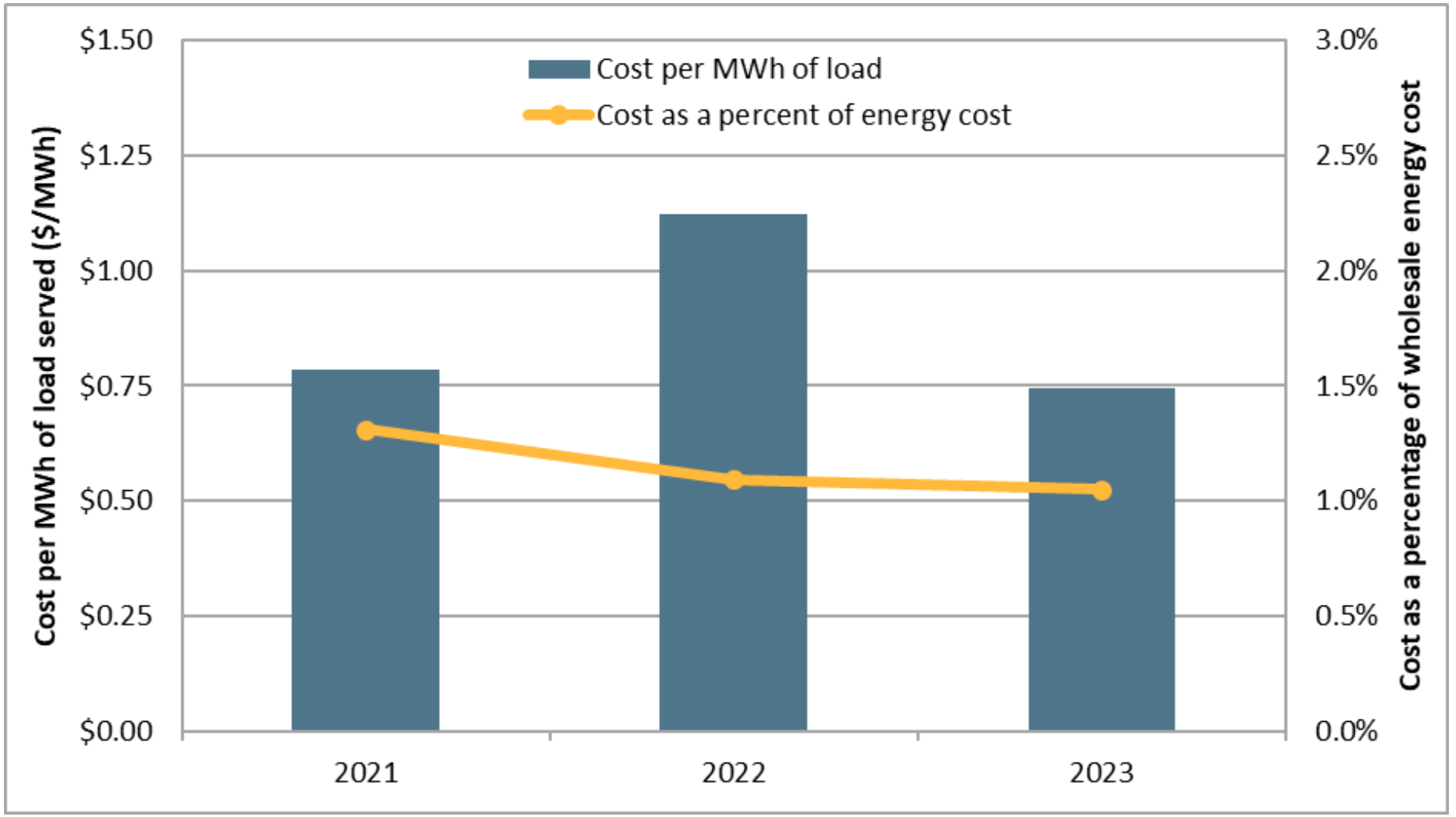
Average impact of internal constraint congestion on price separation between major load areas decreased slightly in 2023



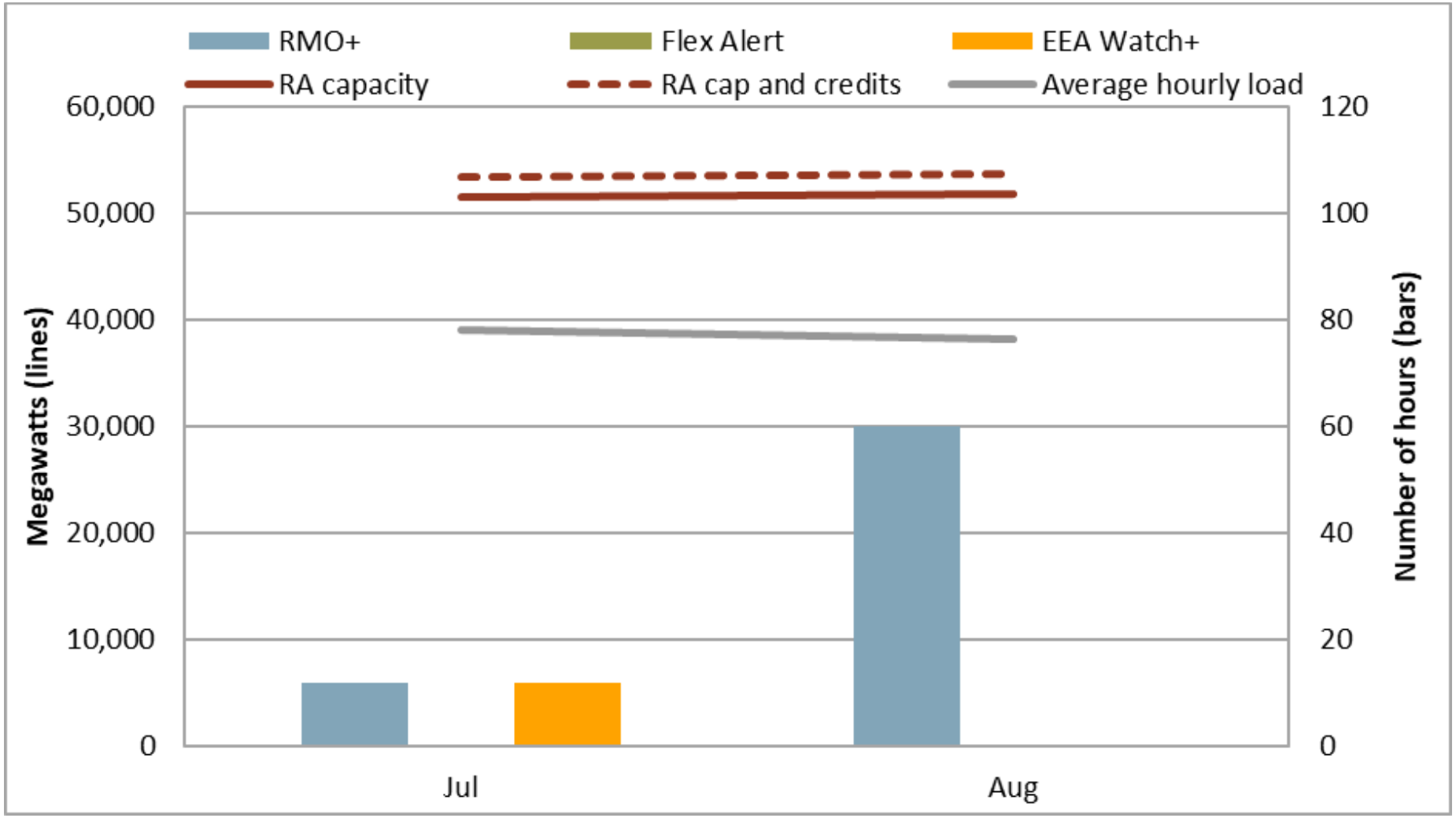
Transmission ratepayers lost about $59 million from auctioned CRRs in 2023, receiving only about 76 cents per dollar paid out to buyers



Ancillary service costs decreased to 1.0% of total wholesale energy costs



Average hourly resource adequacy capacity and load (2023 emergency notification hours)



Average total system resource adequacy capacity, availability, and performance by system emergency notification category

Year	Alert category	Number of hours	Total RA capacity	Day-ahead market			Real-time market				Meter	Uncapped meter
				Capacity de-rate	Bids and self-schedules	Schedules	Capacity de-rate	Bids and self-schedules	Schedules	Uncapped schedules		
2020	RMO+	390	47,723	94%	87%	61%	93%	86%	58%	68%	55%	64%
	Flex Alert+	154	48,602	95%	87%	67%	93%	85%	63%	73%	61%	68%
	Alert+	97	45,404	95%	89%	72%	94%	88%	68%	79%	65%	73%
2021	RMO+	359	41,480	93%	88%	57%	92%	87%	52%	66%	50%	63%
	Flex Alert+	38	48,878	94%	88%	81%	92%	87%	77%	87%	73%	81%
	Alert+	14	49,359	93%	85%	80%	92%	85%	77%	85%	73%	80%
2022	RMO+	151	49,799	95%	90%	75%	94%	89%	69%	83%	64%	77%
	Flex Alert+	56	49,509	95%	91%	85%	93%	89%	77%	88%	72%	81%
	EEA Watch+	35	49,390	95%	90%	87%	93%	89%	79%	89%	74%	81%
	EEA 2+	17	49,490	95%	91%	89%	93%	90%	82%	92%	78%	85%
2023	RMO+	72	51,688	94%	90%	73%	93%	89%	67%	82%	62%	75%
	EEA Watch+	12	51,772	96%	94%	68%	94%	92%	58%	80%	54%	75%

Recommendations

- Extended day-ahead market
  - Decrease imbalance reserve product demand curve and consider procuring imbalance reserve only in residual unit commitment market
  - Develop real-time product covering uncertainty several hours out to retain imbalance reserves procured in EDAM
  - Address potential market power in resource sufficiency market created by requirement for firm transmission
  - Rules to help prevent supply in EDAM balancing area with EDAM energy or capacity award from subsequently supporting non-source specific import counted towards another balancing area's resource sufficiency requirement
- Congestion revenue rights
  - Eliminate auction based on transmission capacity that forces transmission ratepayers to offer to sell CRRs at a $0 reservation price
  - Replace with auction in which every seller sets their reservation price

Recommendations

- Batteries
  - Revise bid cost recovery rules to eliminate eligibility when state-of-charge constraints cause uneconomic schedules
  - Enhance default energy bids to allow variation throughout day based on current opportunity costs
  - Create standardized default energy bid for batteries in WEIM
  - Extend local market power mitigation to include hybrid resources

- Price formation enhancements
  - Extend flexible ramping product time horizon or develop simpler product to ensure ramping capacity to cover uncertainty several hours in future
  - Re-optimize ancillary services in real-time
  - Fix maximum import bid price shaping factor that converts bilateral multi-hour block price into hourly prices

Recommendations

- High priority wheeling rights
  - More thoroughly study internal constraint limitations in determination of transmission available for monthly high priority wheeling rights

- Resource adequacy
  - Redesign mechanism for incentivizing availability to evaluate performance and to have much larger financial penalties
  - Enhance outage reporting requirements so CAISO operators can decline discretionary maintenance outage requests made within the “forced outage” timeframe