Analysis on Maximum Import Bid Price Shaping Factor

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May 28, 2024

Scope

Historical performance and targeted changes to the logic of hourly shaping factor component used in the MIBP calculation

Agenda

- Overview of max import bid price (MIBP) and shaping factor formulas
- Historical performance of current shaping factor calculation
- Potential improvements to the calculation

BACKGROUND AND OVERVIEW

Background on FERC Order No. 831 – Import Bidding and Market Parameters initiative

- FERC Order No. 831 (2016)[1] directed ISOs/RTOs to allow cost-verified energy bids above $1,000/MWh up to $2,000/MWh
- CAISO opened the stakeholder initiative titled "FERC Order 831 – Import Bidding and Market Parameters"[2] to comply with the order
  - Policy introduced the Max Import Bid Price (MIBP) calculation as a way to screen import/virtual supply bids above $1,000/MWh
  - MIBP is intended to represent prevailing energy prices outside of the CAISO area using two main bilateral power hubs: Mid-C, Palo Verde
  - Bilateral power prices are published in multi-hour blocks (on-peak and off-peak)
  - MIBP enables CAISO to translate block power prices into an hourly curve, reflecting the fact that CAISO prices vary hourly

1 FERC order text: https://www.ferc.gov/sites/default/files/2020-06/RM16-5-000.pdf

2 Initiative home page: https://stakeholdercenter.caiso.com/StakeholderInitiatives/FERC-Order-831-Import-bidding-and-market-parameters

The hourly shaping factor is used in the Maximum Import Bid Price calculation to scale block bilateral prices

$$MIBP_i = Electric\ Hub\ Price_{TOU} * Hourly\ Shaping\ Factor_i * 1.1$$

Where:

i : hour between 1 and 24

Electric Hub Price : the maximum of Mid-C or Palo Verde bilateral index price

TOU : Time of use, peak or off-peak

$$Hourly\ Shaping\ Factor = 1 + \frac{Hourly\ DA\ SMEC_{current} - Average\ DA\ SMEC_{high-priced}}{Average\ DA\ SMEC_{high-priced}}$$

The formula of the shaping factors can be rewritten as follows:

$$Hourly\ Shaping\ Factor = \frac{Hourly\ DA\ SMEC_{current}}{Average\ DA\ SMEC_{high-priced}}$$

Current implementation of the logic aligns with the intended logic described in the policy efforts

- Day-ahead shaping factor uses DA SMEC from most recent day (1 day lag) while real-time shaping factor uses DA SMEC for the upcoming trading day (no lag)
- Above formulas were captured in
  - Revised Final Proposal (2020),[1]
  - the Business Requirement Specifications[2], and later in
  - the BPM for Market Instruments[3]

1 https://www.caiso.com/InitiativeDocuments/RevisedFinalProposal-FERCOrder831-ImportBidding-MarketParameters.pdf
2 https://www.caiso.com/Documents/BusinessRequirementsSpecificationFERC831ImportBiddingMarketParameters.pdf
3 https://bpmcm.caiso.com/Pages/BPMDetails.aspx?BPM=Market%20Instruments

Stakeholders have highlighted that the formula in the CAISO tariff results in a different formula than what is captured in BPM and Policy documents

- 30.7.12.5.3: *"As detailed in the CAISO Business Practice Manual, the CAISO calculates the hourly shaping ratio for each hour by dividing the Day-Ahead Market System Marginal Energy Cost for the CAISO Balancing Authority Area in that hour of a previous representative Trading Day by the average Day-Ahead Market System Marginal Energy Cost for the CAISO Balancing Authority Area in all on-peak hours of the same previous representative Trading Day."*

$$Hourly\ Shaping\ Factor = \frac{Hourly\ DA\ SMEC_{high-priced}}{Average\ DA\ SMEC_{high-priced}}$$

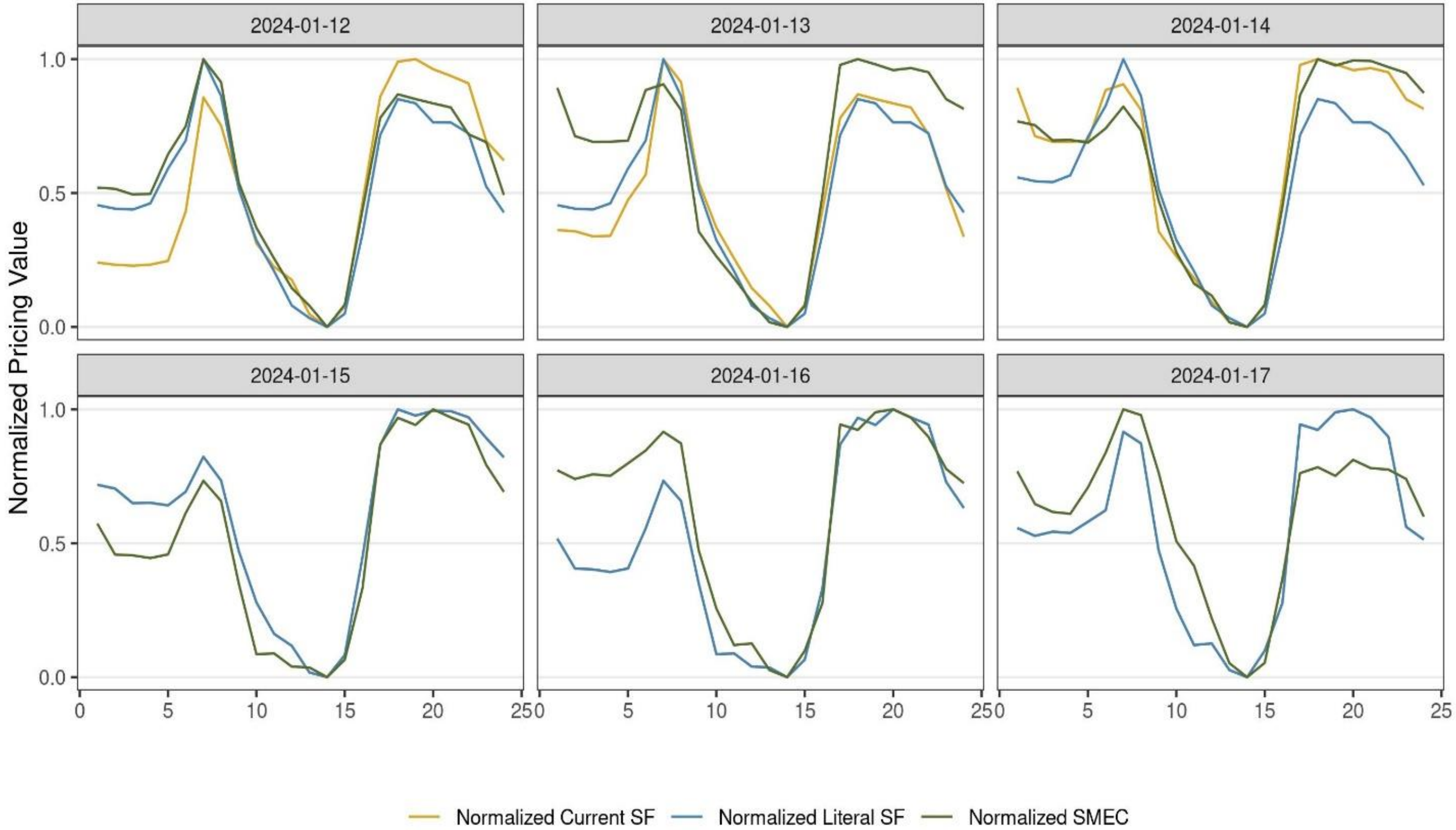
- When the current day is the same as the high-priced day, this "literal" formula and the current formula yield the very same results
- Main differences between formulas arise at the beginning and tail end of high-priced periods

SHAPING FACTOR HISTORICAL PERFORMANCE

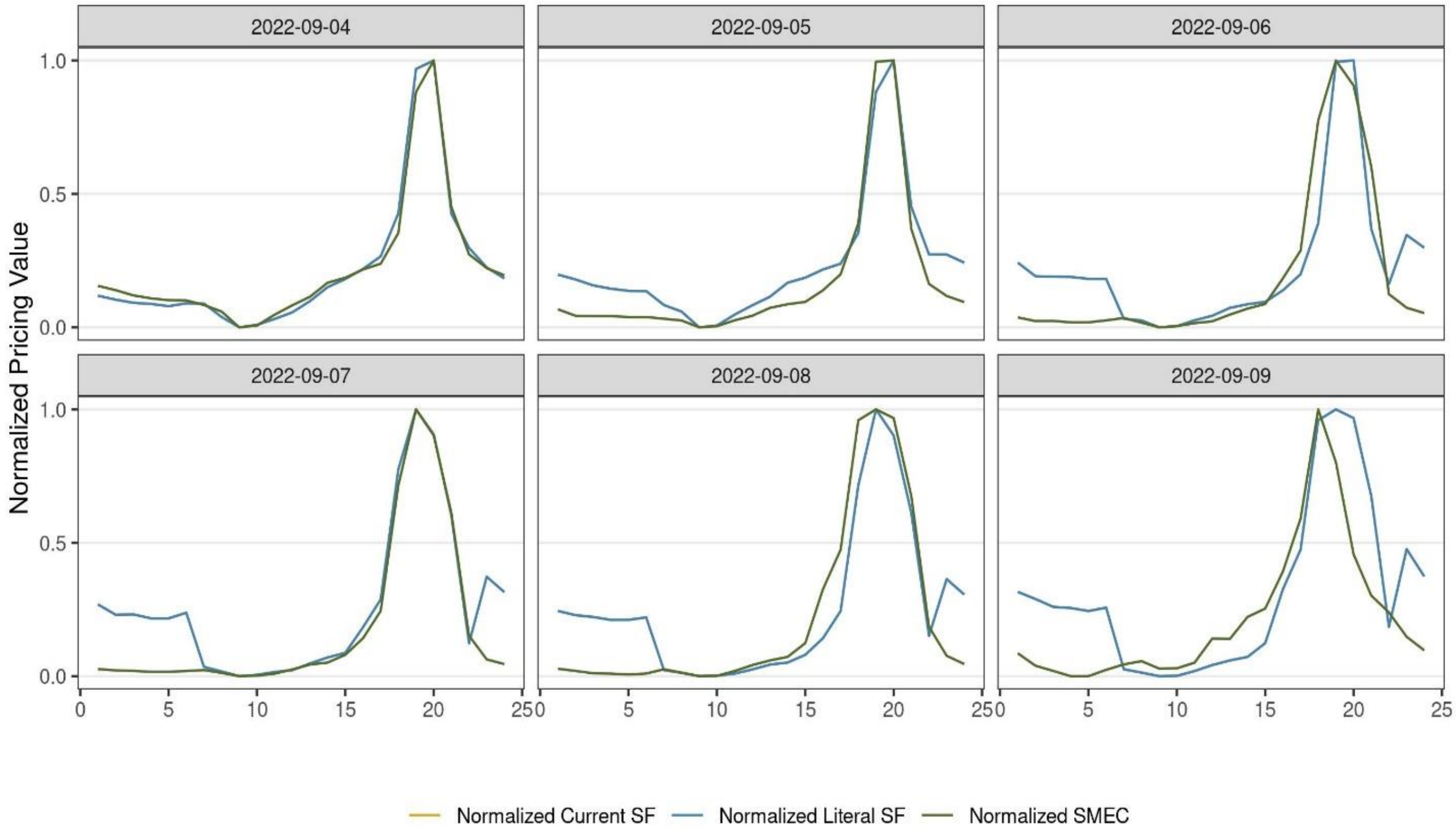
Comparison of the shaping factor to actual, materialized market prices can help evaluate shaping factor's performance after-the-fact

- Compare hourly day-ahead shaping factor to hourly day-ahead SMEC
- Compare hourly real-time shaping factor to average hourly real-time (RTPD) SMEC
- Use normalization to compare prices on the same scale [0,1]

Normalized shaping factors track normalized day-ahead SMEC well during on-peak hours but more poorly during off-peak hours – Jan 12-17, 2024



Results for Sep 4-9, 2022 track similarly with closer correlation between peak hours and poorer correlation on off-peak hours



SHAPING FACTOR FORMULAS AND THEIR IMPACT ON MIBP

Two different formulas are enumerated depending on interpretation of policy/Tariff/BPM language

Current:

$$1 + \frac{Hourly\ DA\ SMEC_{current} - Average\ DA\ SMEC_{high-priced}}{Average\ DA\ SMEC_{high-priced}}$$

Literal:

$$\frac{Hourly\ DA\ SMEC_{high-priced}}{Average\ DA\ SMEC_{high-priced}}$$

Example: Calculating day-ahead shaping factor for Jan 12 2024, HE17. Latest available DA SMEC is from Jan 11. Jan 25, 2023 is latest high-priced day above $200.

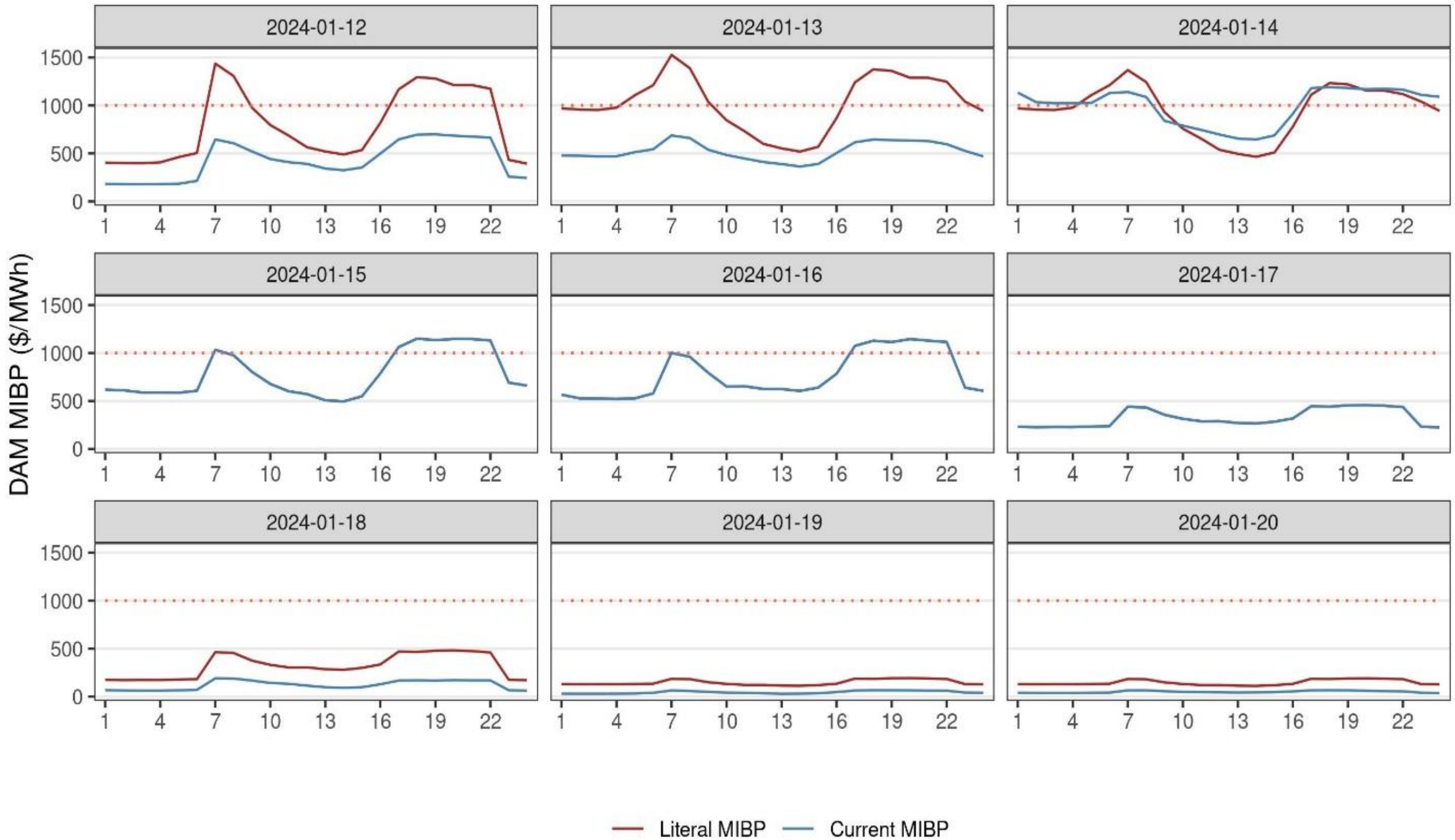
$$1 + \frac{HE17\ SMEC_{Jan\ 11} - Average\ SMEC_{Jan\ 25\ 2023, on\ peak}}{Average\ SMEC_{Jan\ 25\ 2023, on\ peak}}$$

$$= 1 + \frac{102.17 - 152.93}{152.93} = 0.67$$

$$\frac{HE17\ SMEC_{Jan\ 25\ 2023, on\ peak}}{Average\ SMEC_{Jan\ 25\ 2023, on\ peak}}$$

$$= \frac{184.76}{152.93} = 1.21$$

The two shaping factor formulas yield divergent results at onset of high-price periods, like for January 2024, but catch up and are equivalent once DA SMEC surpasses $200/MWh



A full comparison of the two formulas from June 2021 – April 2024 show that there are more instances where the “literal” shaping factor’s MIBP is above the “current” shaping factor’s MIBP when the calculations exceed $1,000/MWh

Scenario	DAM impacted hours	Percentage of total hours	Percentage of DAM hours above $1,000/MWh	RTM impacted hours	Percentage of total hours	Percentage of RTM hours above $1,000/MWh
1: Current MIBP < $1,000/MWh, literal MIBP ≥ $1,000/MWh	32	0.13%	30%	19	0.08%	17%
2: Current MIBP ≥ $1,000/MWh, literal MIBP < $1,000/MWh	5	0.02%	6.4%	6	0.02%	6.2%

The use of two difference price references in the current shaping factor logic may lead to unintended results

$$Hourly\ Shaping\ Factor = 1 + \frac{Hourly\ DA\ SMEC_{current} - Average\ DA\ SMEC_{high-priced}}{Average\ DA\ SMEC_{high-priced}}$$

This formula can be notated as follows:

$$SF_t = 1 + \frac{P_t^c - \sum_{t \in T} \frac{P_t^h}{|T|}}{\sum_{t \in T} \frac{P_t^h}{|T|}} \quad \forall t \in T$$

Getting a common denominator and simplifying the expression yields:

$$SF_t = \frac{|T| P_t^c}{\sum_{t \in T} P_t^h} \quad \forall t \in T$$

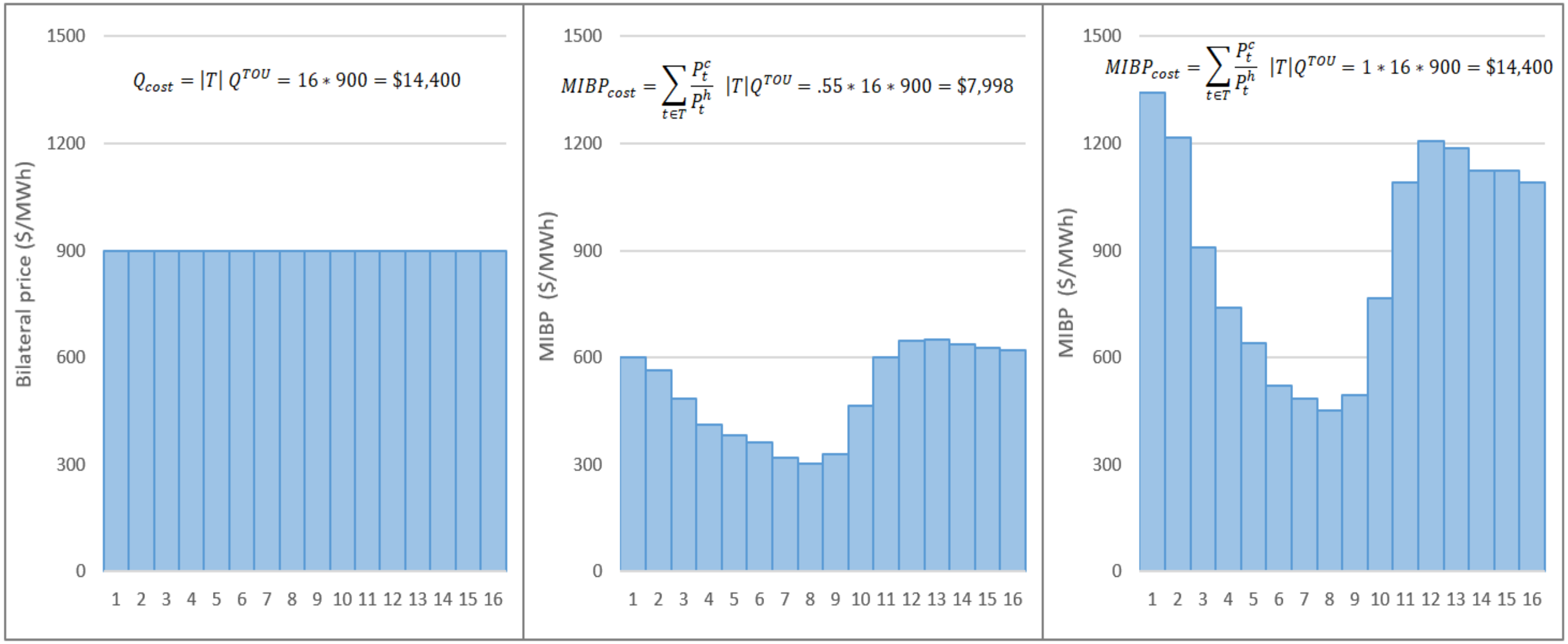
The average of the shaping factors for the block of $|T|$ hours can be derived as

$$\widetilde{SF} = \sum_{t \in T} \frac{\frac{|T| P_t^c}{\sum_{t \in T} P_t^h}}{|T|} = \sum_{t \in T} \frac{P_t^c}{P_t^h}$$

The average of the resulting shaping factors will equal to 1 per unit only when the same day is used for both current and high-price day

The shaping factor should maintain consistency between the price reference in both numerator and denominator

In order for the implied bilateral cost derived from the shaping factors to match the nominal bilateral cost, the average of the block of shaping factors, $\sum_{t \in T} \frac{P_t^c}{P_t^h}$, should equal 1



The current logic can result in either higher or lower shaping factors depending on the combination of prices of the current and high-price day

POTENTIAL IMPROVEMENTS TO SHAPING FACTOR LOGIC

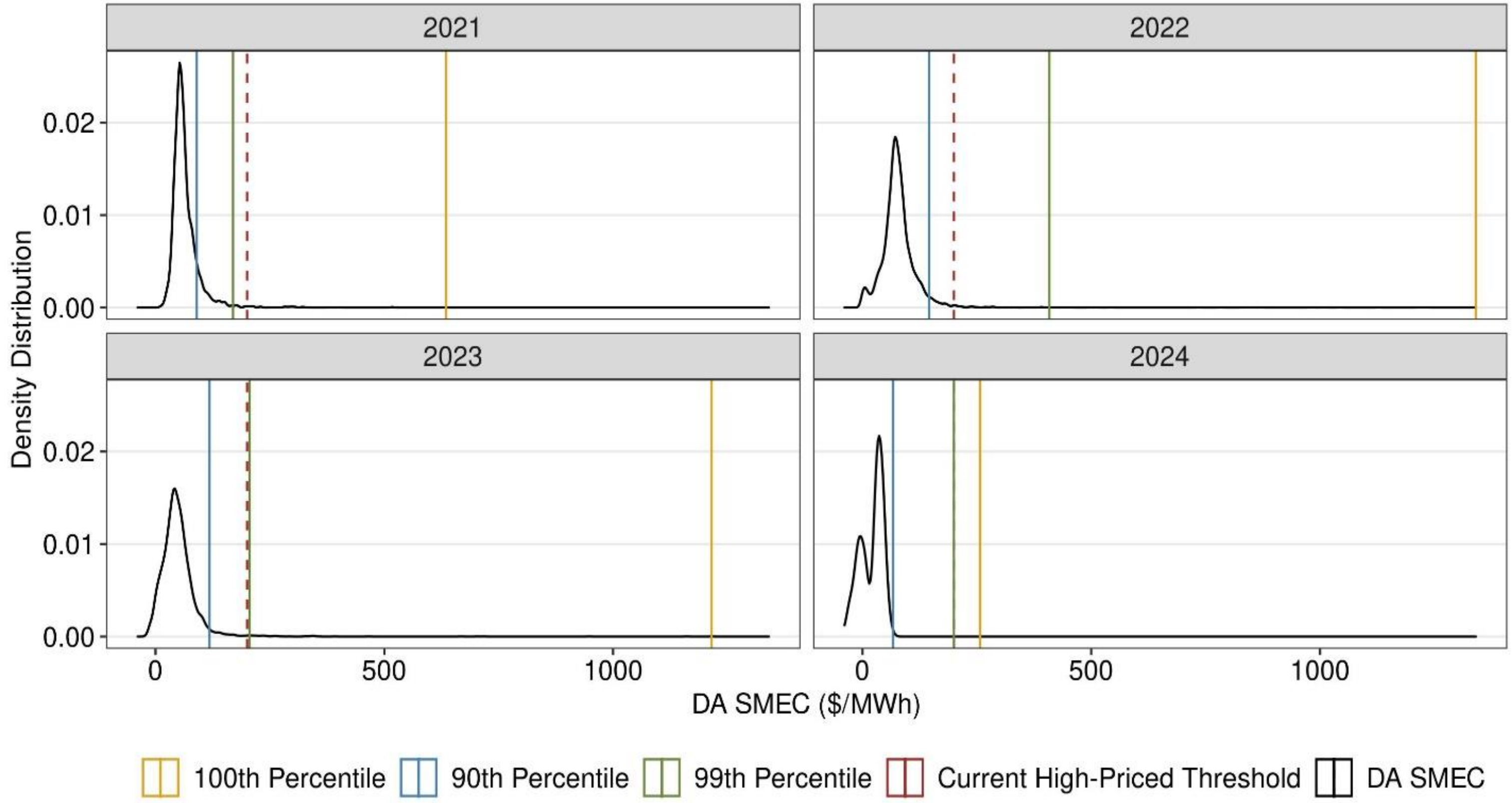
There are two main area for potential improvements in the shaping factor calculation

- Near term: Logic for the shaping factors
  - Alignment of days used in shaping factor for consistency

- Longer term: Reference prices to estimate shaping factors
  - More scientific assessment of “high-priced day”
  - Regional pricing considerations for real-time
  - Exploration of static shaping factor

The current $200/MWh high-priced threshold may be too high when examining historical price distributions

Distribution of day-ahead SMEC, summer period, Jun 2021 – Apr 2024, shows that $200/MWh is often at 99th percentile of historical prices. Winter period distribution shows similar results



The current use of day-ahead SMEC in the shaping factor does not fully capture regional price differences

- Though the MIBP is used for screening RA imports into the CAISO BAA, it is also used to scale penalty prices to the $2,000/MWh cap that impacts the entire market
  - High penalty prices on 831 days can influence the intra-day opportunity costs for storage and others

- Challenges:
  - Pricing reference is required pre-market to inform the shaping factor, and there is no way to get a real-time pricing reference pre-market
  - Market needs to have one consistent MIBP input, no way to handle multiple regional MIBP curves

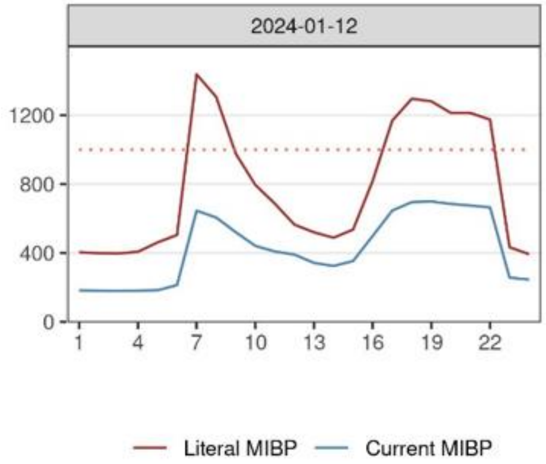
A static shaping factor could be designed to incorporate real-time prices and/or regional pricing differences

- The CAISO initially proposed static shaping factors in previous 831 policy iterations but pivoted following stakeholder feedback that the design would not be flexible or dynamic enough
- Static shaping factor can be updated at certain frequency such as quarterly
- MIBP still retains reference to expected price movement for upcoming day though the use of the next-day bilateral price
- Pros:
  - Could be formulated to integrate historical real-time WEIM prices in the real-time shaping factor
- Cons:
  - Would not be flexible enough to reflect expected hourly price variation for upcoming day

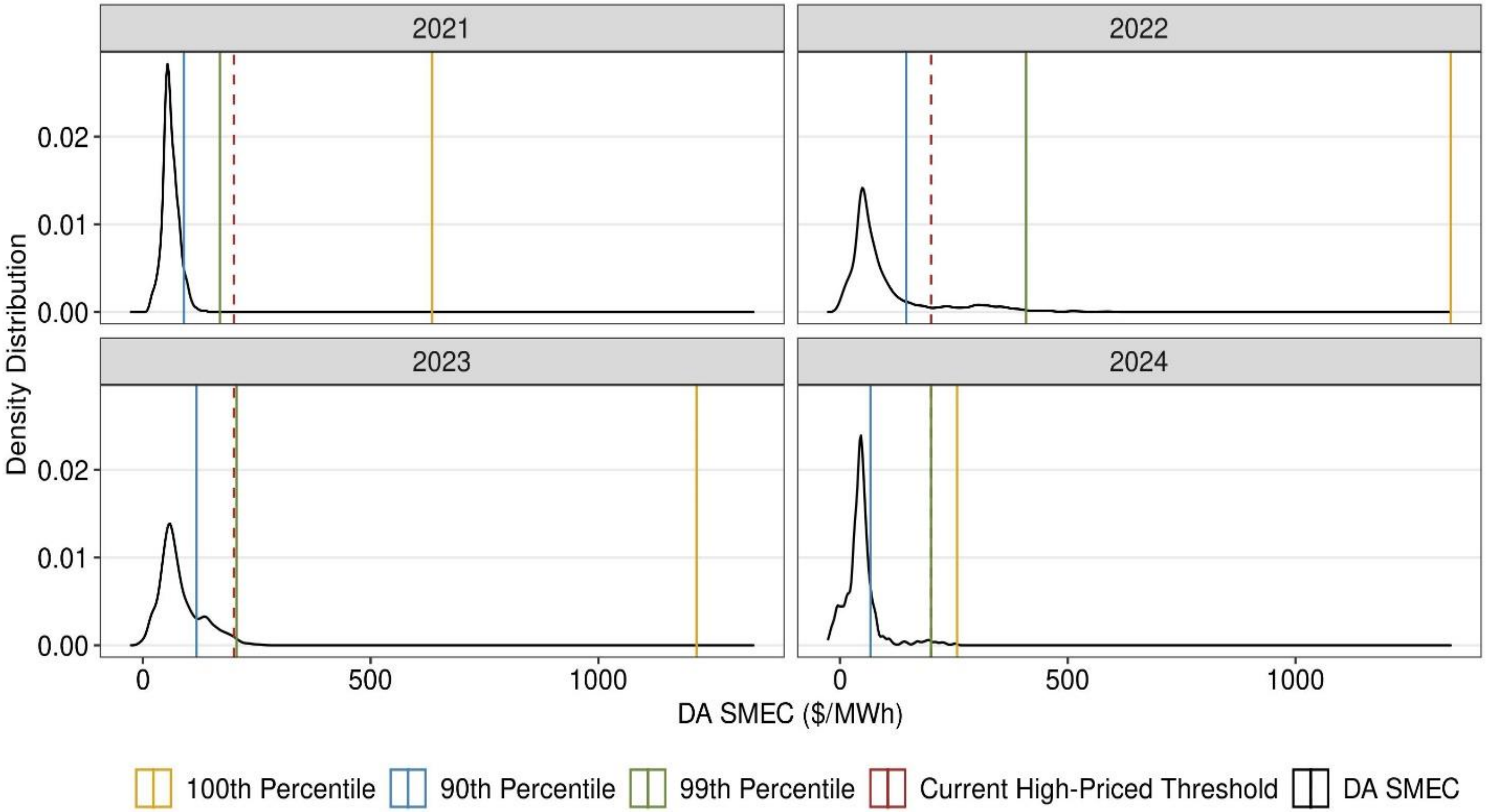
APPENDIX

Hourly example of shaping factor calculations, DAM January 12, 2024 (onset of Jan cold snap)

Hour-ending	Time of use	Jan. 11, 2024 DA SMEC (latest day)	Jan. 25, 2023 DA SMEC (high-priced day)	Current hourly shaping factor	Literal hourly shaping factor
1	OFF	72.57	161.07	0.43	0.95
2	OFF	72.02	158.90	0.43	0.94
3	OFF	71.79	158.34	0.42	0.94
4	OFF	72.04	162.20	0.43	0.96
5	OFF	72.97	183.78	0.43	1.09
6	OFF	85.08	201.16	0.50	1.19
7	ON	102.04	227.28	0.67	1.49
8	ON	95.81	206.64	0.63	1.35
9	ON	82.29	154.49	0.54	1.01
10	ON	69.76	125.82	0.46	0.82
11	ON	64.59	108.48	0.42	0.71
12	ON	61.72	89.25	0.40	0.58
13	ON	54.08	82.19	0.35	0.54
14	ON	51.29	77.21	0.34	0.50
15	ON	55.83	84.72	0.37	0.55
16	ON	78.83	129.38	0.52	0.85
17	ON	102.17	184.76	0.67	1.21
18	ON	109.93	204.89	0.72	1.34
19	ON	110.50	202.54	0.72	1.32
20	ON	108.28	191.83	0.71	1.25
21	ON	106.79	191.76	0.70	1.25
22	ON	105.14	185.70	0.69	1.21
23	OFF	102.32	172.63	0.60	1.02
24	OFF	97.56	156.58	0.58	0.92



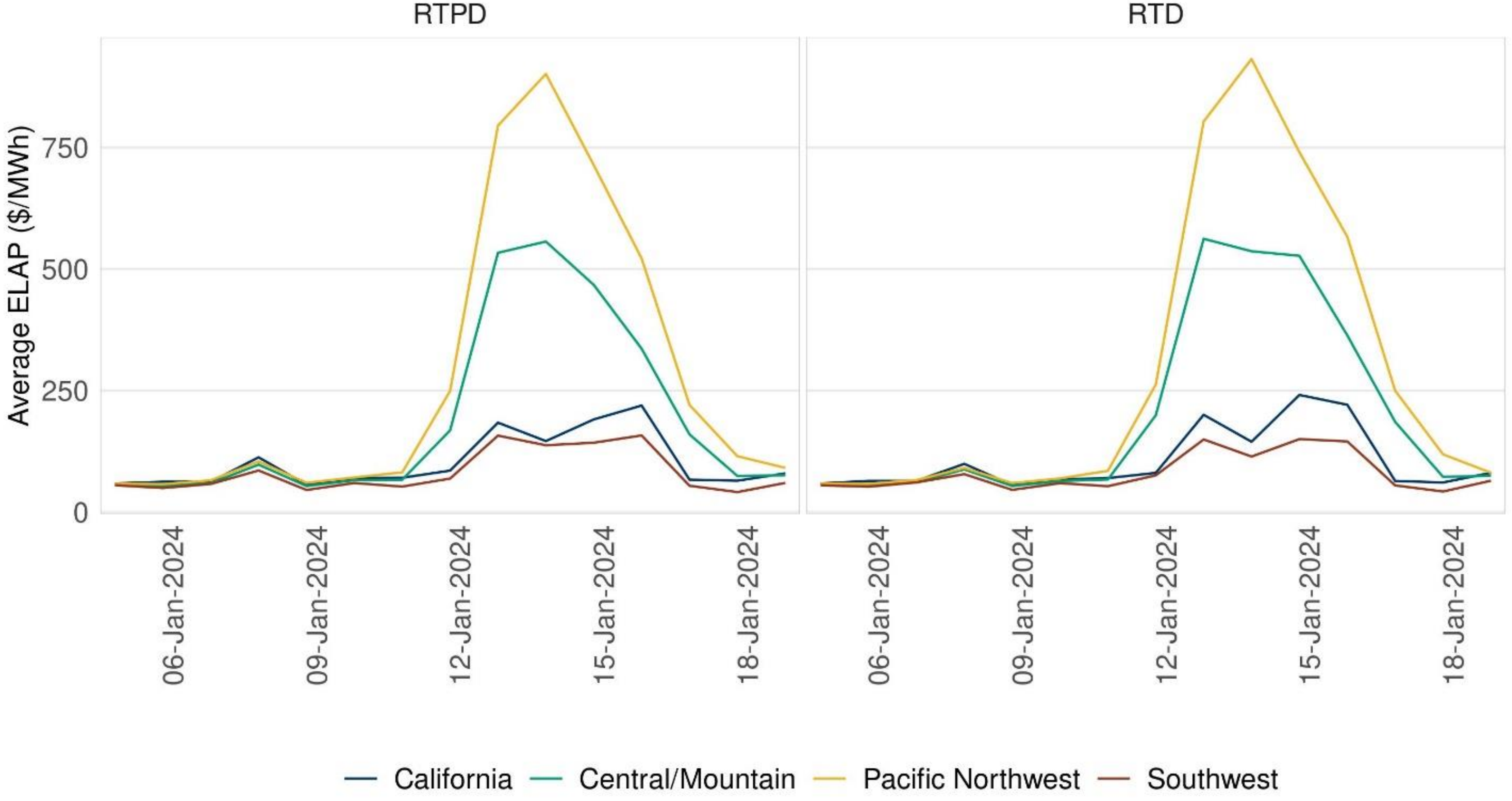
Distribution of day-ahead SMEC, winter period, Jun 2021 – Apr 2024



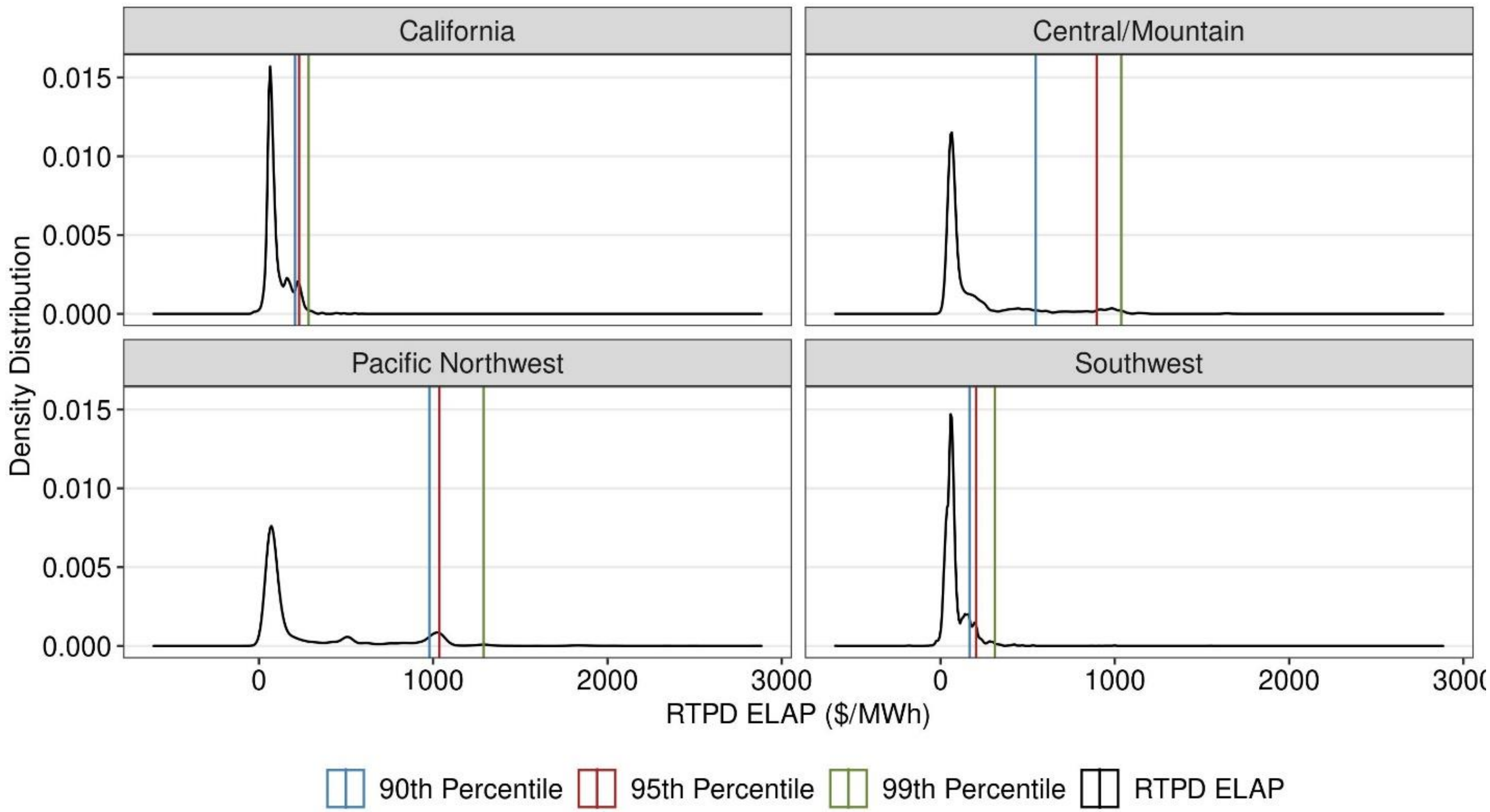
CAISO day-ahead SMEC statistical metrics, 2021 through 2024

Year	2021		2022		2023		2024	
Time of use	OFF	ON	OFF	ON	OFF	ON	OFF	ON
Mean	55.93	69.77	83.49	94.34	59.82	64.10	43.51	36.44
80th Percentile	64.13	85.28	92.04	115.30	76.99	90.66	50.53	57.21
90th Percentile	70.47	100.00	122.03	159.66	104.55	125.77	64.91	67.31
95th Percentile	78.64	119.81	234.85	259.40	138.48	166.02	79.32	86.72
99th Percentile	101.37	211.40	364.82	448.37	172.25	227.38	200.19	197.11

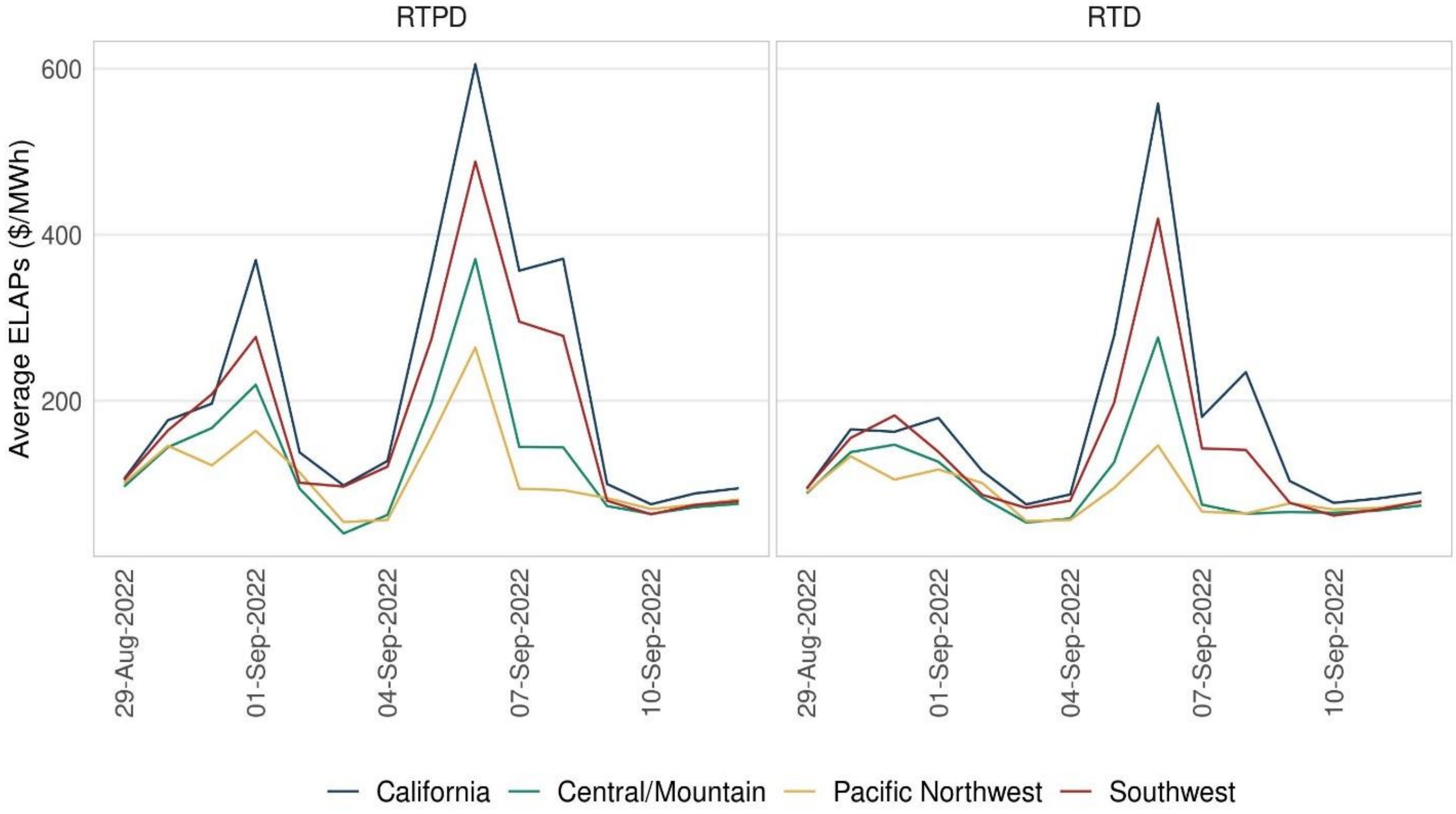
RTPD and RTD ELAP price trends, January 5-19, 2024



Distribution of RTPD ELAPs, January 5-19, 2024



RTPD and RTD ELAP price trends, August 29 – September 12, 2022



Distribution of RTPD ELAPs, August 29 – September 12, 2022