California ISO

Day-Ahead Market Enhancements

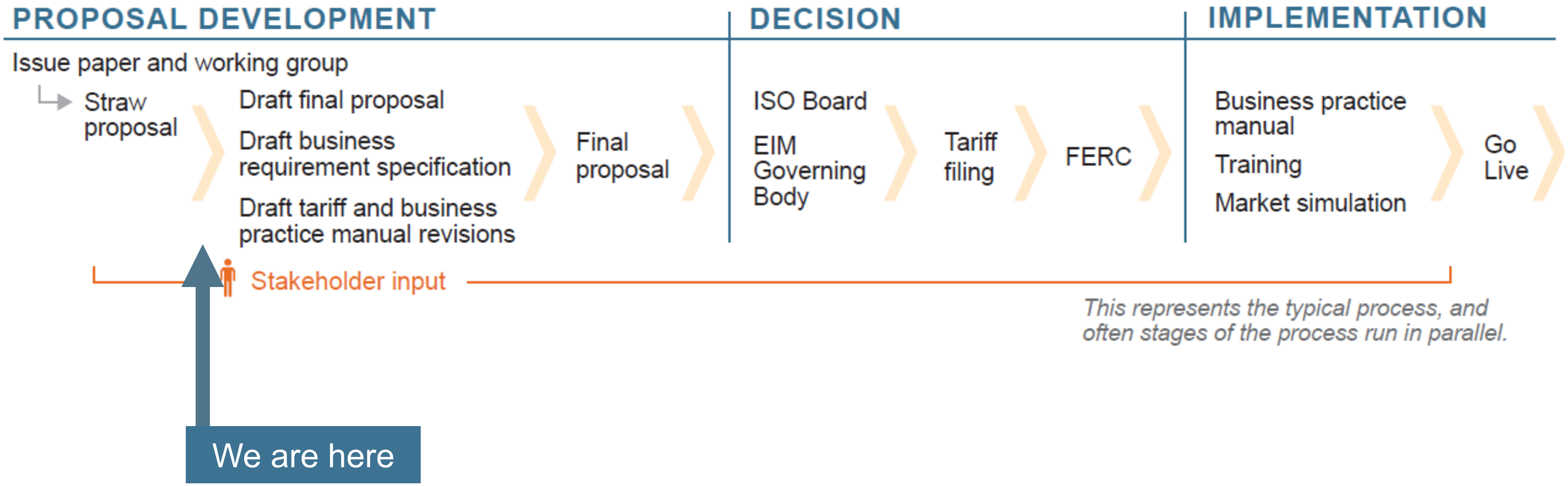
Stakeholder Workshop

September 14, 2022

Agenda

Time	Topic	Presenter
1:00 – 1:05PM	Welcome and introductions	Isabella Nicosia
1:05 – 3:55PM	Discussion topics: • Methods to avoid duplicative payments for imbalance reserves and reliability capacity • Local market power mitigation of imbalance reserves and reliability capacity • Real-time energy offer cap to incorporate energy costs into capacity procurement • Variable energy resource (VER) eligibility for imbalance reserve/reliability capacity • Energy storage resources and capacity procurement	James Friedrich Katie Wikler
3:55 – 4:00PM	Next steps	Isabella Nicosia

Stakeholder Process



PROPOSAL DEVELOPMENT

Issue paper and working group

Straw proposal

Draft final proposal

Draft business requirement specification

Draft tariff and business practice manual revisions

Final proposal

DECISION

ISO Board

EIM Governing Body

Tariff filing

FERC

IMPLEMENTATION

Business practice manual

Training

Market simulation

Go Live

Stakeholder input

This represents the typical process, and often stages of the process run in parallel.

We are here

Day-Ahead Market Enhancements

METHODS TO AVOID DUPLICATIVE PAYMENTS FOR IMBALANCE RESERVES AND RELIABILITY CAPACITY

Context

- DAME introduces a new imbalance reserve (up/down) product and remodels RUC supply into reliability capacity (up/down).

- Suppliers will submit offers to provide these capacity products

- If offers clear, the market would compensate suppliers the marginal price of each capacity product awarded

Issue

- Current rules require RA resources to participate in RUC with $0 bids and have a real-time must-offer obligation
- Since RA resources currently do not receive market payments for their real-time availability, they must recover these costs through RA capacity contracts
- DAME proposes RA resources would be eligible to submit offers and receive market payments for their real-time availability through imbalance reserves and reliability capacity
  - RA contract provisions may assume all products and services are the buyers; thus, explicit payments for capacity may be considered duplicative and already paid-for in the RA contract

Potential solutions

- CAISO is offering two potential options to help load-serving entities avoid these duplicative payments as they transition their RA capacity contracts over time to incorporate the DAME/EDAM market design changes

- **Option 1:** Extend inter-SC trade functionality to imbalance reserves and reliability capacity

- **Option 2:** Settlement approach to “claw back” capacity payments on RA resources

Option 1: Extend inter-SC trade functionality to imbalance reserves and reliability capacity

- Inter-SC trading (IST) is an existing, optional settlement service to facilitate bilateral agreements between two scheduling coordinators.
  - Current functionality supports ISTs for energy, ancillary services, and IFM load uplift obligations

- CAISO could expand IST functionality to include imbalance reserves and reliability capacity

- To keep it simple, examples will focus on imbalance reserves

Basic functionality

SC1 represents LSE1. LSE1 is under contract with Resource A that has an obligation to provide 10MW of imbalance reserves up and down. SC2 represents Resource A.

1. Before the market, SC1 and SC2 engage in an inter-SC trade for 10MW of imbalance reserves up and imbalance reserves down.
2. SC2 bids the 10MW of IRU/IRD from Resource A.
3. If the market clears the 10 MW award, SC2 receives the IRU/IRD payment at the MW quantity * price for Resource A
4. The inter-SC trade kicks in and SC2 pays SC1 10 MW quantity * price for the market awards

Complications to work out

- RA resources should keep the portion of the imbalance reserve payment associated with opportunity cost from co-optimization

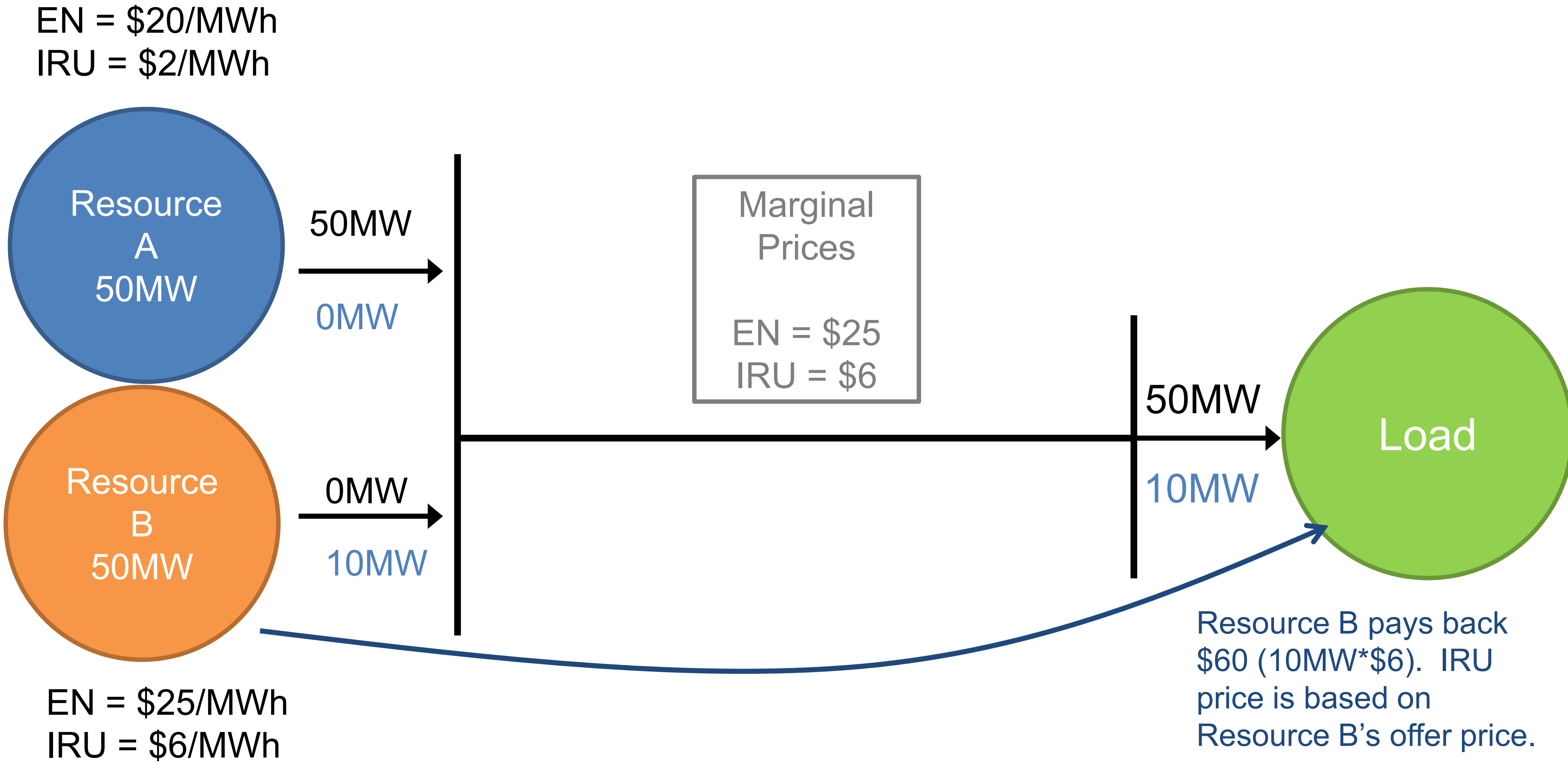
- Individual resources may have RA capacity assigned to multiple LSEs

RA resources should keep the portion of the imbalance reserve payment associated with opportunity cost from co-optimization

- For imbalance reserves up (IRU), opportunity cost is the foregone cost of selling IRU instead of energy

- For imbalance reserves down (IRD), opportunity cost is the incurred cost of selling energy above its bid price to sell IRD

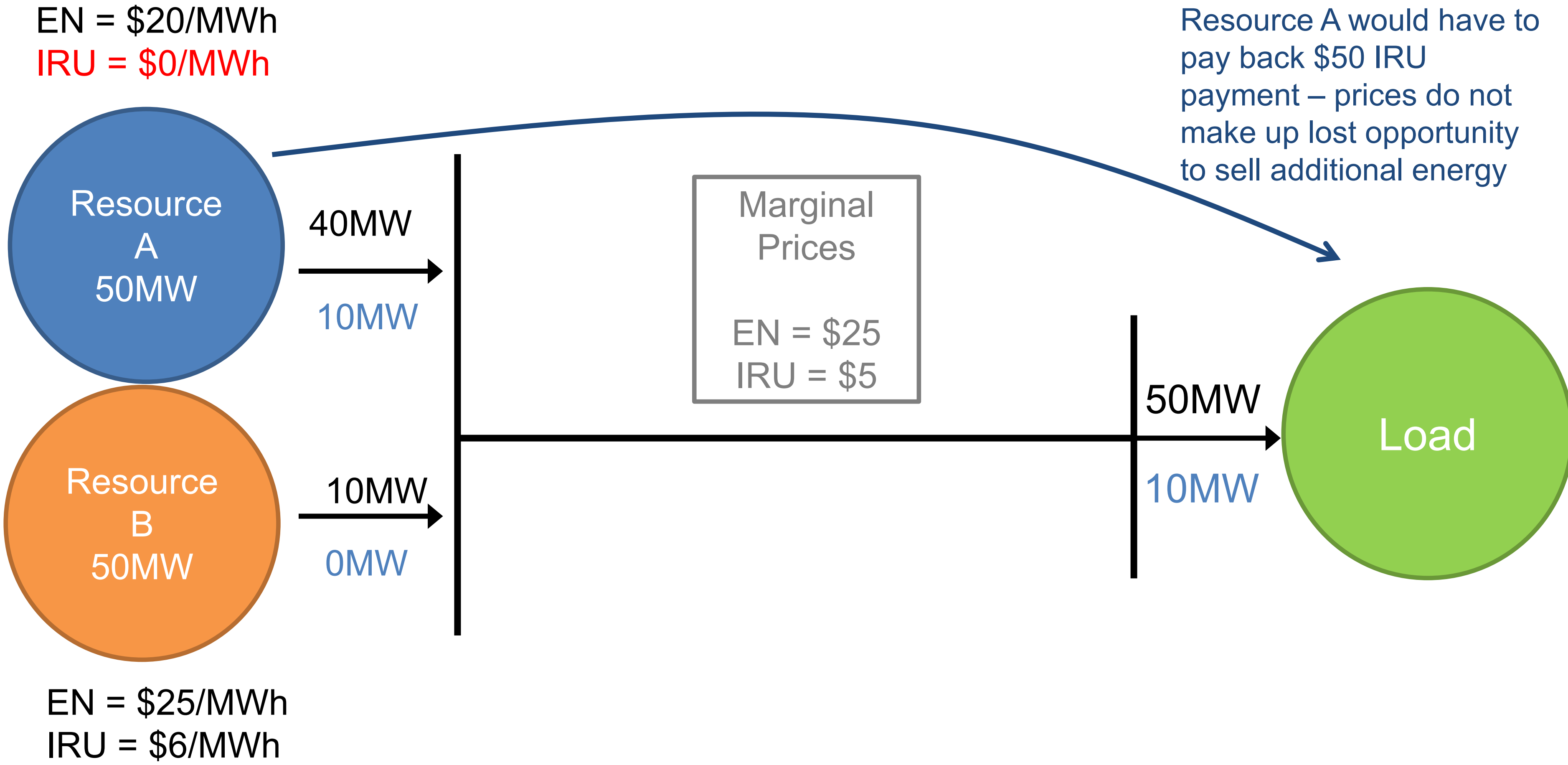
RA resources should keep the portion of the imbalance reserve payment associated with opportunity cost from co-optimization



Resource B pays back $60 (10MW*$6). IRU price is based on Resource B’s offer price.

RA resources should keep the portion of the imbalance reserve payment associated with opportunity cost from co-optimization

IRU Opportunity Cost Example



EN = $20/MWh
IRU = $0/MWh

Resource
A
50MW

40MW

10MW

Marginal
Prices

EN = $25
IRU = $5

Resource A would have to pay back $50 IRU payment – prices do not make up lost opportunity to sell additional energy

50MW

10MW

Load

Resource
B
50MW

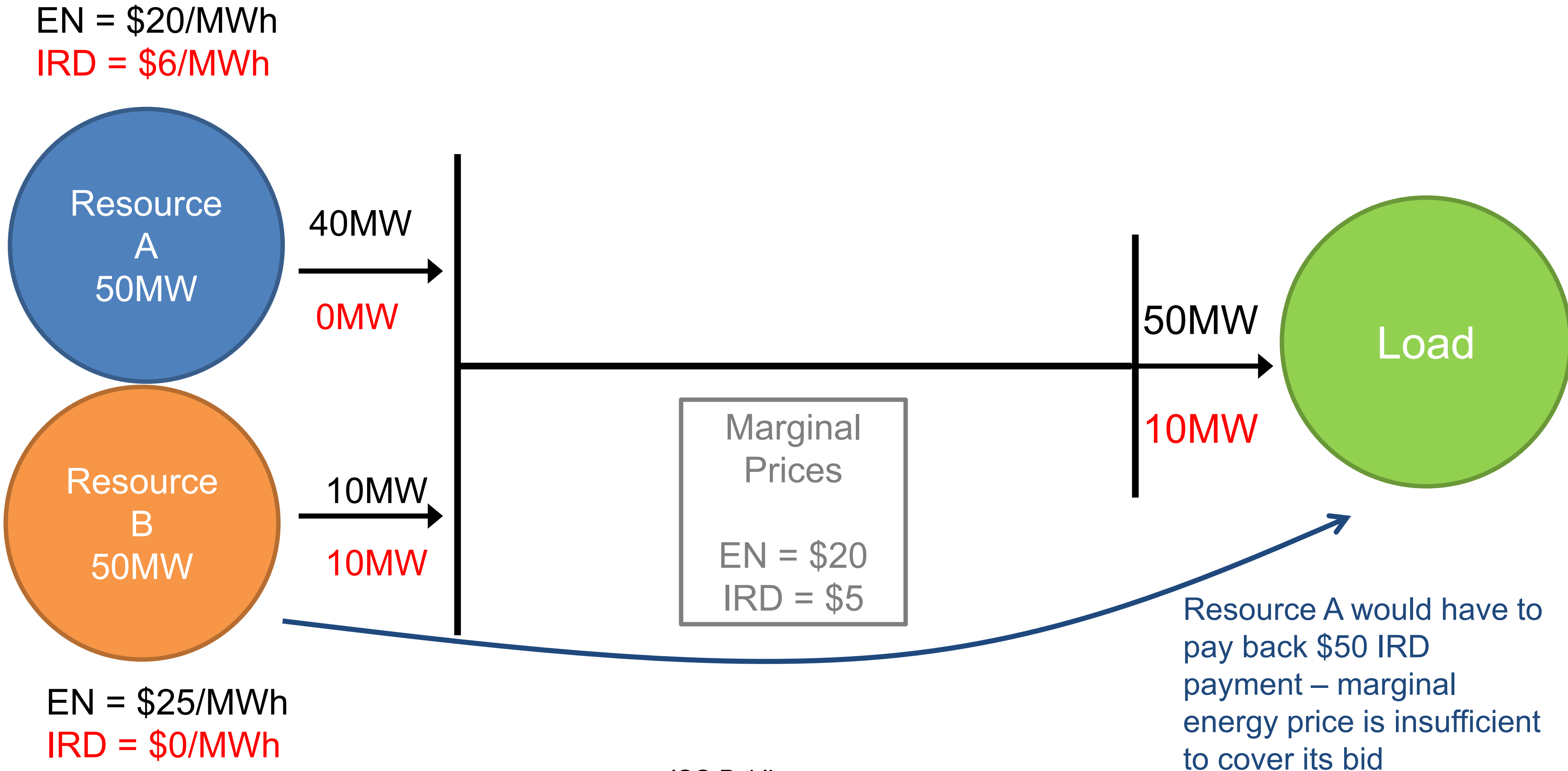
10MW

0MW

EN = $25/MWh
IRU = $6/MWh

RA resources should keep the portion of the imbalance reserve payment associated with opportunity cost from co-optimization

IRD Opportunity Cost Example



EN = $20/MWh
IRD = $6/MWh

Resource A
50MW

40MW
0MW

Resource B
50MW

10MW
10MW

EN = $25/MWh
IRD = $0/MWh

Marginal Prices

EN = $20
IRD = $5

50MW
10MW

Load

Resource A would have to pay back $50 IRD payment – marginal energy price is insufficient to cover its bid

RA resources should keep the portion of the imbalance reserve payment associated with opportunity cost from co-optimization

- Compare bids to LMPs
  - If resource receives imbalance reserve up award, compare energy bid to energy LMP
  - If energy bid < energy LMP, remove (energy bid – energy LMP) * IRU award from the IST settlement
  - If resource receives imbalance reserve down award, compare energy bid to energy LMP
  - If energy bid > energy LMP, remove (energy bid – energy LMP) * IRD award from the IST settlement

Individual resources may have RA capacity assigned to multiple LSEs

- IST quantity would settle proportionally to the RA contribution of that resource to each LSE

- For example:
  - Resource A has 20MW of RA with LSE1 and 40MW of RA with LSE2. The resource receives a 30MW IRU award. Then 10MW IST clears with LSE1 and 20MW IST clears with LSE2.

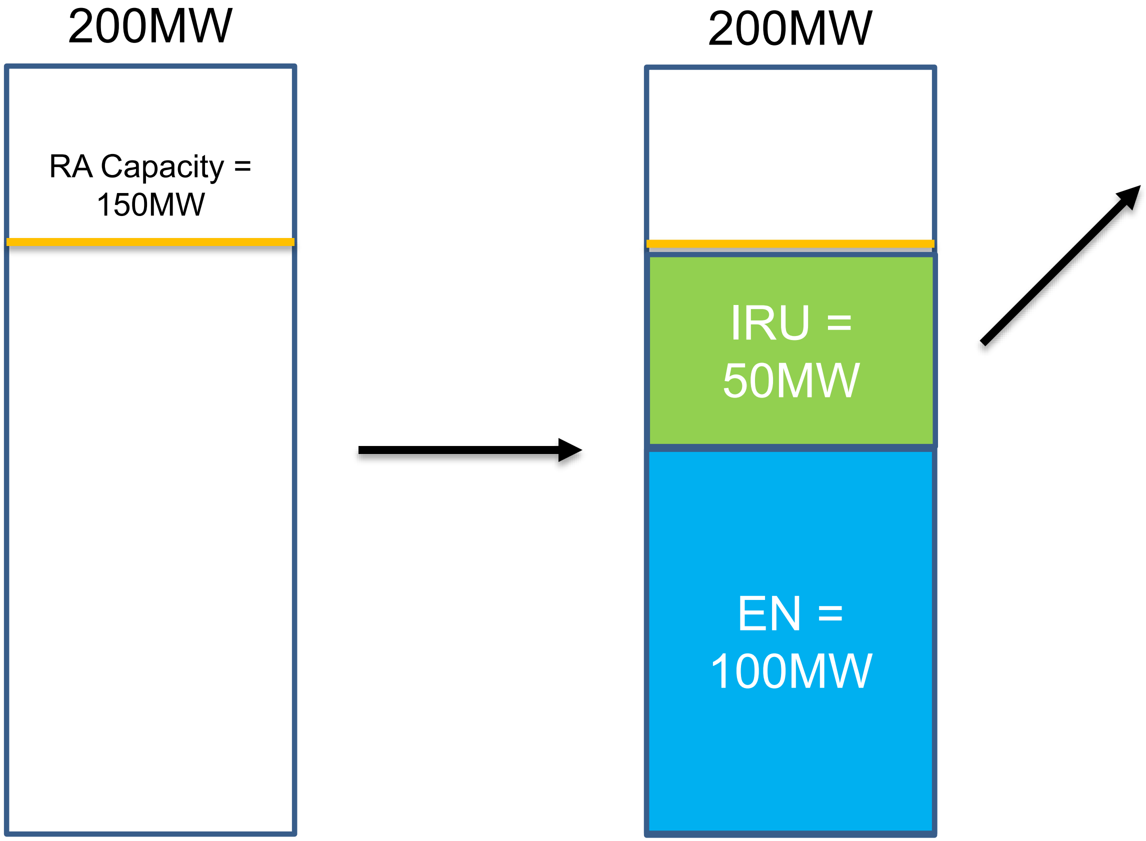
Option 2: Settlement approach to “claw back” capacity payments on RA resources

1. Allocate IRU/IRD awards on resource capacity to determine overlap with RA capacity; IRU/IRD awards are stacked above/below the day-ahead schedule.

2. Pay the IRU/IRD awards the IRU/IRD marginal price. Calculate and allocate the cost per the original design.

3. Claw back the IRU/IRD payments for IRU/IRD awards overlapping with RA capacity and distribute the revenue to metered demand.

Example 1



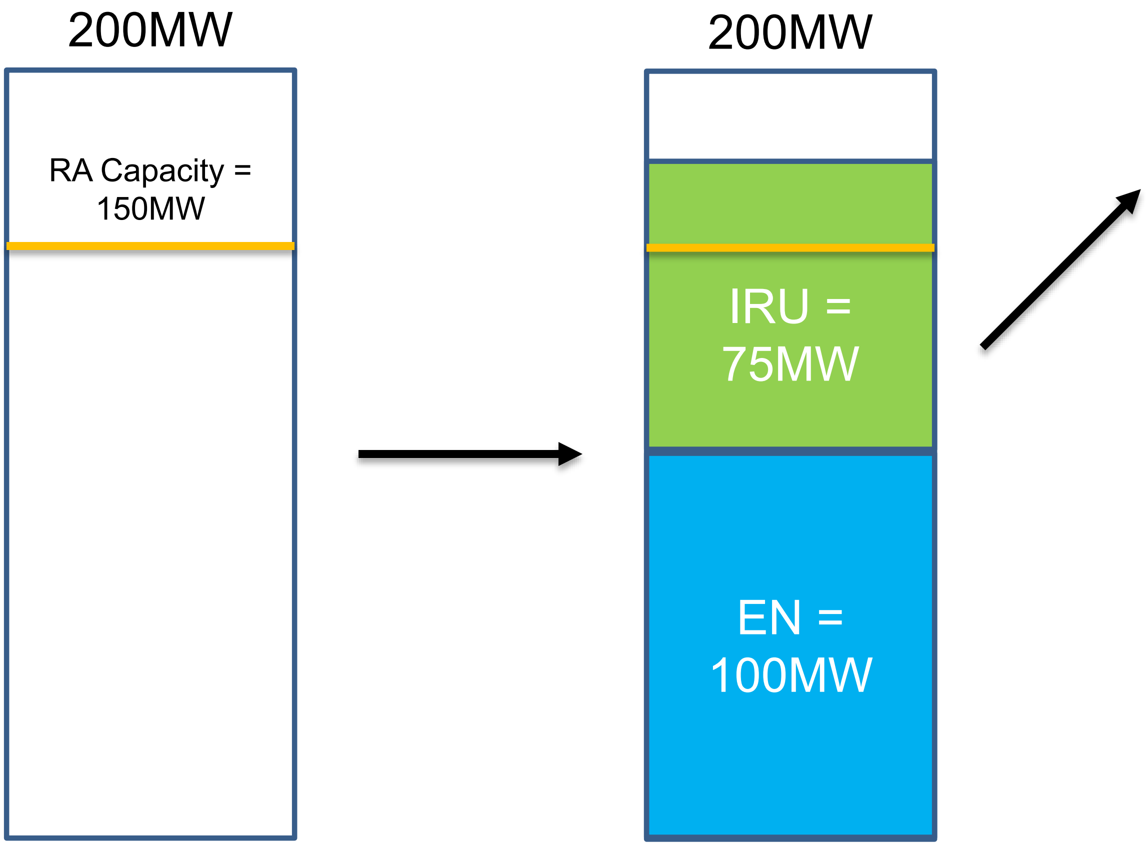
1. Pay the resource the IRU marginal price. Assume the marginal price is $2. Pay the resource $100.

2. Allocate the $100 through IRU cost allocation.

3. Claw back the $100 payment from the resource since it overlaps with RA capacity.

4. Distribute the $100 proportionately back to metered demand.

Example 2



1. Pay the resource the IRU marginal price. Assume the marginal price is $2. Pay the resource $150.
2. Allocate the $150 through IRU cost allocation.
3. Claw back $100 payment from the resource since only 50MW overlaps with RA capacity.
4. Distribute the $100 proportionately back to metered demand.

Complications to work out

- CAISO could track re-negotiated RA contracts with a Master File flag on RA resources to exclude them from the claw back.
  - The claw back revenue is still distributed to all load for simplicity
  - Initial flag set to “no”; develop annual process around yearly RA showings to update
- There could be a sunset provision on the claw back to support its transitional nature
- The claw back would include similar provisions to not claw back opportunity costs.

Tradeoffs

- The IST approach is more targeted but more complex
  - It connects specific capacity back to its contracted LSE
  - Requires effort from participant side to coordinate ISTs on daily basis compared to settlement approach
  - May be more convenient than the same process done bilaterally and can automatically remove the opportunity cost portion and manage multiple LSEs

- The claw back settlement approach is less targeted but simpler
  - Claw back revenues are distributed among LSEs instead of targeted to an LSEs contracted capacity
  - “Hands off” approach

Day-Ahead Market Enhancements

LOCAL MARKET POWER MITIGATION OF IMBALANCE RESERVES AND RELIABILITY CAPACITY

Local market power mitigation of imbalance reserves and reliability capacity

- Local market power mitigation of imbalance reserves and reliability capacity is appropriate because they are nodally procured and therefore local market power could exist

- Modifying proposal to re-introduce a default bid and not just mitigate availability bids only to a competitive LMP

Default availability bids

- Need more information to design “default availability bids” to the same rigor as “default energy bids”

- CAISO believes conservative (from supplier’s perspective) and system-wide default bid (same for all resources) can provide a mitigation “floor” in the short-run as CAISO and market participants gain operational experience with imbalance reserves and reliability capacity
  - Would still propose to limit mitigation to competitive LMP if it is higher

- After sufficient information on costs of offering these products under competitive conditions is available, CAISO would re-engage stakeholders on developing a more rigorous methodology

Day-Ahead Market Enhancements

REAL-TIME ENERGY OFFER CAP TO INCORPORATE ENERGY COSTS INTO CAPACITY PROCUREMENT

Real-time energy offer cap to incorporate energy costs into capacity procurement

- Market does not differentiate between two resources with same capacity offer but different energy offers when awarding upward capacity products
- Objective is to prevent opportunities for high energy cost resources from routinely being awarded IRU/RCU when the resources will rarely be dispatched for energy in the RTM
- Greater concern for IRU/RCU than contingency reserves because there is a higher likelihood of being dispatched for energy in RTM

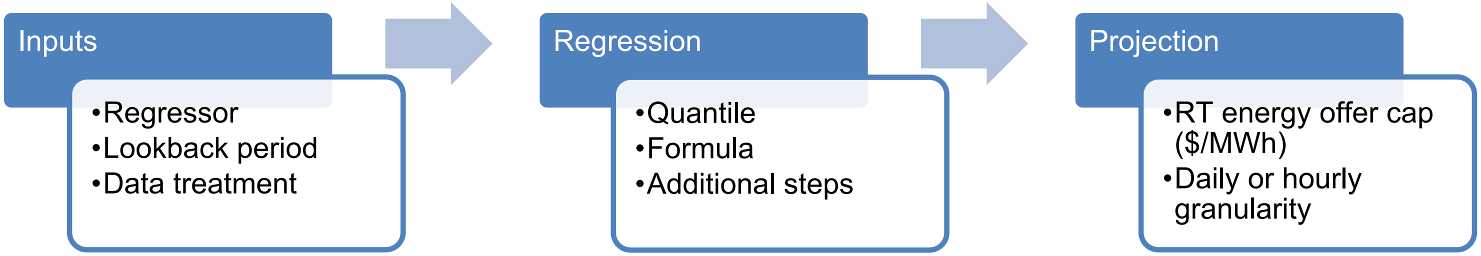
Real-time energy offer cap limits imbalance reserve awards to resources with energy bids less than expected real-time price under high imbalance scenario

- Proposal includes a real-time energy bid price cap (“strike price”) that applies to all resources awarded IRU/RCU
  - Bid cap set to expected real-time price under high upward imbalance scenario
- Resources with energy costs above cap must incorporate financial risk into IRU/RCU bid → higher bids for RCU and IRU → less likely to be awarded → meets policy objective
- Quantity of real-time energy bids subject to the real-time energy bid price cap limited to the MW quantity of IRU/RCU awards

Real-time energy offer cap calculation methodology and analysis

- Objective: calculate a real-time energy offer cap ($/MWh) at hourly or daily granularity that is available prior to close of day-ahead market bidding window
- Analysis explored a quantile regression using historical data to predict next day's real-time energy offer cap
  - Regressors: CAISO net load, natural gas commodity prices
  - Historical data: simple average of FMM DLAPs

Overview of real-time energy offer cap methodologies



Inputs
- Regressor
- Lookback period
- Data treatment

Regression
- Quantile
- Formula
- Additional steps

Projection
- RT energy offer cap ($/MWh)
- Daily or hourly granularity

Example methodologies

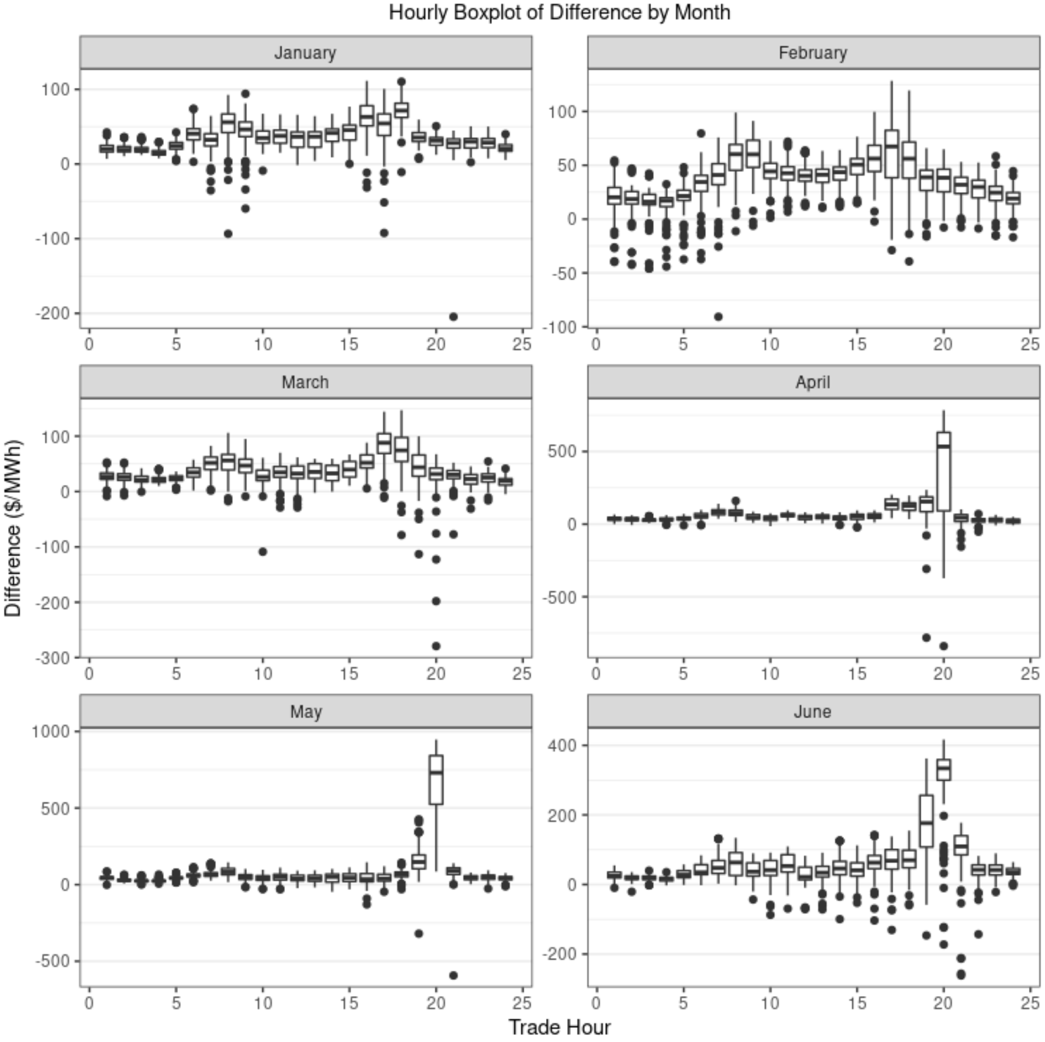
	Regressor(s)	Lookback period	Regression type	Quantile	Data granularity	Additional Treatment
1	Avg. gas price [a]	60/60	Linear	97.5	Fifteen minute	--
2	Avg. gas price	60/60	Linear	90	Fifteen minute	1.2 scalar [b]
3	Avg. gas price	45/0	Quadratic	97.5	Hourly	Weekend distinction
4	Avg. gas price and net load	30/30	Linear	90	Fifteen minute	--

a. Simple average of Socal Citygate and PG&E Citygate
b. Configurable scalar value

Metrics to compare effectiveness of real-time energy offer cap calculation methodologies

- **Coverage:** Percentage of time that the projected bid cap was sufficient to cover, i.e., was greater than or equal to, the actual FMM price.
- **Difference**: Difference between the projected bid cap and the actual FMM price. Positive difference indicates that the projected bid cap covers the actual FMM price.
- **Closeness**: Absolute difference between the projected bid cap and the actual FMM price.
- **Scale:** Ratio of the actual FMM price to the projected bid cap. A scale value less than one indicates that the projected bid cap covers the actual FMM price.

Methodology 1: Avg. Gas Price, 97.5 Quantile, 60/60 Lookback



Month	Coverage	Avg Closeness	Avg Difference	Avg Scale
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Apr 2022	97.81%	73.95	70.80	0.49
May 2022	97.51%	81.35	79.87	0.51
Jun 2022	95.59%	64.04	60.92	0.59

- Some case examples for variation:
  - – 2022-04-07 prices near $1000
  - – 2021-07-09 prices above $1000, up to $1500

Day-Ahead Market Enhancements

VARIABLE ENERGY RESOURCE (VER) ELIGIBILITY FOR IMBALANCE RESERVE AND RELIABILITY CAPACITY

Variable energy resource (VER) eligibility for imbalance reserve and reliability capacity

- CAISO maintains that variable energy resources (VERs) should be eligible to provide imbalance reserves and reliability capacity in both directions.
  - Resource types should not be excluded from participating in market products they are technically capable of providing
  - However, CAISO is concerned about VERs holding capacity above their forecast, which could undermine the reliability of the market. (These concerns do not apply to downward products)
- Previous proposal deferred specific mechanics of how VERs would participate in these products
  - Early proposals considered two classes of VERs

Variable energy resource (VER) eligibility for **imbalance reserves**

- Restrict all VERs upper economic limit in IFM to their VER forecast
  - VERs can offer virtual supply if they want to take a financial position above their forecast

- All VERs are eligible for IRU awards

- Restricts VER IRU awards such that EN + IRU <= VER forecast

Variable energy resource (VER) eligibility for **reliability capacity**

- VERs must bid RCU quantity up to their forecast
  - CAISO will insert RCU bids for VERs at a bid price of $0 if they do not bid up to their VER forecast
- Update RCU no pay rule to just pay back the RCU price; no longer pay back the higher of RCU and RTPD FRU price
  - Holds VERs harmless if they cannot deliver their day-ahead forecast in real-time
- Remove VERs from RCU/RCD cost allocation
  - VERS would no longer contribute to RCU/RCD procurement target

Day-Ahead Market Enhancements

ENERGY STORAGE RESOURCES AND CAPACITY PROCUREMENT

Energy storage resources and capacity procurement

- IFM limits the capacity that can be awarded to an energy storage resources to not violate state of charge constraints

$$SOC_{i,t} = SOC_{i,t-1} - \left(EN_{i,t}^{(+)} + \eta_i\, EN_{i,t}^{(-)}\right)$$

$$\left.\begin{array}{l} \underline{SOC}_{i,t} + RU_{i,t} + SR_{i,t} + NR_{i,t} + IRU_{i,t} \leq SOC_{i,t} \\ SOC_{i,t} \leq \overline{SOC}_{i,t} - \eta_i \left(RD_{i,t} + IRD_{i,t}\right) \end{array}\right\}, \forall i \in S_{LESR} \wedge t = 1,2,\ldots,T$$

Energy storage resources and capacity procurement

- IFM limits the capacity that can be awarded to an energy storage resources to not violate state of charge constraints

$$\boxed{SOC_{i,t} = SOC_{i,t-1} - \left(EN^{(+)}_{i,t} + \eta_i \, EN^{(-)}_{i,t}\right)}$$

A resource’s state of charge in the current interval is the state of charge in the previous interval +/- the current interval charging or discharging schedule

$$\left.\begin{array}{l} \underline{SOC}_{i,t} + RU_{i,t} + SR_{i,t} + NR_{i,t} + IRU_{i,t} \le SOC_{i,t} \\ SOC_{i,t} \le \overline{SOC}_{i,t} - \eta_i \left(RD_{i,t} + IRD_{i,t}\right) \end{array}\right\}, \forall i \in S_{LESR} \wedge t = 1,2,\dots,T$$

Energy storage resources and capacity procurement

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The sum of upward capacity awards cannot exceed the quantity between the resource’s current state of charge and it’s minimum state of charge

Energy storage resources and capacity procurement

- IFM limits the capacity that can be awarded to an energy storage resources to not violate state of charge constraints

$$SOC_{i,t} = SOC_{i,t-1} - \left(EN_{i,t}^{(+)} + \eta_i \, EN_{i,t}^{(-)}\right)$$

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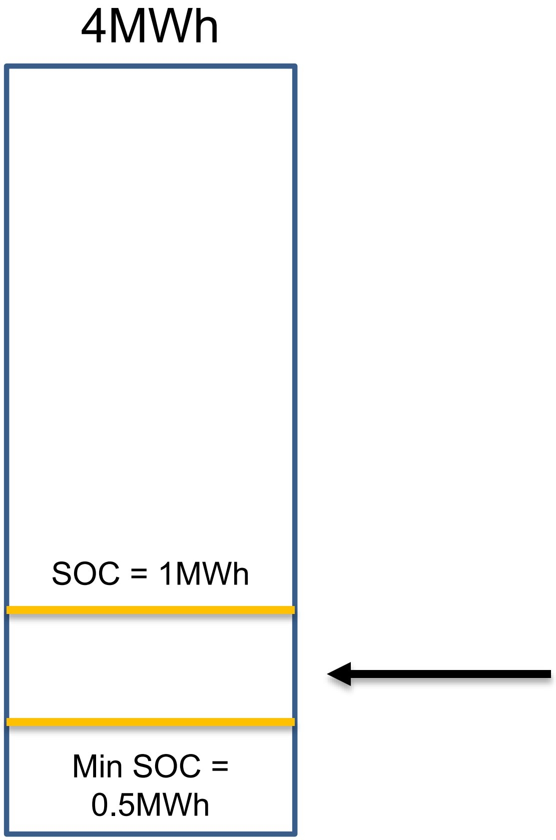
The sum of downward capacity awards cannot exceed the quantity between the resource’s current state of charge and it’s maximum state of charge

Energy storage resources and capacity procurement



4MWh

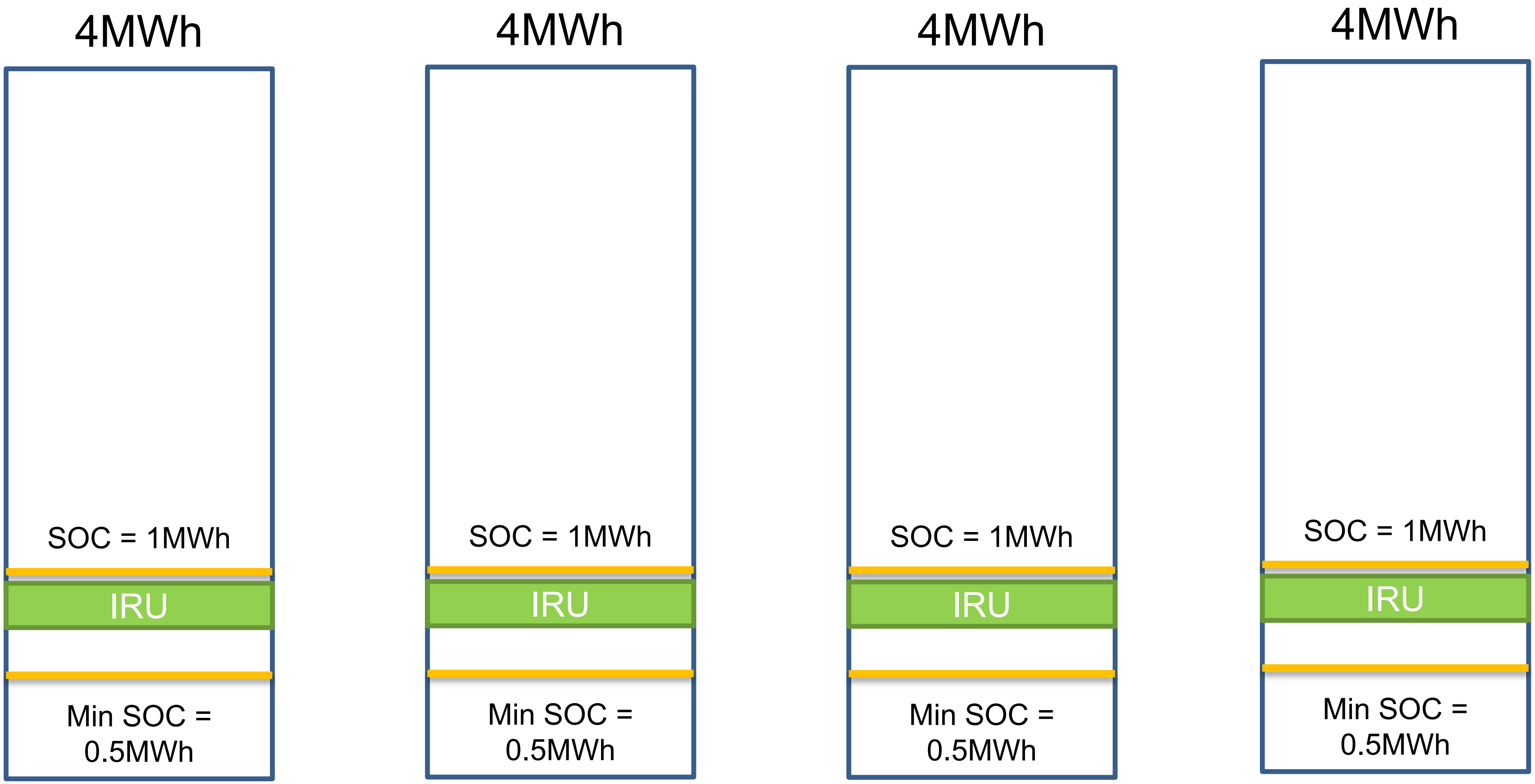
SOC = 1MWh

Min SOC = 0.5MWh

SOC capacity constraint ensures upward capacity cannot exceed this range within any hourly interval. But what about between intervals?

Energy storage resources and capacity procurement

In the day-ahead market, this resource can get an imbalance reserve up award over several consecutive hours. That the SOC is not changing over hours assumes it’s not receiving charging/discharging schedules.



4MWh

SOC = 1MWh

IRU

Min SOC = 0.5MWh

4MWh

SOC = 1MWh

IRU

Min SOC = 0.5MWh

4MWh

SOC = 1MWh

IRU

Min SOC = 0.5MWh

4MWh

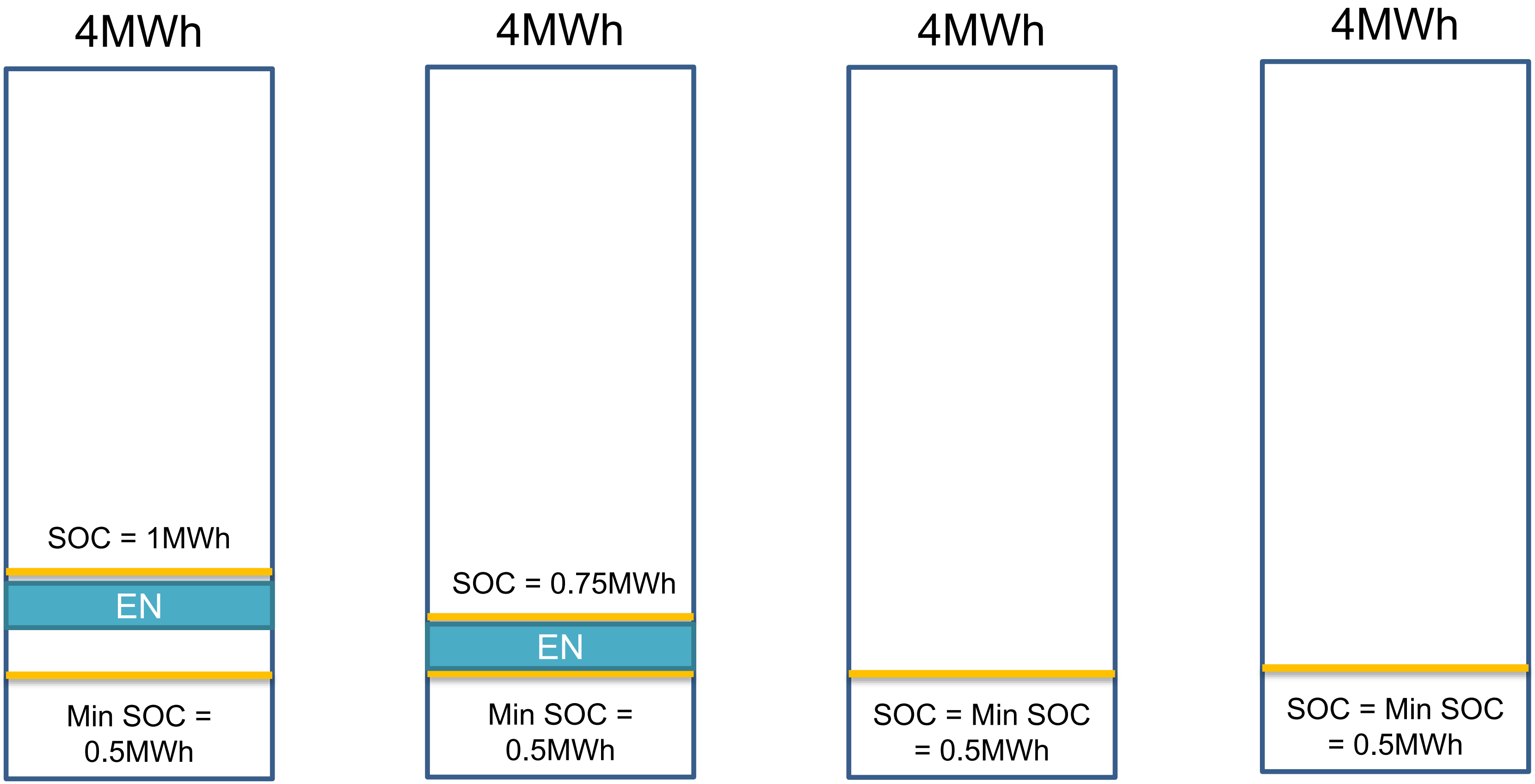
SOC = 1MWh

IRU

Min SOC = 0.5MWh

Energy storage resources and capacity procurement

In the real-time market, this resource has a must-offer obligation to provide energy bids. Assuming upward uncertainty materializes, this resource is dispatched for energy. The resource does not have sufficient state of charge to maintain imbalance reserve awards in all hours.



4MWh
SOC = 1MWh
EN
Min SOC = 0.5MWh

4MWh
SOC = 0.75MWh
EN
Min SOC = 0.5MWh

4MWh
SOC = Min SOC = 0.5MWh

4MWh
SOC = Min SOC = 0.5MWh

Energy storage resources and capacity procurement

- State of charge formulation does not assume capacity awards ultimately increase/decrease state of charge

- This can result in “leaky” capacity and dilutes the quantity of reserves held across the day

- Also creates a disconnect between the way storage resources are incentivized to participate in the market and how they can be most useful to the system
  - E.g., when load uncertainty materializes we want to rely on resources holding imbalance reserves to provide RT energy, but storage resources have to manage their exposure to no pay settlements

Energy storage resources and capacity procurement

- $SOC_{i,t} = SOC_{i,t-1} - \left(EN_{i,t}^{(+)} + a_{RU}\, RU_{i,t} + a_{SR}\, SR_{i,t} + a_{NR}\, NR_{i,t} + IRU_{i,t} + \eta_i \left(EN_{i,t}^{(-)} - a_{RD}\, RD_{i,t} - IRD_{i,t} \right) \right)$
- State of charge formulation would be updated to assume that imbalance reserve awards are deployed in the real-time market (similar formulation would be extended to RCU/RCD)
- The configurable coefficients “a” are between 0 and 1 and reflect the expectation that some energy will be produced/consumed for positive/negative capacity services.

Next Steps

Milestone	Date
4th Revised Straw Proposal	October 6, 2022
Stakeholder Meeting	October 14, 2022
Comments Due	October 28, 2022

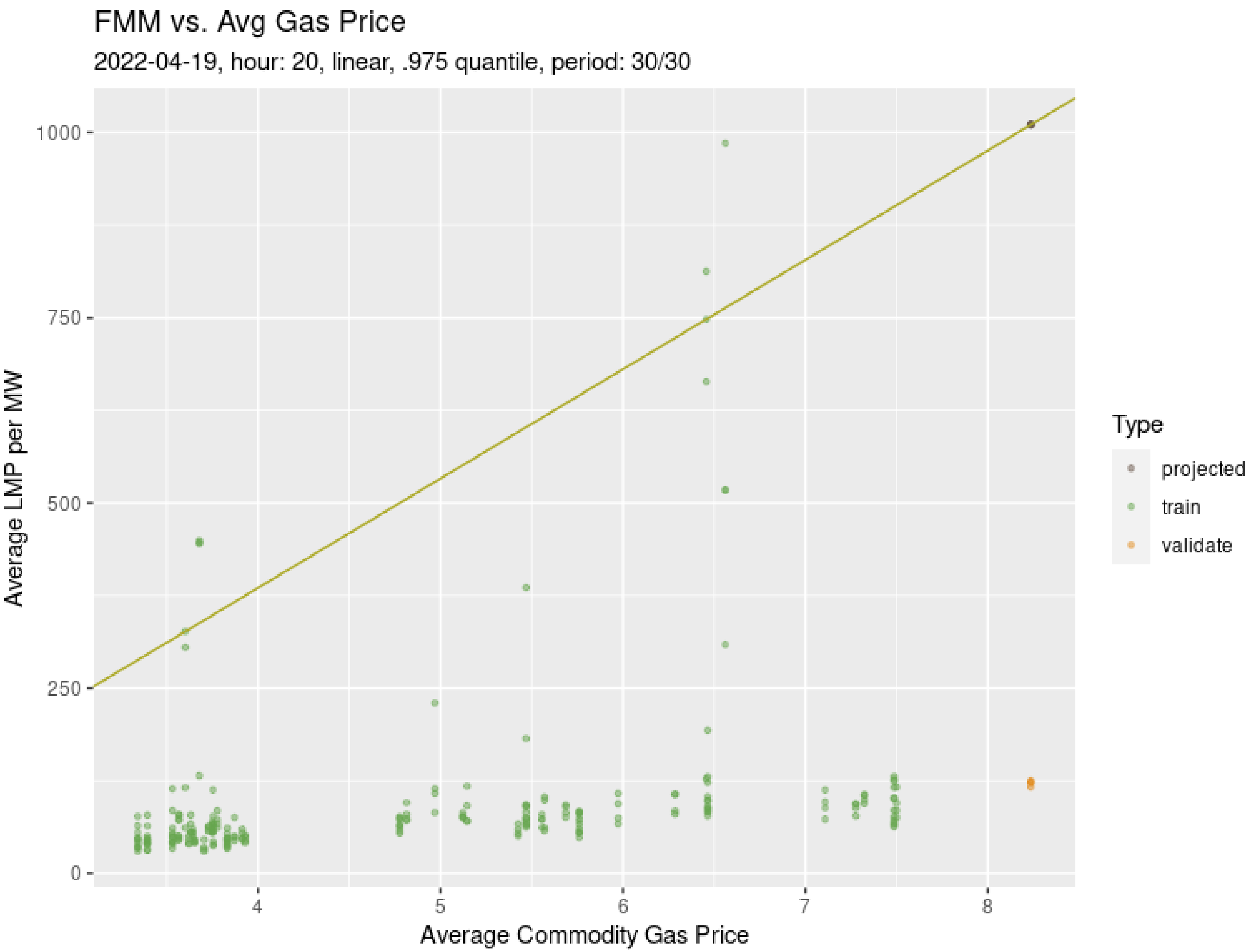
All initiative related information is available at: [California ISO - Day-ahead market enhancements (caiso.com)]()

Please contact Isabella Nicosia at inicosia@caiso.com or isostakeholderaffairs@caiso.com if you have any questions.

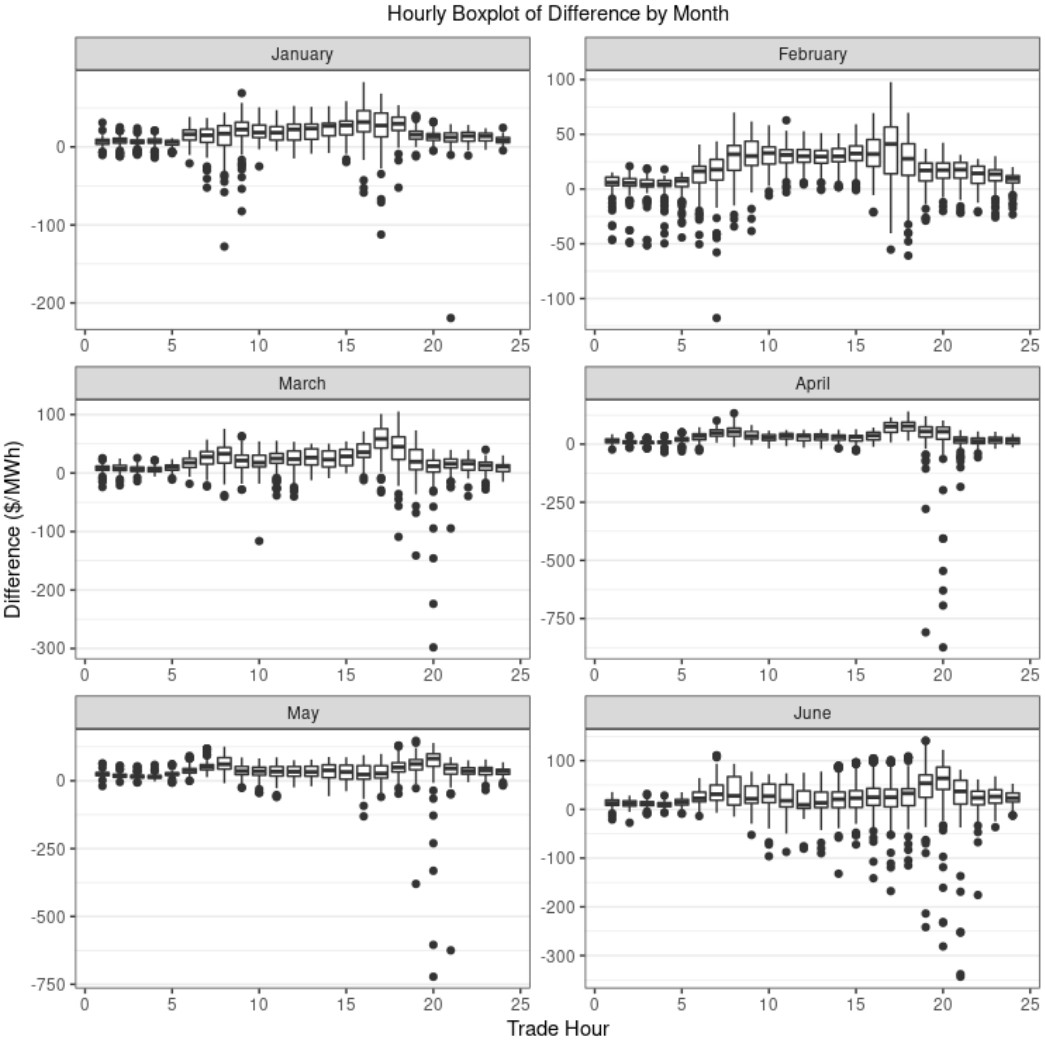
Day-Ahead Market Enhancements

APPENDIX

Motivation for testing different quantiles



Methodology 2: Avg. Gas Price, 90 Quantile, 60/60 Lookback, 1.2 Scalar



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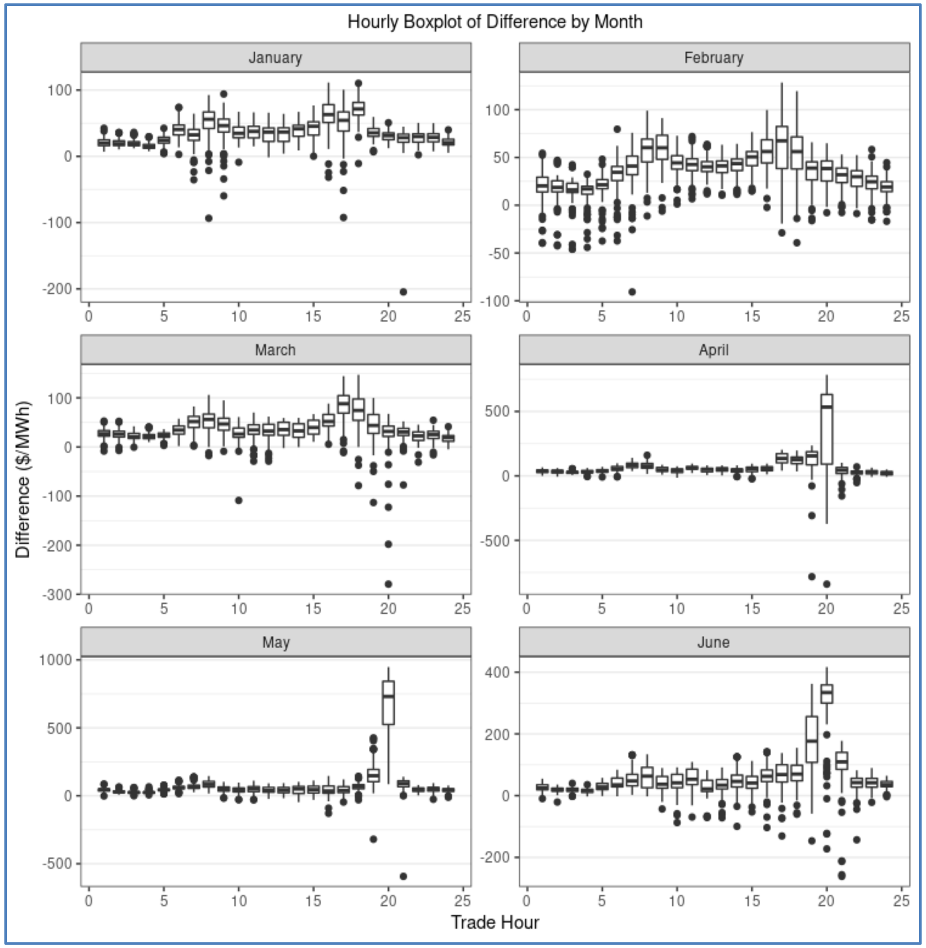
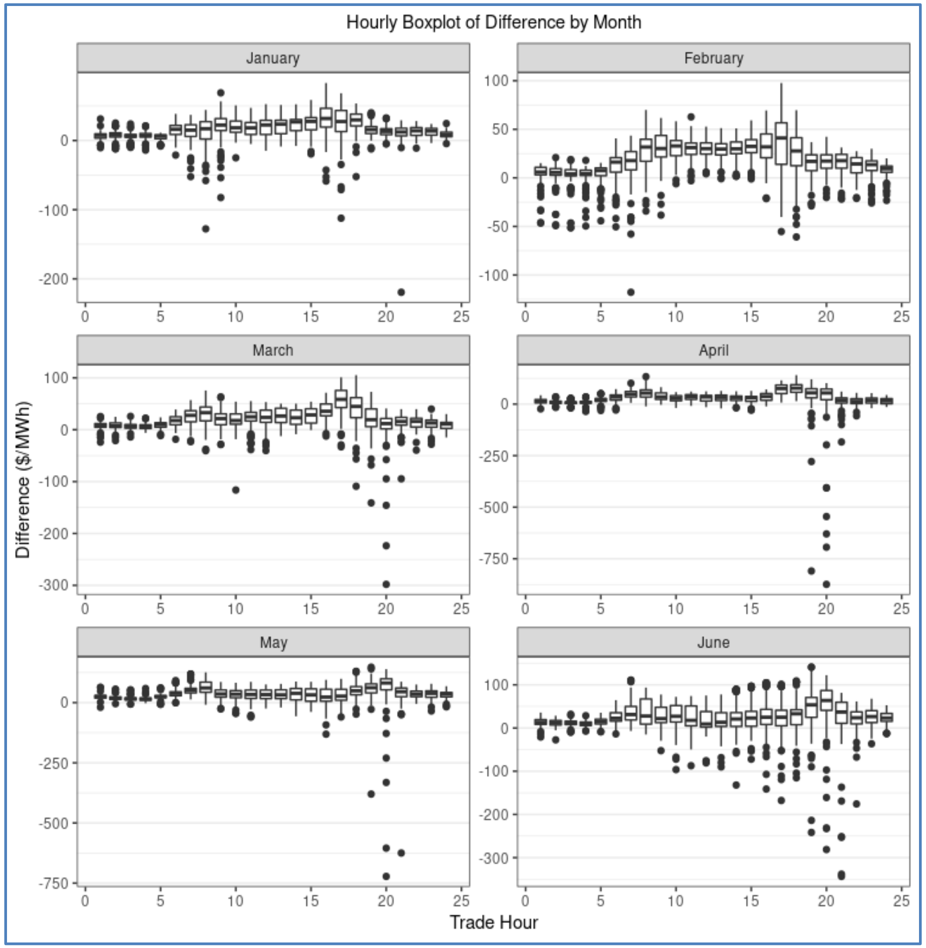
Mar 2022	97.21%	33.80	32.48	0.55
Apr 2022	97.57%	50.01	46.07	0.53
May 2022	97.78%	57.73	55.12	0.51
Jun 2022	95.21%	47.74	43.45	0.62

- Scalar of 1.2 was selected as it provided modest increase to coverage while keeping closeness at lower values

Methodology 1 vs. Methodology 2 - Difference





Methodology 1 vs. Methodology 2 – all metrics

1. Avg gas price, 97.5 quantile, 60/60 lookback

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2. Avg gas price, 90 quantile, 60/60 lookback, 1.2 scalar

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- Similar metrics for coverage and scale
- Lower closeness and difference values for methodology 2 → indicates lower potential to overestimate cap
- Application of 1.2 scalar improved coverage metrics across study months, while sacrificing modest increases in closeness, difference, and decrease in scale (compared to the same test without application of a scalar)

Other methodologies and inputs explored

- Quantile regression w/ quadratic formula
  - Observed multiple instances of extreme outliers with the projected cap much greater than actual FMM price
- Using net load as regressor
  - Generally performed worse than comparable tests that only used gas prices; modest improvement when considered along with gas prices in a multivariate regression
- Week days/weekends as a feature in the regression
  - Lower coverage without significant improvement in other metrics
- Daily bid cap instead of hourly bid cap (i.e. one $/MWh value per day instead of 24 distinct $/MWh values)
  - Eliminates some variability present with hourly methodologies and introduces simplicity but may over/underestimate cap depending on how it is set