Day-ahead market enhancements discussion

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Imbalance reserve penalty prices

- The market uses penalty prices to establish the priority of different schedules and constraints, and to set market prices when schedules or constraints need to be relaxed.
- The appropriate imbalance reserve penalty price structure needs to be coordinated with EDAM design and requires more stakeholder discussion.
- Gradually lowering reserve requirements at higher costs is common across ISO/RTOs and is a good fit for imbalance reserves.
  - At what cost should the imbalance reserve requirement start to relax (i.e., procure less than the full requirement)?
  - At what cost should the full imbalance reserve requirement relax (i.e., procure no imbalance reserves in favor of other market schedules)?

Previous proposals

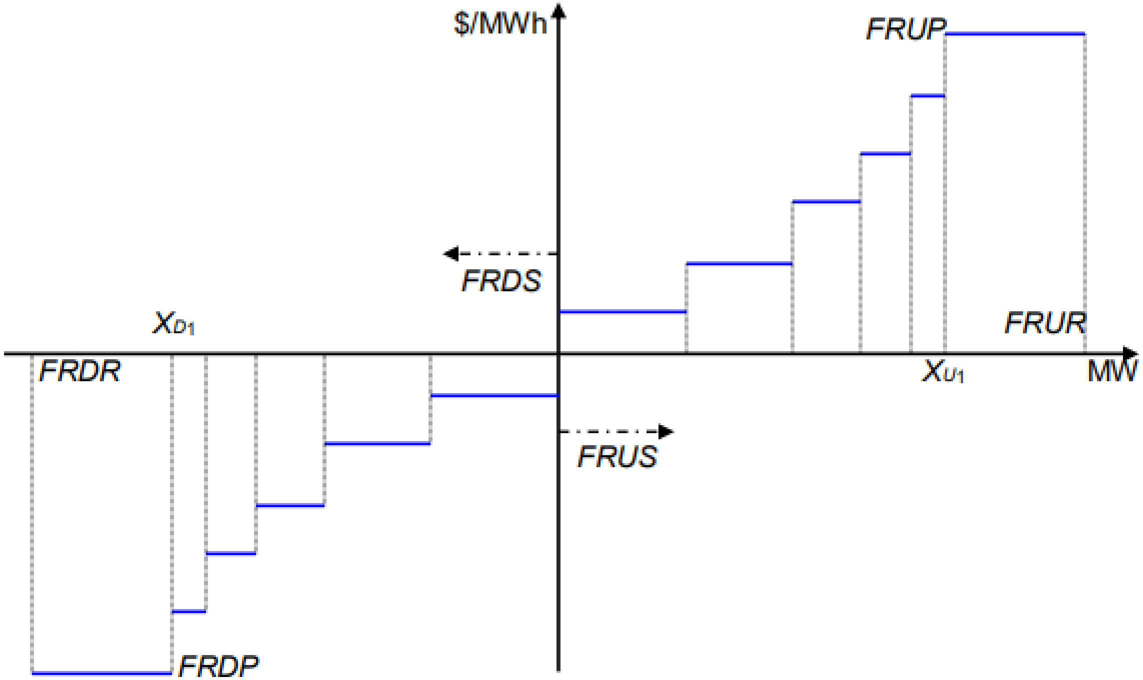
Scheduling run IRU relaxation (%)	Scheduling run penalty price ($)	Upward uncertainty percentile	Pricing run penalty price ($)
0.000	247	97.5	247
0.026	300	95	300
0.051	400	92.5	400
0.077	500	90	500
0.103	600	87.5	600
0.128	700	85	700
0.154	800	82.5	800
0.179	900	80	900
0.205	1000	77.5	1000
0.231	1200	75	1000

Scheduling run IRU relaxation (MW)	Scheduling run penalty price ($)	Pricing run penalty price ($)
<= min(2% of BAA IRU requirement, 30MW)	247	247
> min(2% of BAA IRU requirement, 30MW)	1200	1000

Proposed penalty prices may make imbalance reserves excessively costly during tight system conditions with little added reliability benefit

- Price of insurance should not be equivalent to product you are insuring
- EDAM RSE ensures sufficient supply of imbalance reserves
- EDAM net export transfer constraint ensures transfers out do not jeopardize reliability of the source BAA
- Retention of the RA RT MOO for ISO BAA

Flexible ramping product surplus demand curve



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Possible extension of FRP-like demand curve to imbalance reserves

- Steps determined by (probability of exceeding IRU requirement) * (power balance constraint penalty price)

Upward Uncertainty Percentile	Scheduling Run	Pricing Run	PR(RT_EN>IRU) * PBC$
97.5	$25	$25	0.025 * $1000
95	$50	$50	0.05 * $1000
90	$100	$100	0.1 * $1000
75	$250	$250	0.25 * $1000
50	$500	$500	0.5 * $1000
25	$750	$750	0.75 * $1000
0	$1000	$1000	1 * $1000

Additional considerations

- Does economic relaxation of imbalance reserves disadvantage BAAs in passing the WEIM resource sufficiency evaluation?
- Can imbalance reserve requirements relax without BAA's taking out-of-market actions?
- Connection to EDAM RSE failure consequences
- Connection to IRU local market power mitigation

Day-Ahead Market Enhancements

DEFAULT BIDS FOR IRU/RCU MITIGATION

Local market power mitigation for IRU/RCU

- IRU/RCU are locally procured so suppliers can exercise local market power
- Proposal would mitigate IRU/RCU offers to the higher of the default availability bid or the competitive locational marginal price.
- There is an established methodology to determine default energy bids
  - Costs related to a resource's ability to provide reserves are more nebulous and uncertain

ISO would apply a default bid "floor" based on historical spinning reserve offers

- Intended to balance the need to protect consumers from market power while also protecting suppliers from excessive mitigation by forcing offers below their costs

- Default bid price of $55/MWh for IRU/RCU when mitigated covers 80th percentile of spinning reserve bids

Type	Spinning Reserve Bid Price ($/MWh)
50 Percentile	$1.90
60 Percentile	$5.00
70 Percentile	$21.70
80 Percentile	$50.00
90 Percentile	$100.00

Longer run considerations for IRU/RCU default bids

- Medium run changes:
  - Apply a more dynamic default bid floor by exploring relationship between spinning reserve offers and natural gas prices or energy prices

- Long run changes:
  - After data become available on the costs of offering IRU/RCU under competitive conditions, ISO would re-engage with stakeholders to develop a more rigorous methodology

Day-Ahead Market Enhancements

INCORPORATING ENERGY COSTS INTO IMBALANCE RESERVE PROCUREMENT

Incorporating energy costs in procurement of imbalance reserves

- When awarding imbalance reserves, only the imbalance reserve bid prices contribute to the IFM objective function – the underlying energy costs do not

- DAM could routinely award imbalance reserves to resources that are not economically viable for imbalance energy dispatch in RTM
  - RTM will re-optimize awards and substitute for energy or FRP from cheaper resources, but
  - Are imbalance reserve payments rewarding the right resources?

Previous proposal considered a real-time energy offer cap

- Resources with energy costs higher than the energy bid cap would have an incentive to submit higher-priced reserve bids to cover the risk of incurring a loss in the real-time market

- Issues:
  - Interaction with market power mitigation
  - Price formation concerns

Current proposal applies an IRU eligibility price cap to exclude resources that would not be economically viable for real-time imbalance energy dispatch

- New proposal includes eligibility criteria to consider only imbalance reserve up offers from certain resources based on the resource's day-ahead energy offers

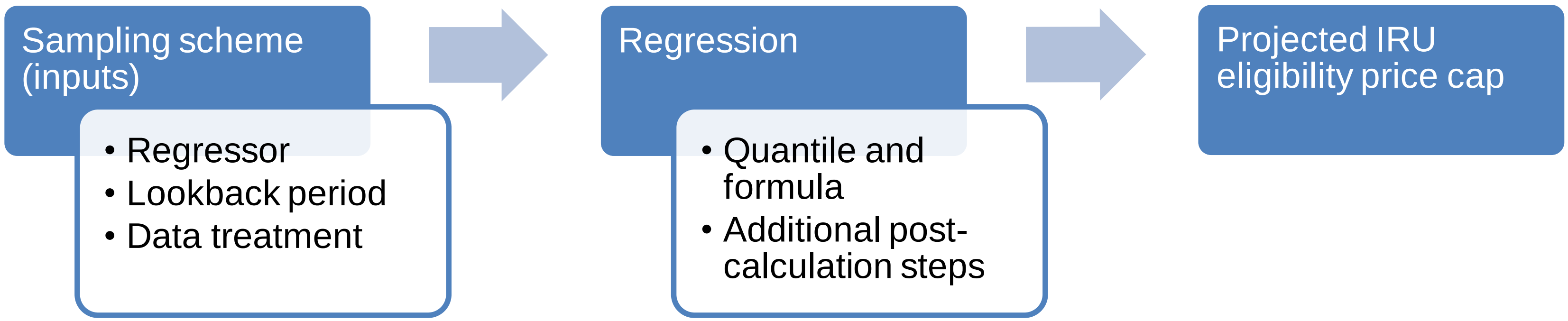
- Resources with any portion of energy bid above calculated eligibility price cap would be excluded from providing IRU bids

- The eligibility cap would leverage the same methodology as proposed for the previous bid cap proposal

Companion analysis - executive summary and findings

- Natural gas commodity prices are a better variable (regressor) for an IRU eligibility price cap than net load data
- The 90th quantile provides a more stable cap than the 97.5th quantile
- Linear regressions performed better than quadratic regressions for the same set of regressors and input variables
- Incremental analysis performed for the summer 2022 months supports the findings derived from data from previous months
- Methodologies tested for summer 2022 months (particularly September 2022) yielded higher difference metrics when compared to previous months due to interplay between lower historical pricing and higher actual FMM LMPs

Overview of companion analysis on IRU eligibility price cap calculation methodologies



- Objective: calculate a real-time eligibility cap ($/MWh) at hourly or daily granularity that is available prior to close of day-ahead market bidding window
- Assessment of quantile regression using historical data to predict next day’s real-time IRU eligibility price
- 30 different methodologies tested for Jan-Jun 2022; 4 of those methodologies tested incrementally for Jul-Sep 2022

Methodology results were compared against standard metrics in a counterfactual analysis

1. Coverage: percentage of time that the projected price cap was sufficient to cover, *i.e.*, was greater than or equal to, the actual FMM price.
2. Difference: the difference between the projected price cap and the actual FMM price. Positive difference indicates that the projected price cap covers the actual FMM price.
3. Closeness: the absolute difference between the projected price cap and the actual FMM price.
4. Scale: the ratio of the actual FMM price to the projected price cap. A scale value less than one indicates that the projected price cap covers the actual FMM price.

- Counterfactual analysis → running regression for each methodology, deriving projected price curves for study range, then comparing projected prices against actual FMM LMPs using the four metrics above

Other items compared between IRU eligibility price cap methodologies

- Testing different historical lookback periods
- Applying a configurable scalar
- Single *vs*. multiple regression features
- Linear *vs*. quadratic regression formula
- Using historical data at different granularities
- Setting daily cap (1 value) *vs*. hourly cap (24 values)

Recommended methodology for calculating IRU eligibility offer cap

- Methodology 11:
  - Hourly cap methodology
  - 60/60 lookback period for historical data
    - FMM LMPs
    - Gas prices
  - Predictor variable = average gas price
  - Linear quantile regression at 90^{th} quantile
  - Scaling factor of 1.2 applied to calculated hourly caps
- Why this methodology?
  - Provided reasonable trade-off between coverage and scale compared to other methodologies while minimizing influence from historical data outliers

Coverage results across different lookback periods informed use of a 60/60 lookback period

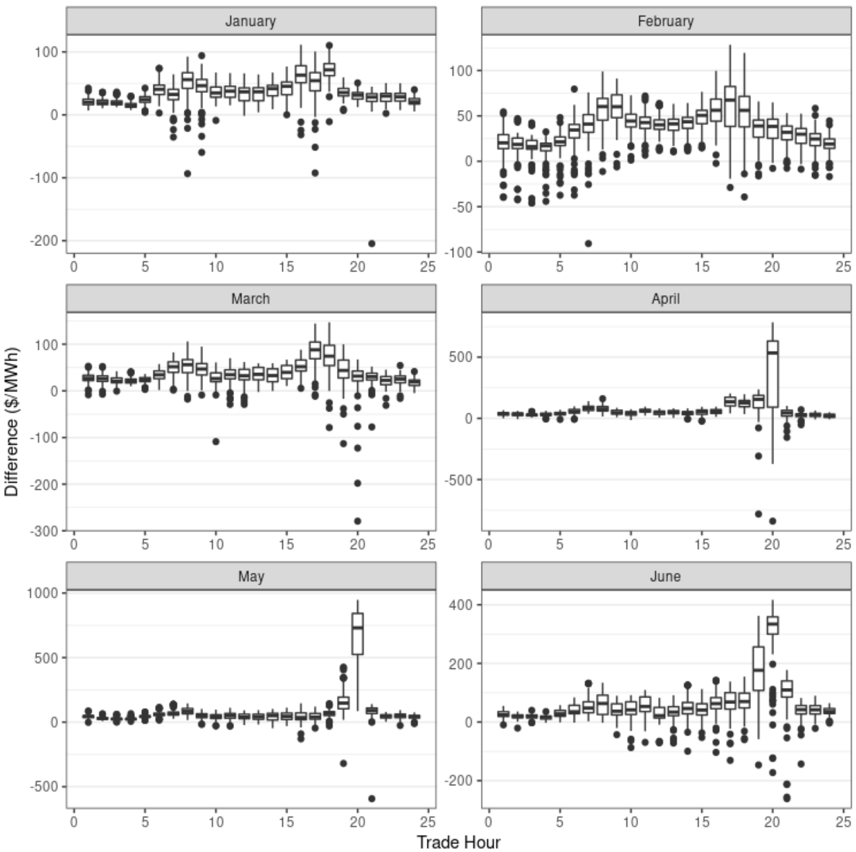
- Table shows average monthly percent coverage across the same methodology with different lookback periods

Lookback Period	Jan	Feb	Mar	Apr	May	Jun
30/30	97.3	96.1	97.2	95.8	96.2	96.4
45/45	97.7	96	97.3	96.8	96.8	95.8
60/60	99.2	96.3	97.7	97.8	97.5	95.6
45/0	96.8	94.6	96.8	95.8	94.2	91.8
60/0	97.7	94.4	97	97.5	95.7	93.8
90/0	97.6	94.8	96.8	98.2	95.7	94.3

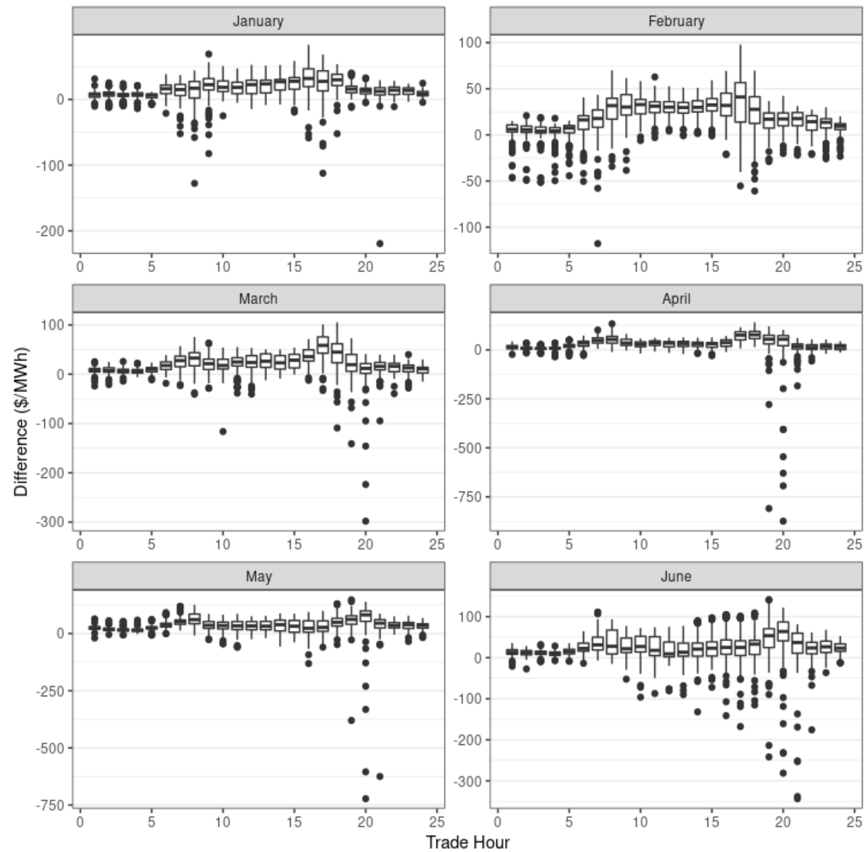
Month — Coverage (%)

Influence from high-priced outliers in the regression informed use of the 90th quantile

Methodology 3 (97.5th quantile)



Methodology 10 (90th quantile)



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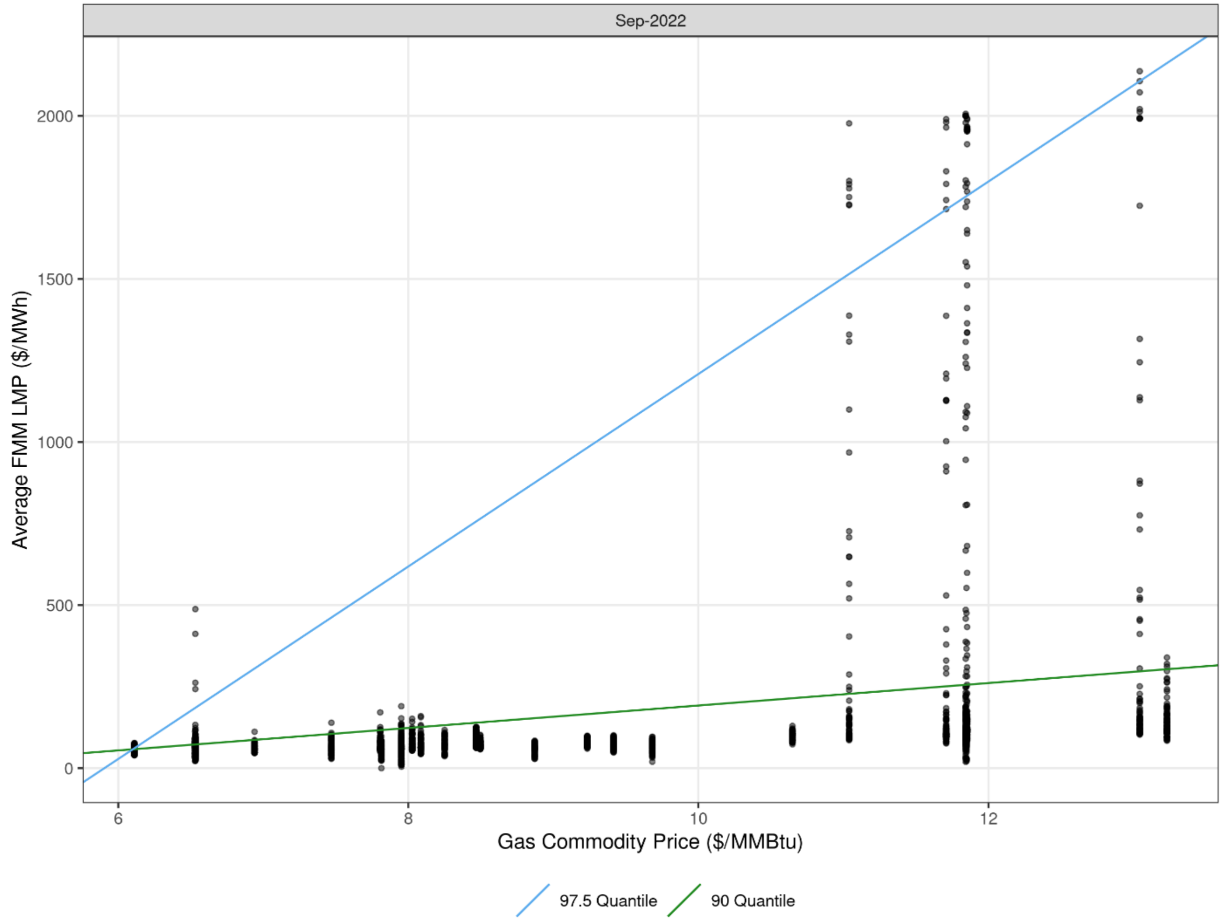
Illustrative example of outlier influence across different quantiles – September 2022 prices



Applying a 1.2 scalar on a 90th percentile quantile regression yielded higher coverage between two similar tests

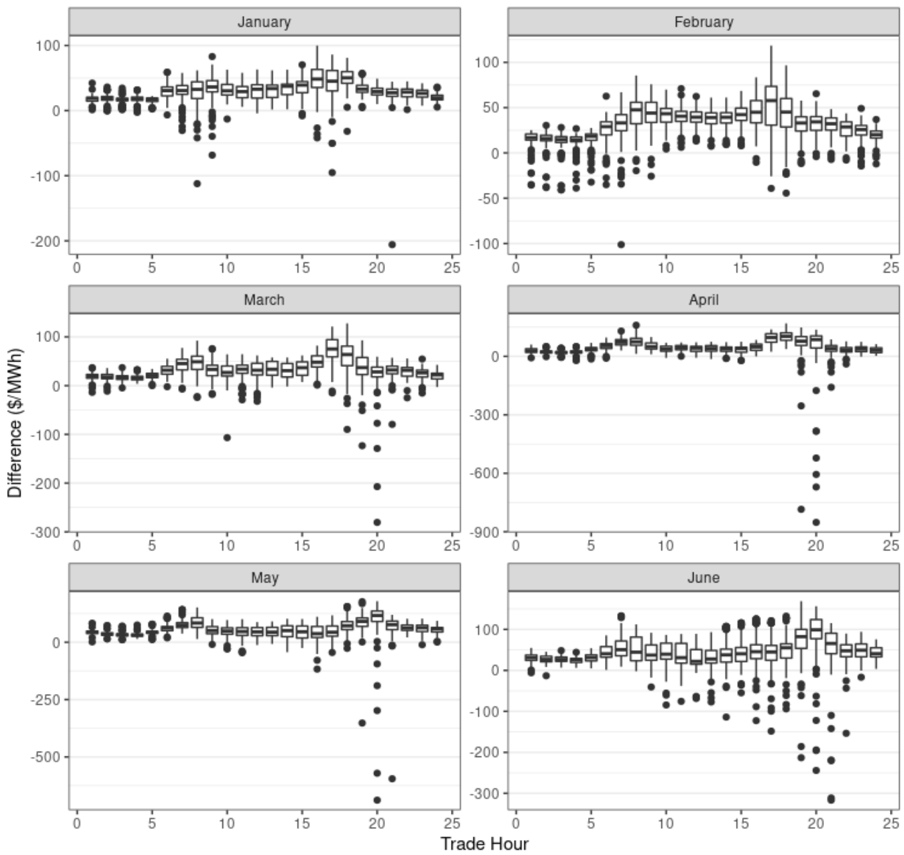
Methodology 10 (no scalar)

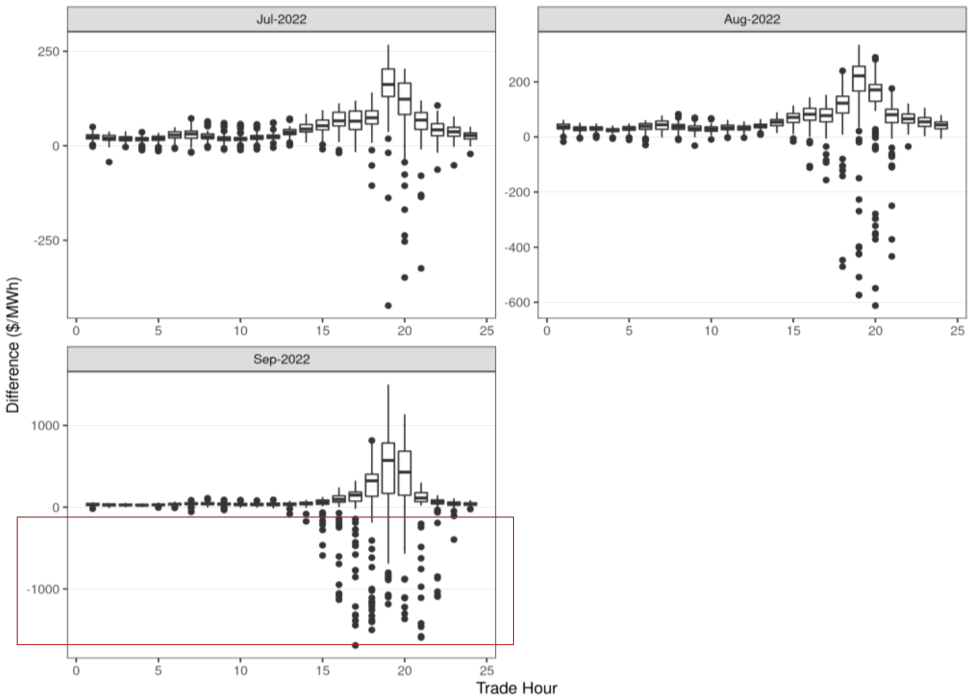
Month	Percent Coverage	Average Closeness	Average Difference	Average Scale
January 2022	91.16%	17.59	15.62	0.76
February 2022	89.32%	21.62	18.65	0.68
March 2022	90.11%	22.72	20.01	0.66
April 2022	91.35%	34.52	29.00	0.64
May 2022	93.78%	39.44	35.54	0.62
June 2022	87.74%	31.64	24.31	0.74
July 2022	86.30%	27.29	22.83	0.80
August 2022	88.74%	40.24	27.91	0.81
September 2022	85.52%	104.37	33.56	0.81

Methodology 11 (1.2 scalar)

Month	Percent Coverage	Average Closeness	Average Difference	Average Scale
January 2022	98.42%	29.92	29.13	0.64
February 2022	96.13%	32.39	31.22	0.57
March 2022	97.21%	33.80	32.48	0.55
April 2022	97.57%	50.01	46.07	0.53
May 2022	97.78%	57.73	55.12	0.51
June 2022	95.21%	47.74	43.45	0.62
July 2022	97.08%	45.13	42.92	0.67
August 2022	97.11%	63.12	54.69	0.67
September 2022	93.64%	127.64	67.72	0.68

Difference results for methodology 11 show larger negative outliers in summer months





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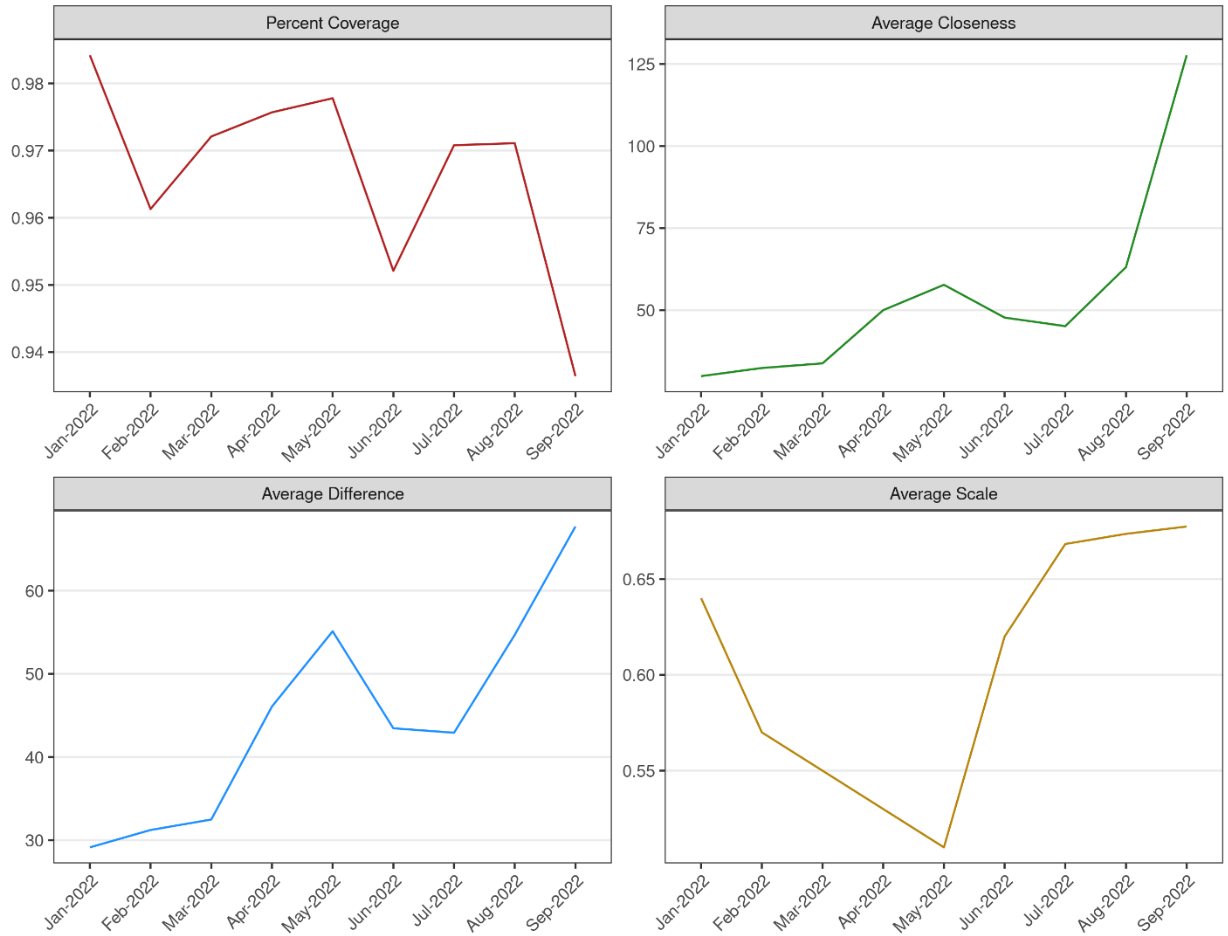
Overall, methodology 11 provides average coverage of 94 – 98% across study period



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Tradeoffs between IRU eligibility offer cap calculation methodologies

- Hourly cap
  - Curve with 24 hourly caps (1 cap/hour)
  - Pros: more representative of hourly pricing dynamics
  - Cons: more complex to react to 24 different values when submitting bids
- Daily cap
  - One cap for the entire trading day, set as max [24 hourly caps]
  - Pros: more straightforward for SCs to react to a value when submitting bids, provides a more conservative estimate for most hours, slightly higher coverage values in some tests
  - Cons: potential for overestimating cap for non-peak hours

Additional considerations

- May need an additional buffer on top of proposed methodology to ensure there are sufficient pool of resources to secure offers and avoid creating artificial scarcity

- May consider a daily eligibility price based on maximum hourly calculated price

- Would turn off functionality during tight system conditions