



California ISO

# Flexible Ramping Product Requirements: Performance review, challenges, and potential enhancement analysis/paths discussion

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Short Term Forecasting

Market Surveillance Committee Meeting

General Session

November 29, 2023

# Recent concerns on FRP requirements

Limited Sample Size

Historical Data Utilized

Future Awareness of Requirements

Movement in requirement between time periods

Mosaic requirement outcomes weekends

Threshold Activations

How to analyze requirement performance

# Performance metrics mapped to key items

## Current Performance Metrics:

Directional Coverage 

Average Requirement 

\*Inter-hour movement 

\*RSE requirement movement 

## Key Items:

**Quality of calibration**

**Informativeness**

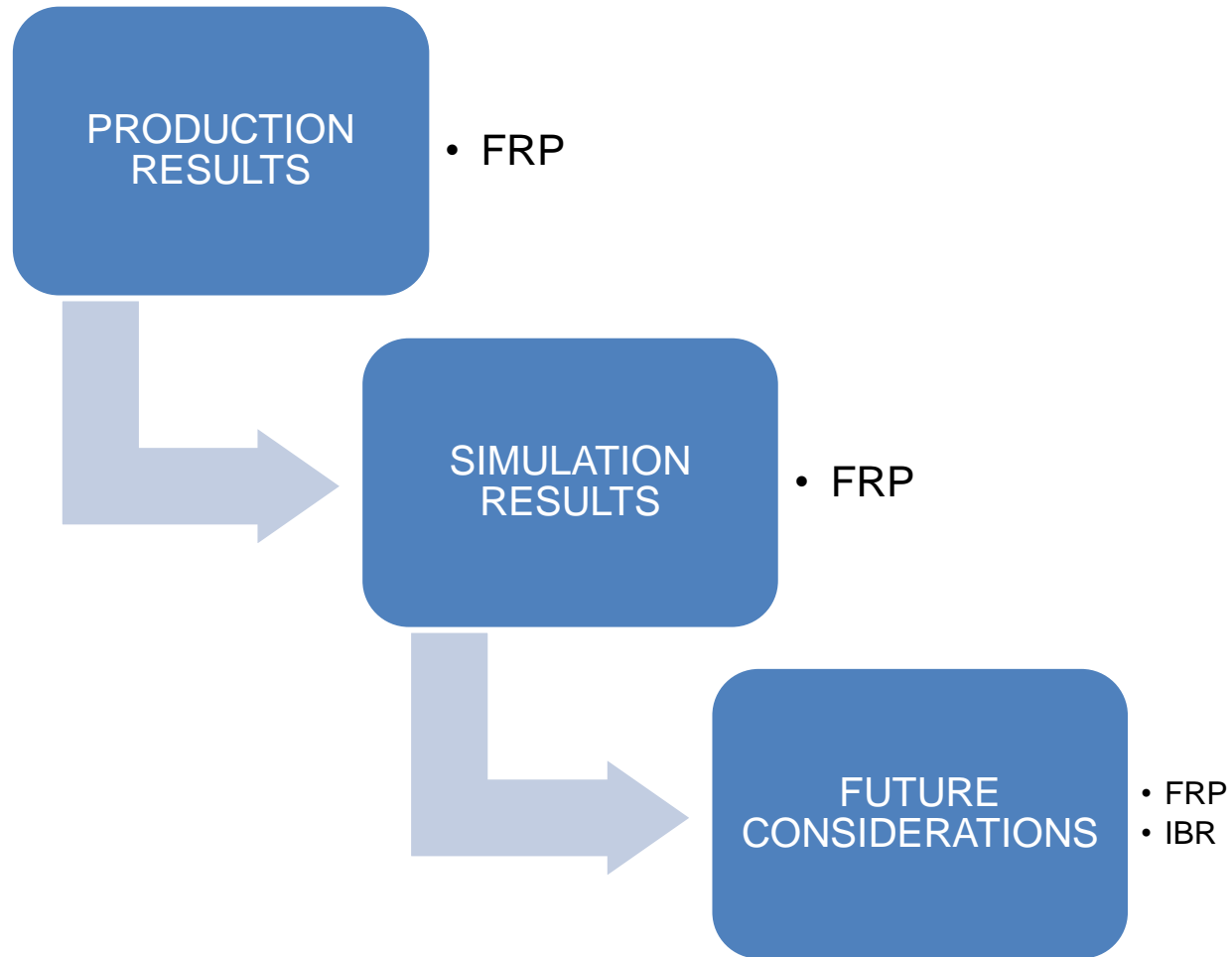
**Cost**

Usability

\* denotes new requirement for presentation  
**bold denotes proposed grouping by MSC**

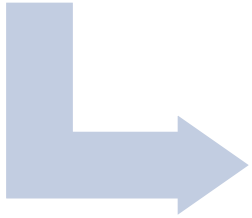
How to analyze  
requirement  
performance

# Presentation Roadmap



PRODUCTION  
RESULTS

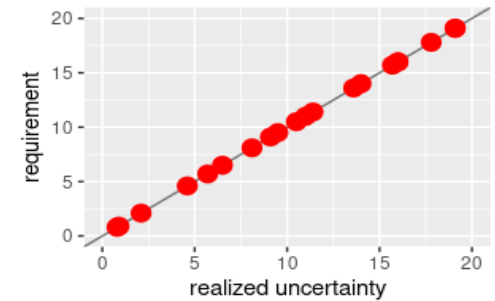
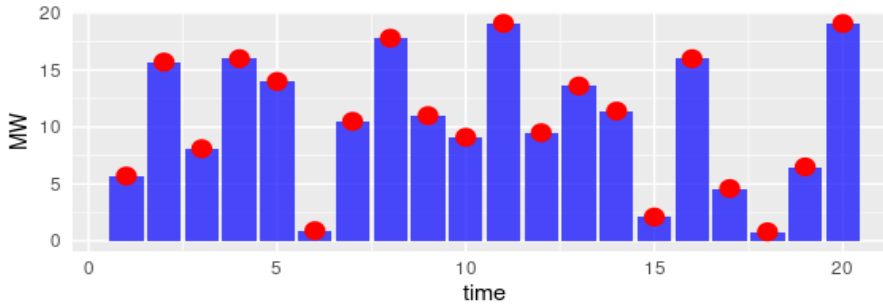
• FRP



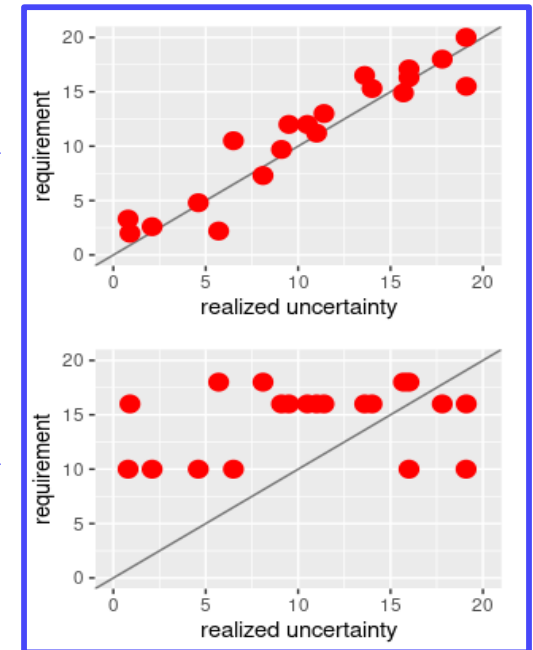
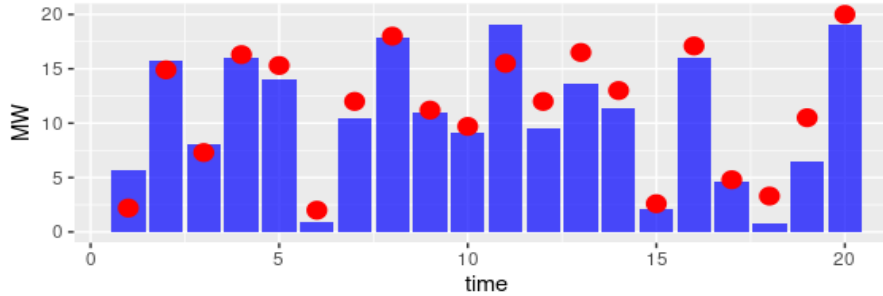
# PRODUCTION RESULTS

# Informativeness

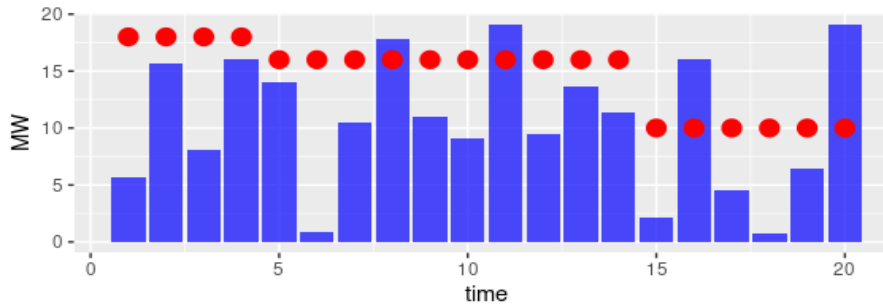
(1)  
Perfect predictor



(2)  
Dynamic predictor



(3)  
Static predictor



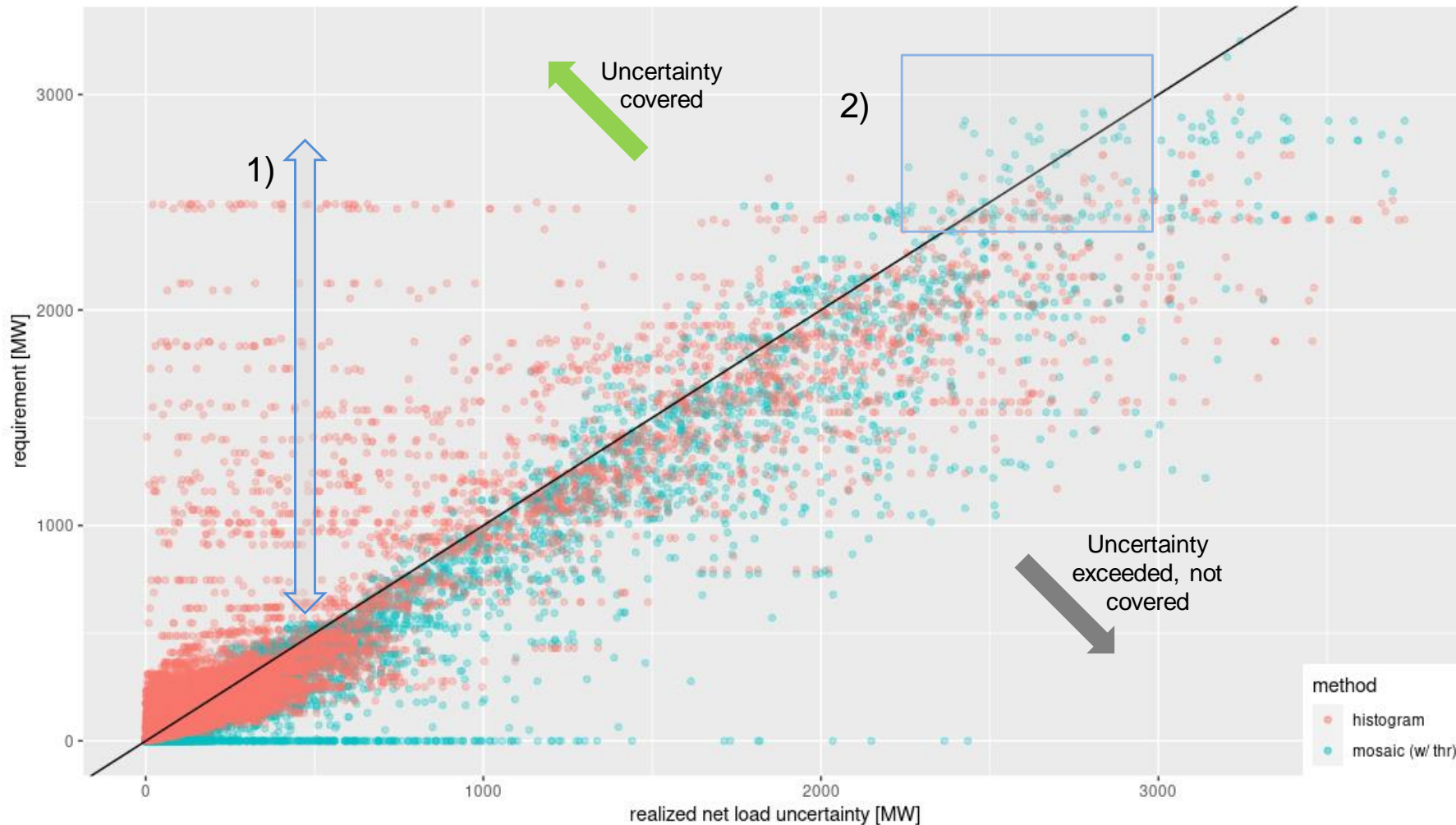
● predictor  
■ uncertainty

Equivalent coverage  
Difference in *informativeness*

## Mosaic requirements are responsive to realized uncertainty

- 1) Mosaic carries low requirement at low uncertainty
- 2) Mosaic shows coverage closer to target at high uncertainty

Instances where uncertainty exceeded mosaic and/or histogram requirement (summer 2023, all BAAs)



# Mosaic better captures realized uncertainty

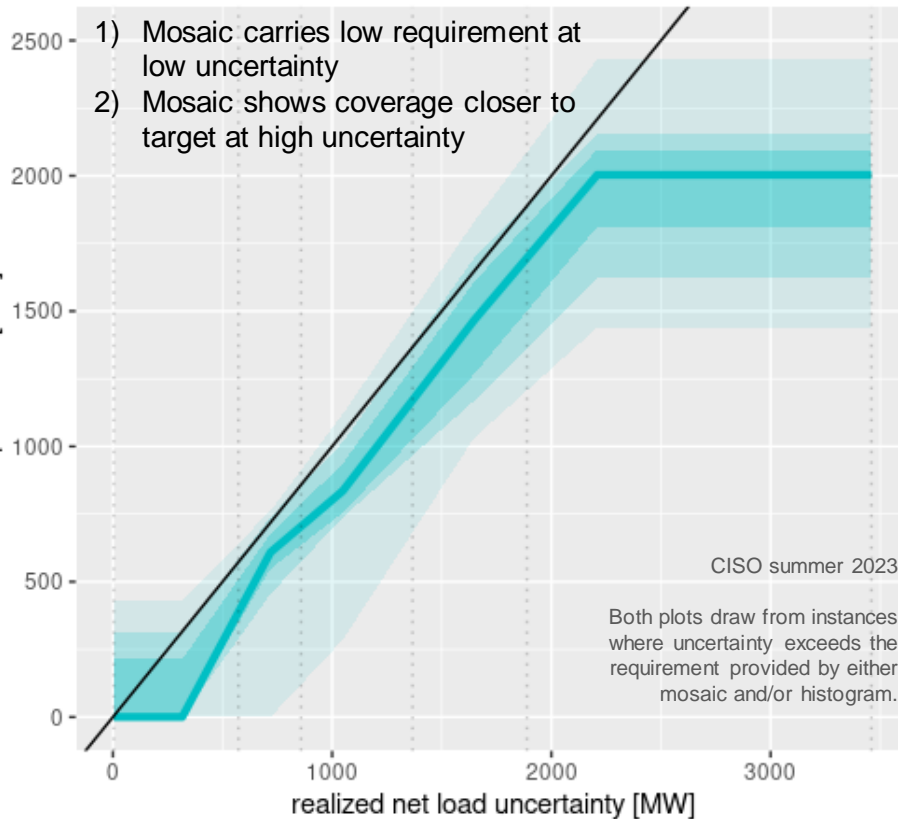
This slide pares down the data visualization from the previous slide and shows spread during periods where uncertainty is near requirements.

Performance benefits of mosaic are most clearly seen at the extremes (low and high) of uncertainty.

Spread (10 <sup>th</sup> -90 <sup>th</sup> )	Lowest 20% [0-701 MW]	Middle 20% [981-1525 MW]	Top 20% [2026-3460 MW]
mosaic	642.7	753.9	685.9
histogram	873.5	839.5	631.7

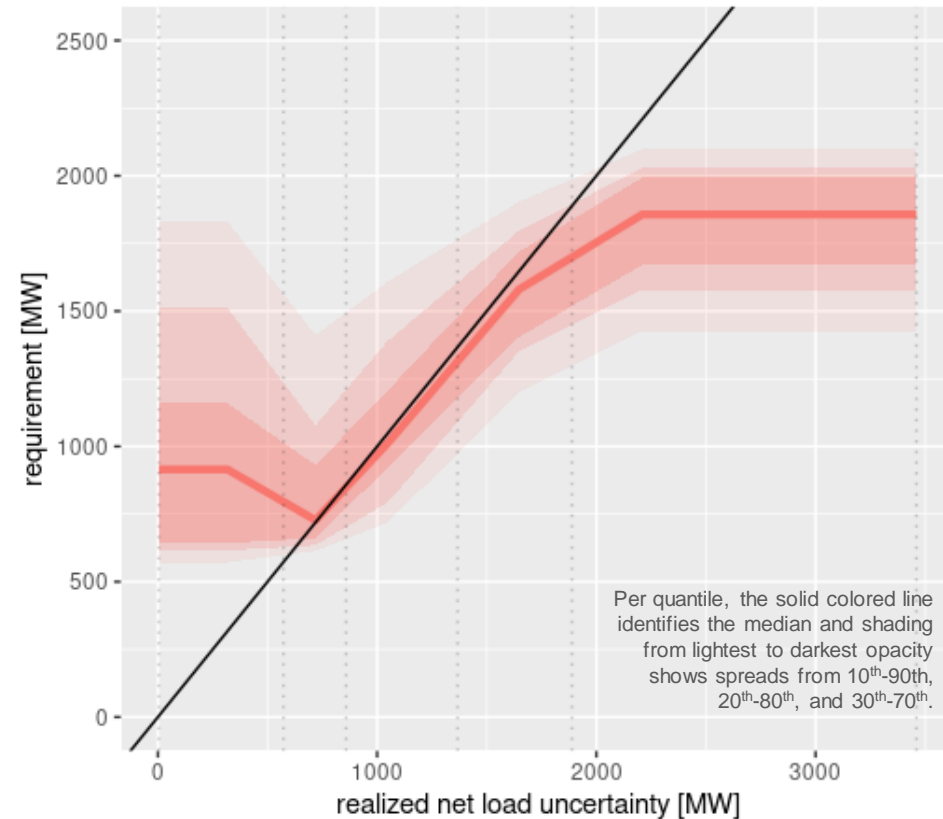
## mosaic

uncertainty exceeded mosaic and/or histogram (summer 2023, CISO)



## histogram

uncertainty exceeded mosaic and/or histogram (summer 2023, CISO)

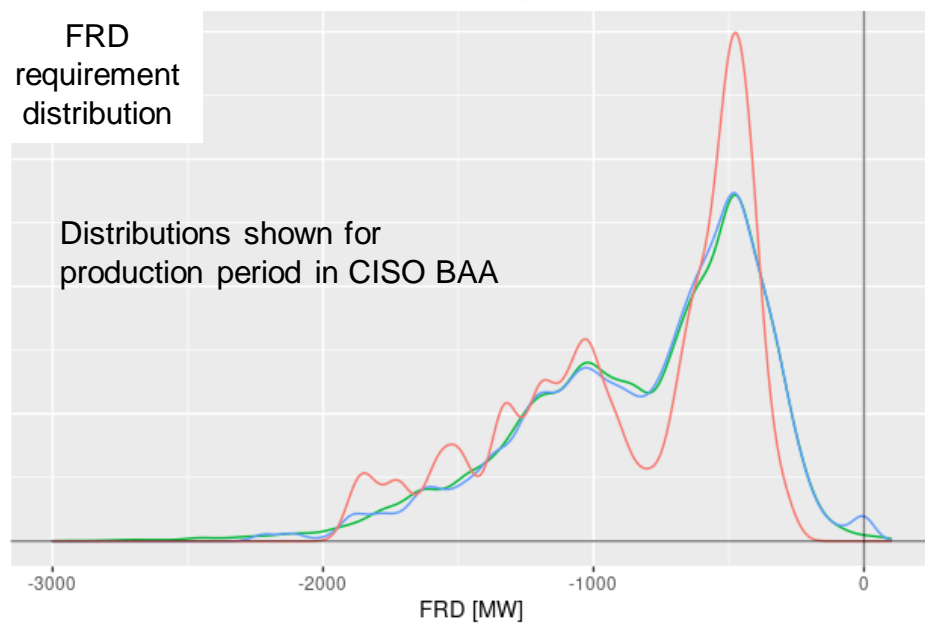
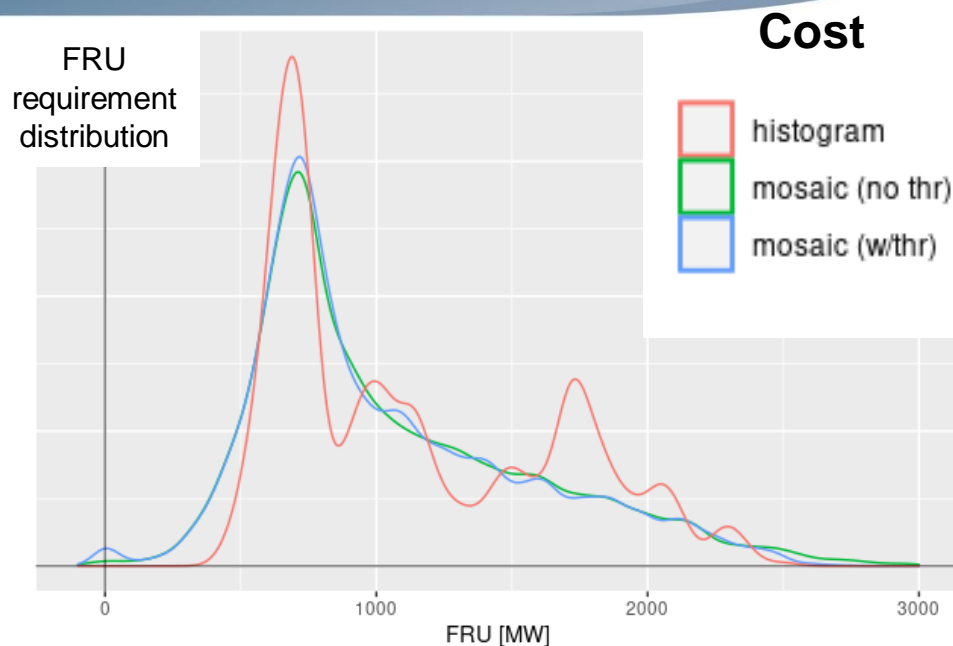




# Mosaic leads to lower requirements

Mosaic method has lower average and median requirement magnitudes. Historical production data shows about a **100 MW reduction in FRU** and 10 to 50 MW in FRD.

		Mosaic	Histogram
FRU	Mean	1040	1141
	Median	874	996
FRD	Mean	-801	-868
	Median	-694	-707



# Mosaic coverage is greater on weekdays than weekends

Coverage		Weekday only	>	Weekend only	Weekday/ Weekend combined
AII	Mosaic	0.931	>	0.897	0.921
	Histogram	0.942		0.934	0.940
FRU	Mosaic	0.966	>	0.945	0.960
	Histogram	0.973		0.966	0.970
FRD	Mosaic	0.965	>	0.956	0.962
	Histogram	0.973		0.972	0.972

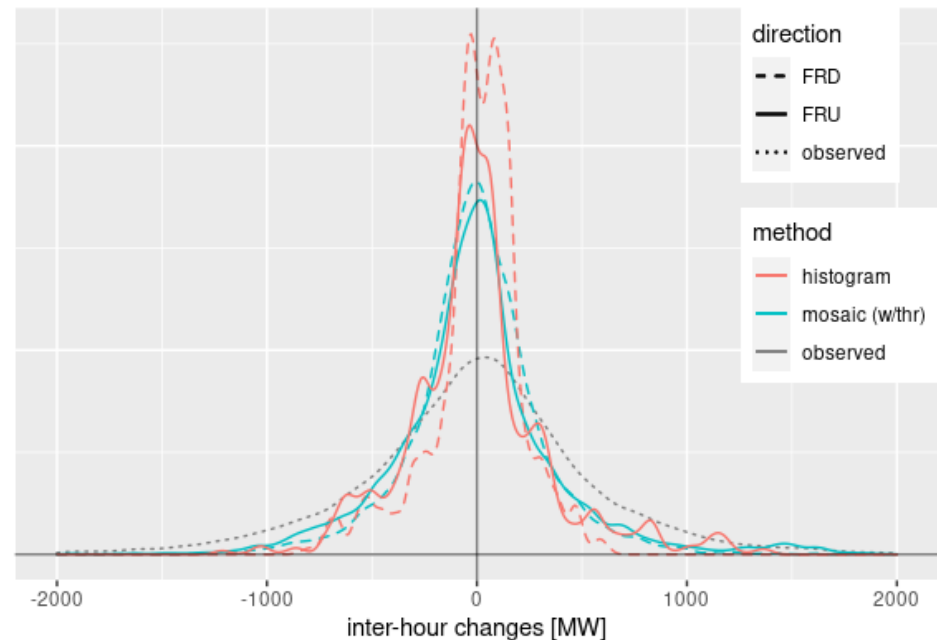
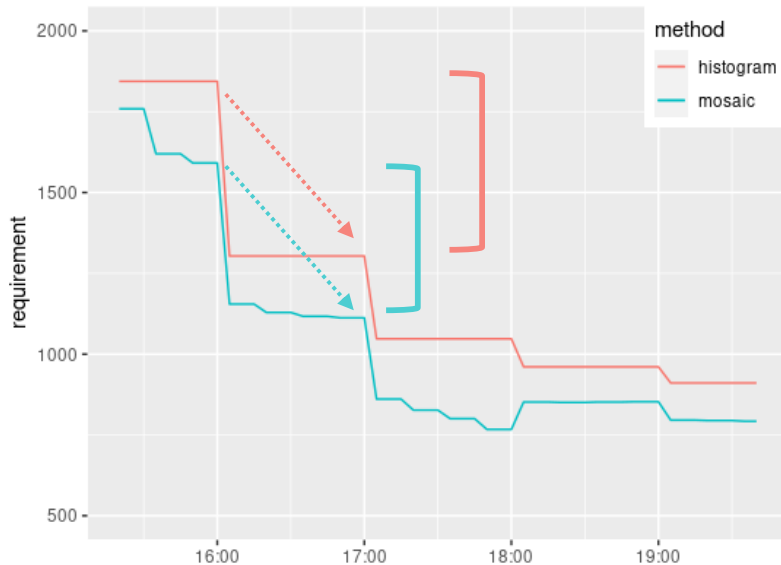
- Coverage is evaluated over the historical period of analysis (2/2/23 to 10/18/23).
- Note that coverage is one characteristic of many and the above metrics offer comparison of day-type performance rather than mosaic vs histogram performance.

Weekend coverage suffers from smaller sample size due to day-type split.

# Quantification of inter-hour movement in RTPD

(1) Mosaic movement relative to histogram is greater in FRD than in FRU and (2) movement in observed uncertainty is greater than either method, which helps validate the need for this movement

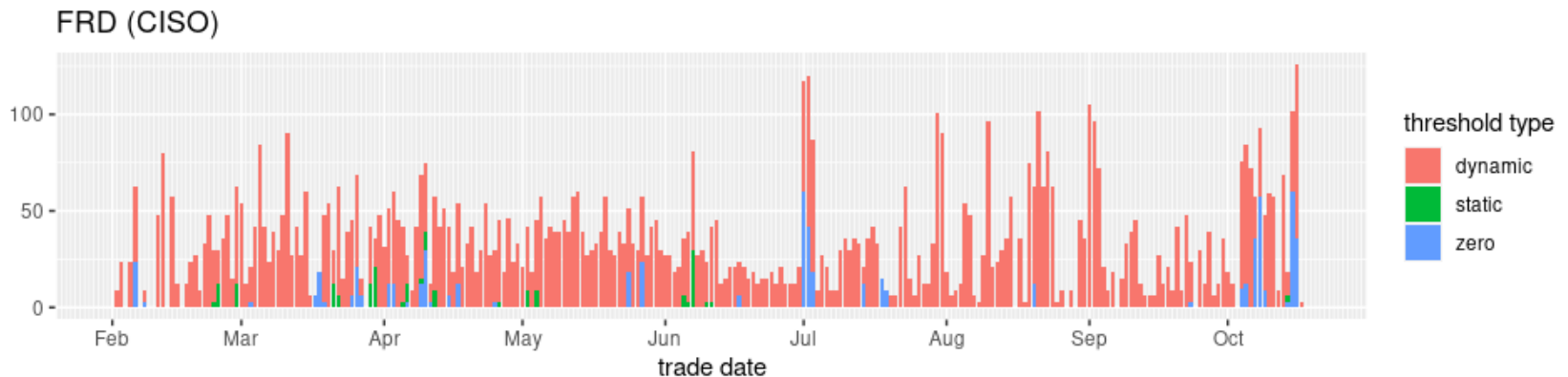
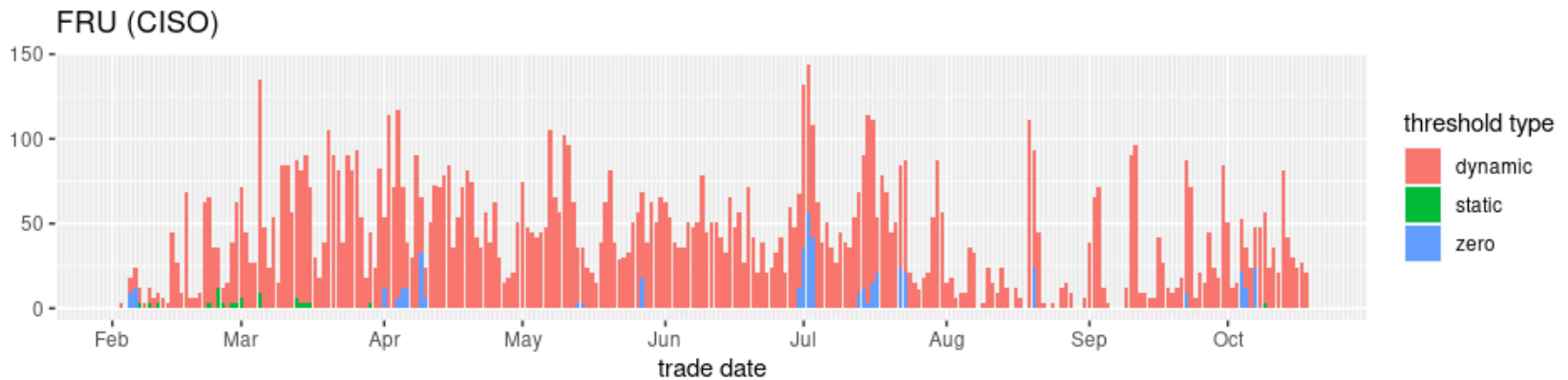
Inter-hour absolute magnitude changes		Mean	Median	90 <sup>th</sup> percentile
FRU	Mosaic	277.8	175.9	660.2
	Histogram	240.0	149.1	587.3
	Histogram → mosaic % change	15.8%	18.0%	12.4%
FRD	Mosaic	222.1	155.5	508.2
	Histogram	162.2	107.3	396.0
	Histogram → mosaic % change	36.3%	44.9%	28.5%
Observed uncertainty		414.2	297.8	931.8



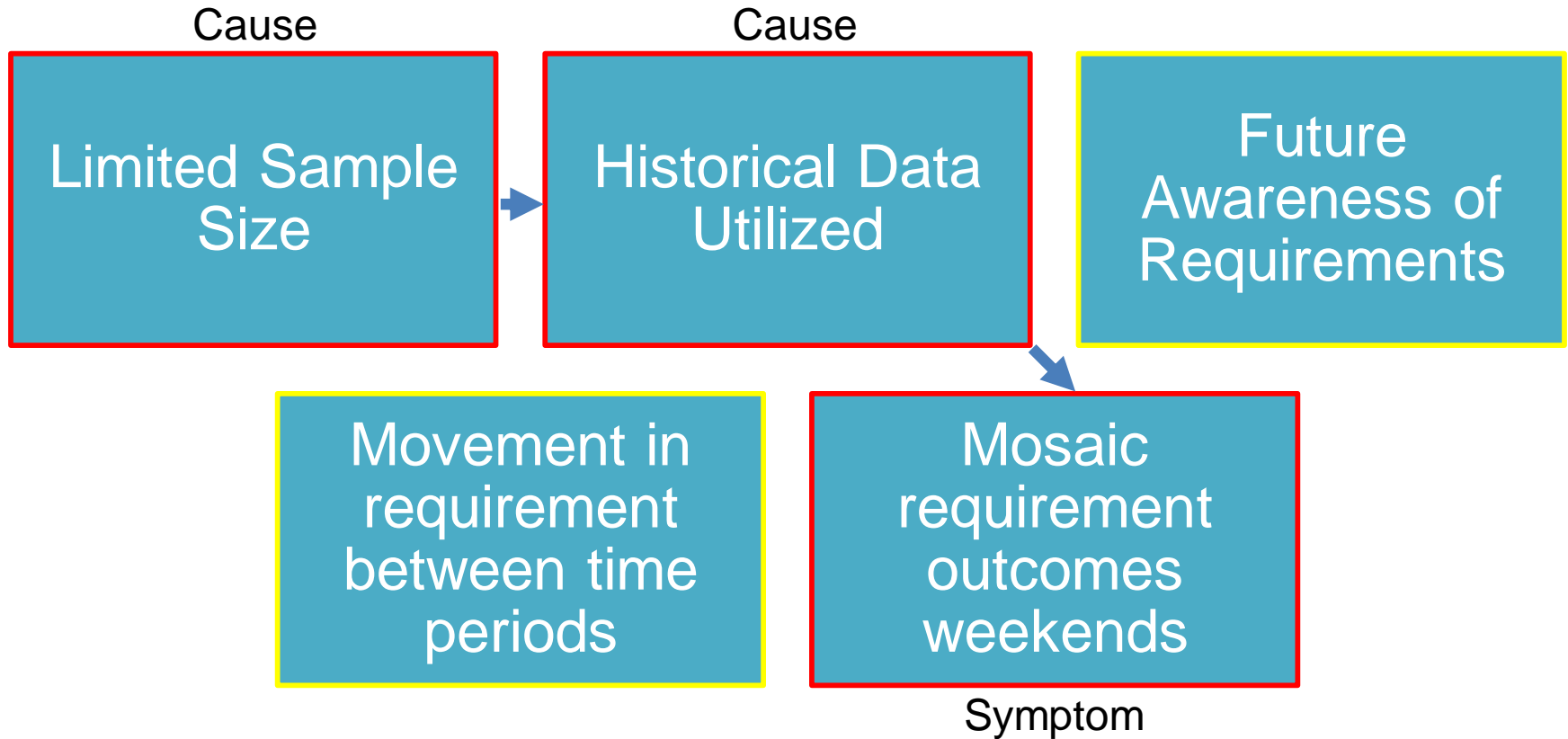
# Dynamic thresholds comprise the bulk of threshold activity

	Summer (6/1 – 9/30)				Overall (2/2 – 10/18)			
	Zero	Static	Dynamic	Total	Zero	Static	Dynamic	Total
CISO	0.5%	1.7%	9.7%	9.8%	0.8%	1.5%	10.6%	10.9%
EIM Area	0.7%	0.6%	7.4%	7.4%	0.7%	1.4%	9.1%	9.6%

% of requirements hitting thresholds, evaluated per day and averaged over a defined period (# hits / 288)

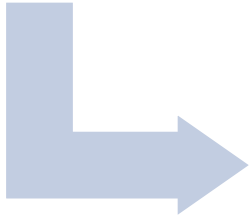


# Top priorities of cause to symptom: FRP requirements from a forecasting perspective



SIMULATION  
RESULTS

• FRP




# SIMULATION RESULTS

# STF Analysis Plan

## 1) Define Objective [function]

- From Benchmark, **increase calibration towards target coverage and decrease cost**
- From Benchmark, **increase calibration towards target coverage and increase informativeness.**



Stakeholder  
Feedback

## 2) Select the parameters to modify/add/subtract

- Pooled suggestions from DMM/MSO and are pursuing in merit order

## 3) Choose a Search Strategy

- Expand grid space / results as they increase objective

# Outline

- Simulations focused on two key areas with respect to sample size:
  - Day Type Consideration
  - Historical Data Utilized
- CAISO will use a subset of metrics to approximate the Pareto optimization of **calibration (through coverage)** vs. **cost (through average requirement)** as primary driver of decisions (objective)
- Proposed alternatives are performed in parameter “sets”



# Parameter sets to evaluate alternative methods

Vary the sample scheme and size used to determine mosaic and histogram requirements

Sample Scheme	Sample Days	Description	Effective Sample Days Weekday	Effective Sample Days Weekend
1	90	Backwards 90 days w/ no day-type consideration	90	90
1	180	Backwards 180 days w/ no day-type consideration	180	180
2	90	Backwards 90 days w/ day-type consideration	~64	~25
2	180	Backwards 180 days w/ day-type consideration	~128	~51
3	90	Backwards 45 days / Forward 45 days w/ day-type consideration	~64	~25
3	180	Backwards 90 days / Forward 90 days w/ day-type consideration	~128	~51
4	90	Backwards 45 days / Forward 45 days w/ no day-type consideration	90	90
4	180	Backwards 90 days / Forward 90 days w/ no day-type consideration	180	180

Current Scheme



Configurable parameters:

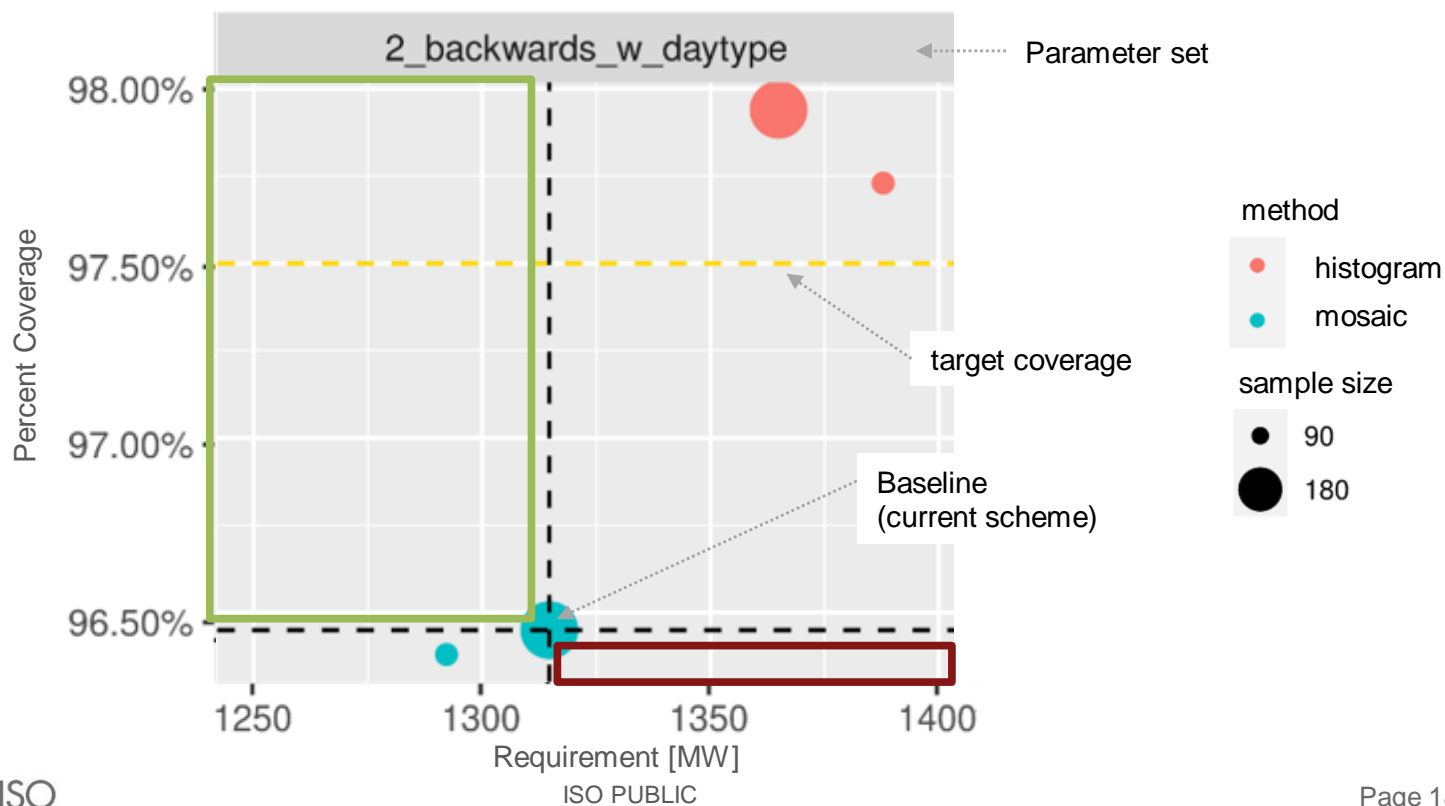
- Sample days (90 vs.180)
- Sample scheme (backwards-only vs. backwards/forwards)
- Day-type split (y/n)

ISO PUBLIC

# Interpreting simulation results

More Reliability  
+  
Less Requirement

Less Reliability  
+  
More Requirement



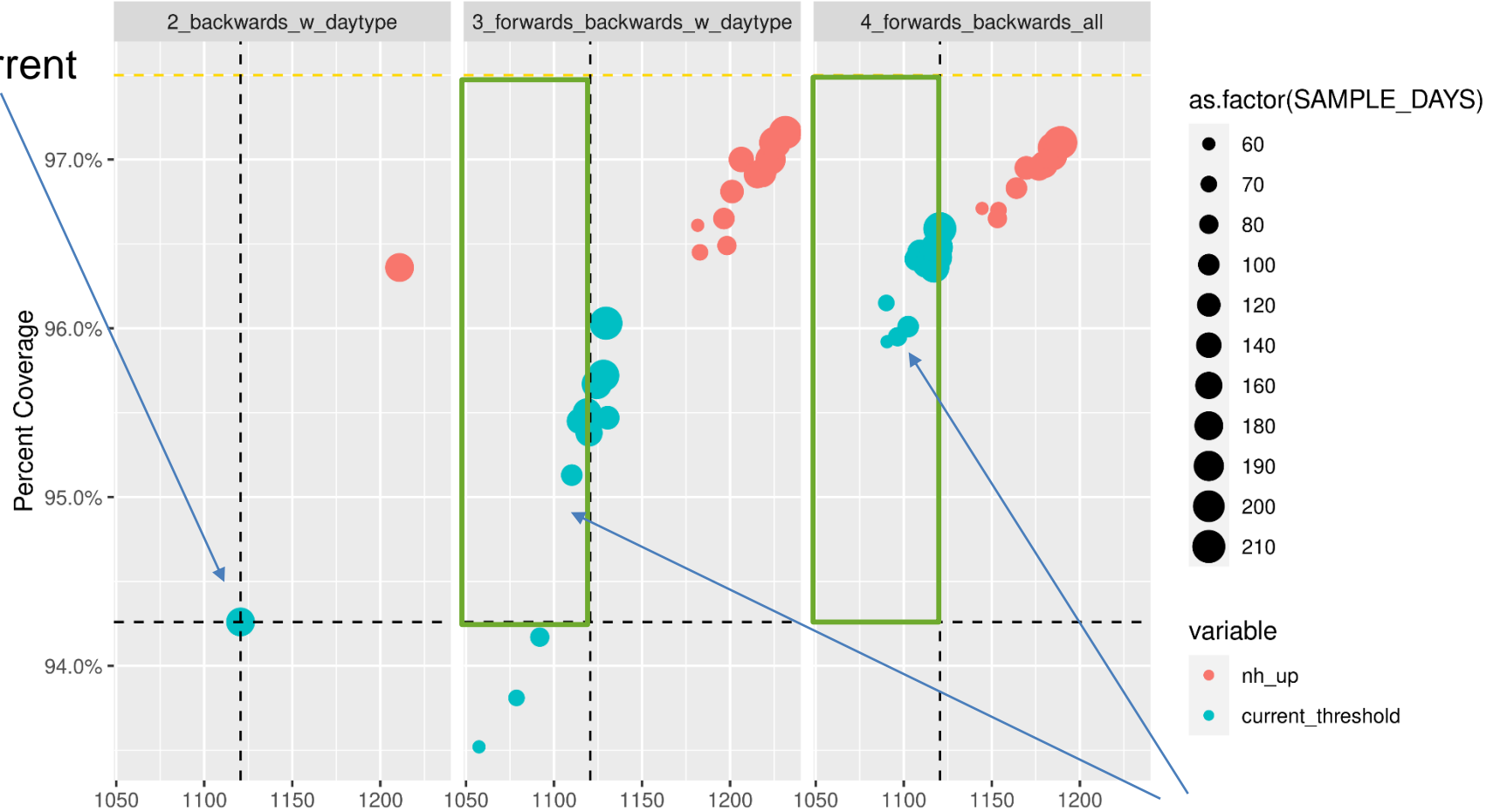
# Pareto Optimization of Calibration and Cost (FRU/WEEKEND)

FRU Requirement vs. FRU Coverage All Hours Weekend (Period Mean)

mosaic w/threshold (blue) vs. histogram (red) | sample size (ascending)

production benchmark (black-dashed) | target coverage (gold-dashed)

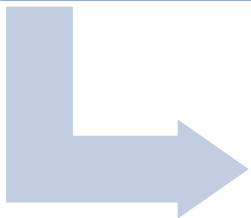
Current



Strong improvement for multiple alternative models  
2023-5-23 - 2023-11-5

Future  
Considerations

- FRP



# SUMMARY AND NEXT STEPS

# Summary

## Production Results

- Positives
  - Mosaic shows significant benefit over histogram at the tails of realized uncertainty.
  - Mosaic has a smoother distribution of requirements and a lower cost/requirement compared to histogram.
- Negatives
  - Mosaic has worse performance on weekends compared to weekdays.
  - Mosaic performance coverage is slightly below target calibration coverage.

## Simulation Results

- Eliminating day-type split will improve weekend overage and mosaic performance overall.
- Forward-backward sample scheme is shown to provide benefit to FRP and IR.
- The next step is to run further simulations across BAAs to ensure the amount of historical data is optimized.
  - Example 90 days historical, 90 days forward

# Summary of next step focus areas for FRP requirements

Increase Sample Size:

Day Type Modifications

Historical Data Utilized:

Forward and Backward Looking

Threshold:

Further study on dynamic thresholds

Future Awareness of Requirements:

Posting future requirements for customers

## Next steps with priority order

Priority	Impact	Description	Benefit
1	Medium	Change day-type within the mosaic methodology	Weekend model performance
2	Low	Change existing model parameters – in relation to historical sample data utilized	Overall model performance especially during seasonal transition
3	Medium	Posting future requirements for further stakeholder visibility	Customer awareness
4	TBD	Evaluate key timing utilized in requirement formulations	TBD
5	TBD	Dynamic threshold simulations and potential modification	TBD

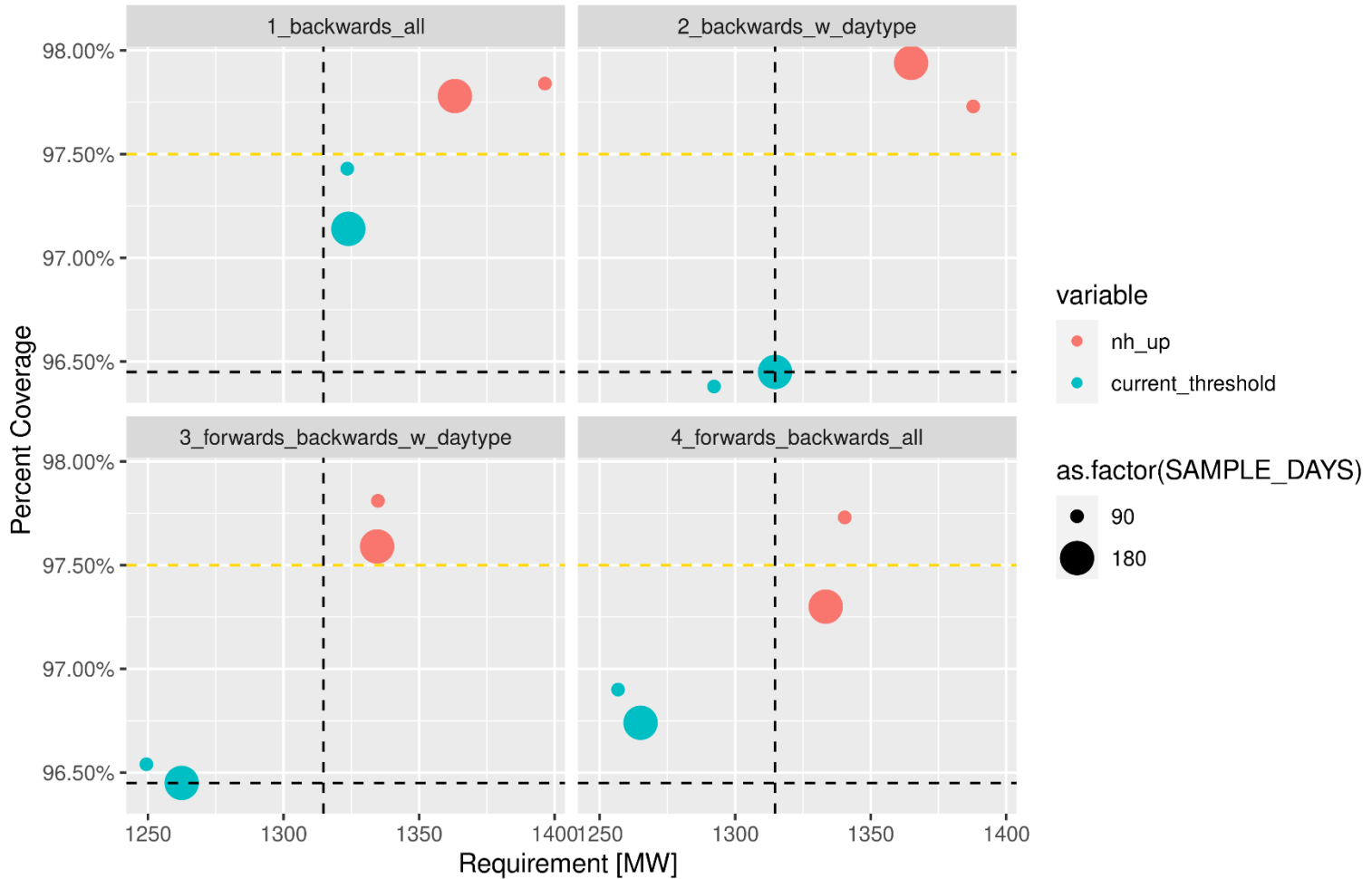
# APPENDIX



# Pareto Optimization of Calibration and Cost (FRU/PEAK)

FRU Requirement vs. FRU Coverage HE 18-21 (Period Mean)

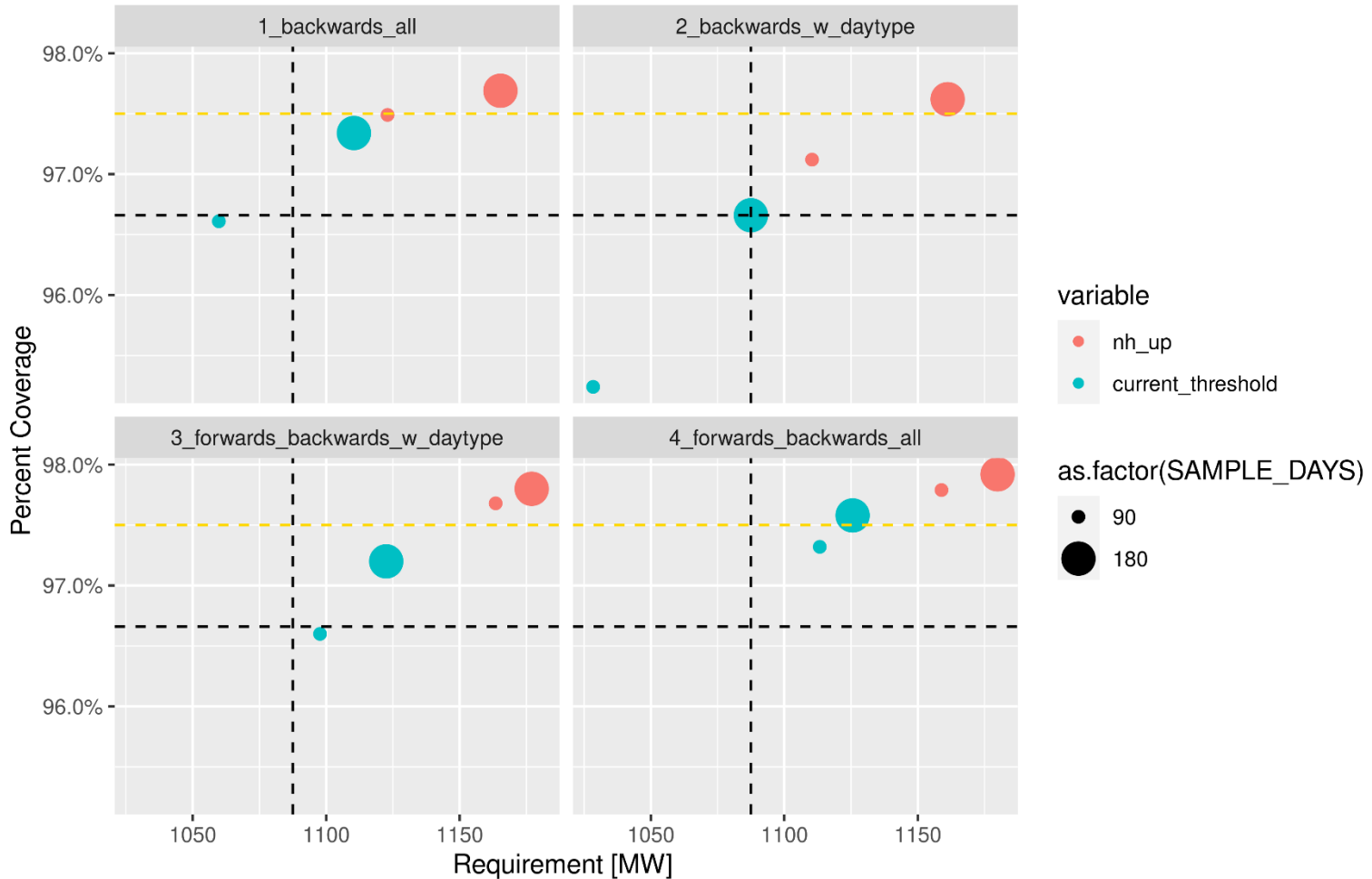
mosaic w/threshold (blue) vs. histogram (red) | sample size (ascending)  
 production benchmark (black-dashed) | target coverage (gold-dashed)



# Pareto Optimization of Calibration and Cost (FRU/ALL)

FRU Requirement vs. FRU Coverage All Hours (Period Mean)

mosaic w/threshold (blue) vs. histogram (red) | sample size (ascending)  
 production benchmark (black-dashed) | target coverage (gold-dashed)

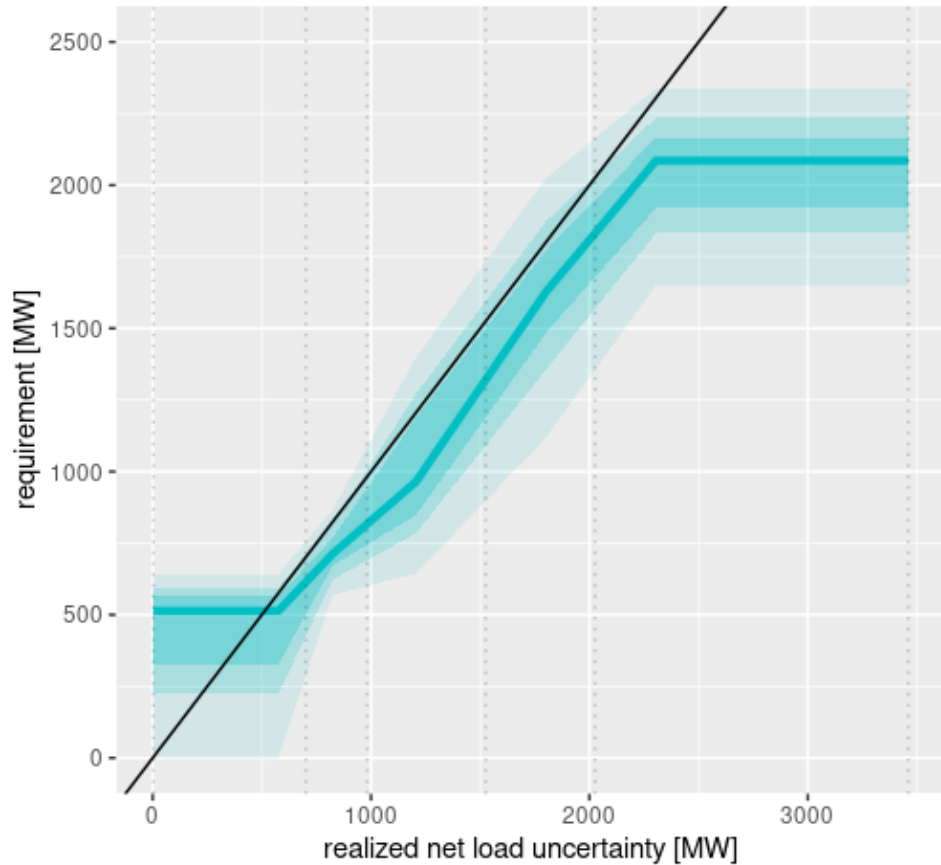


# Simulation results (scheme 4, 160 days) – Informativeness

Removing day-type split and enhancing the sample scheme improves the performance of mosaic as seen in simulated summer 2023 results, especially at low uncertainty values. Histogram changes from production version of this plot as sample scheme is revised, so histogram values reflect simulated histogram requirements.

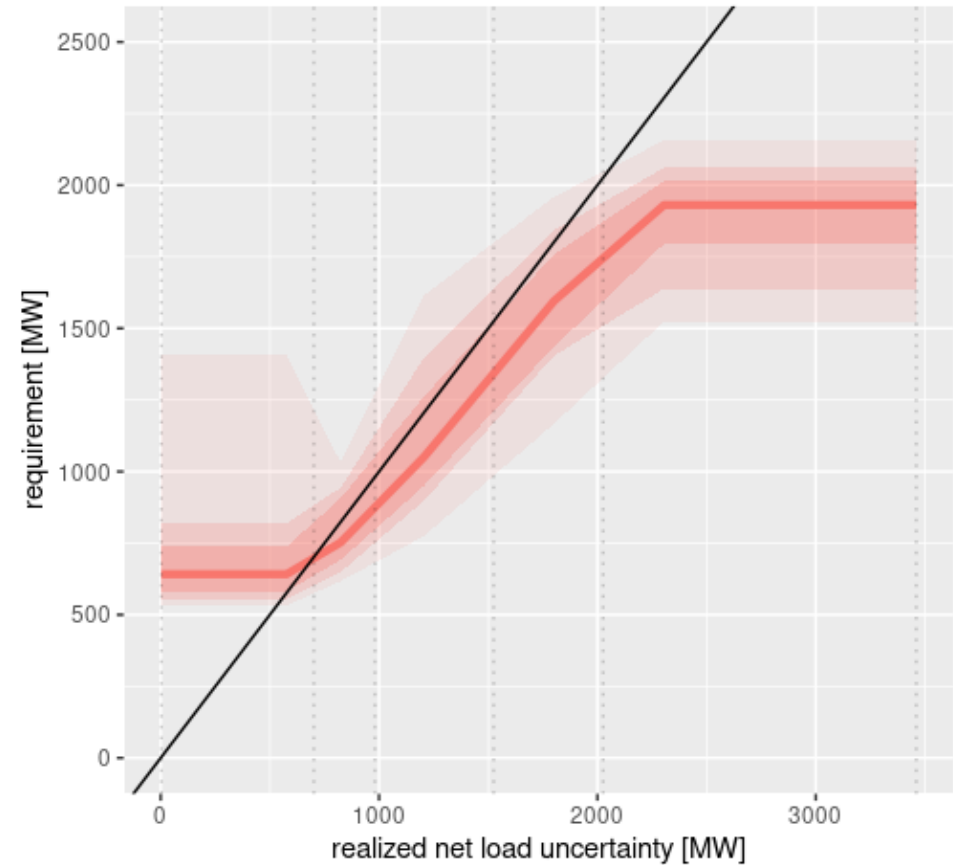
## mosaic

uncertainty exceeded mosaic and/or histogram (summer 2023, CISO)



## histogram

uncertainty exceeded mosaic and/or histogram (summer 2023, CISO)

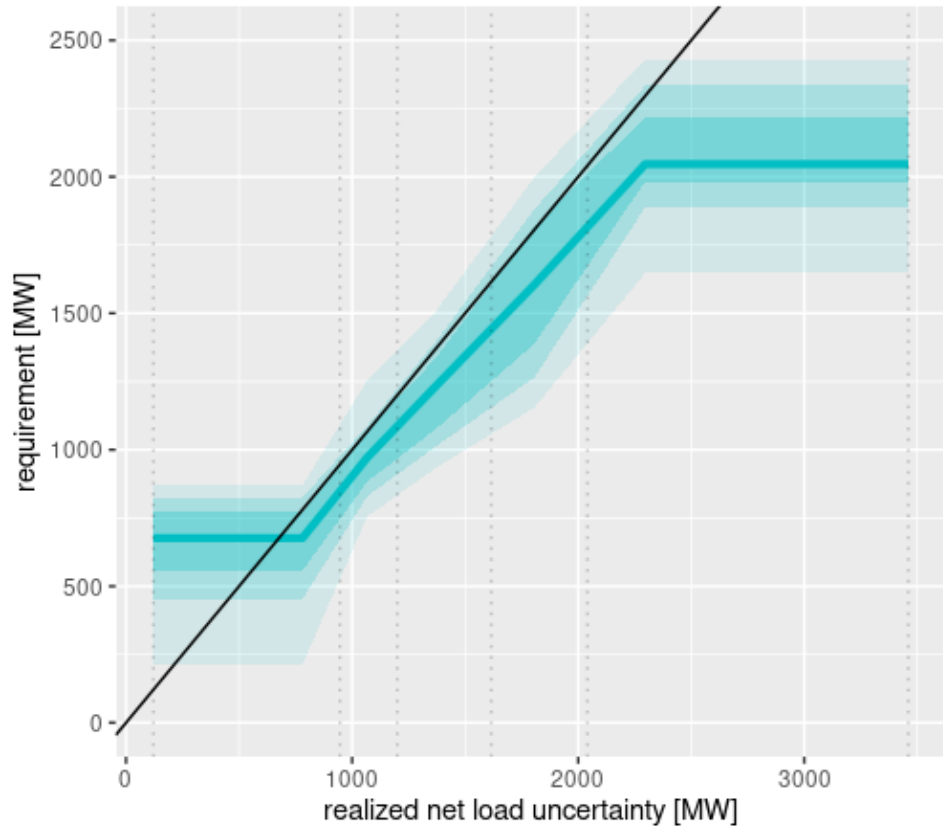


# PRODUCTION RESULTS APPENDIX

# Morning ramp (summer 2023, CISO)

## mosaic

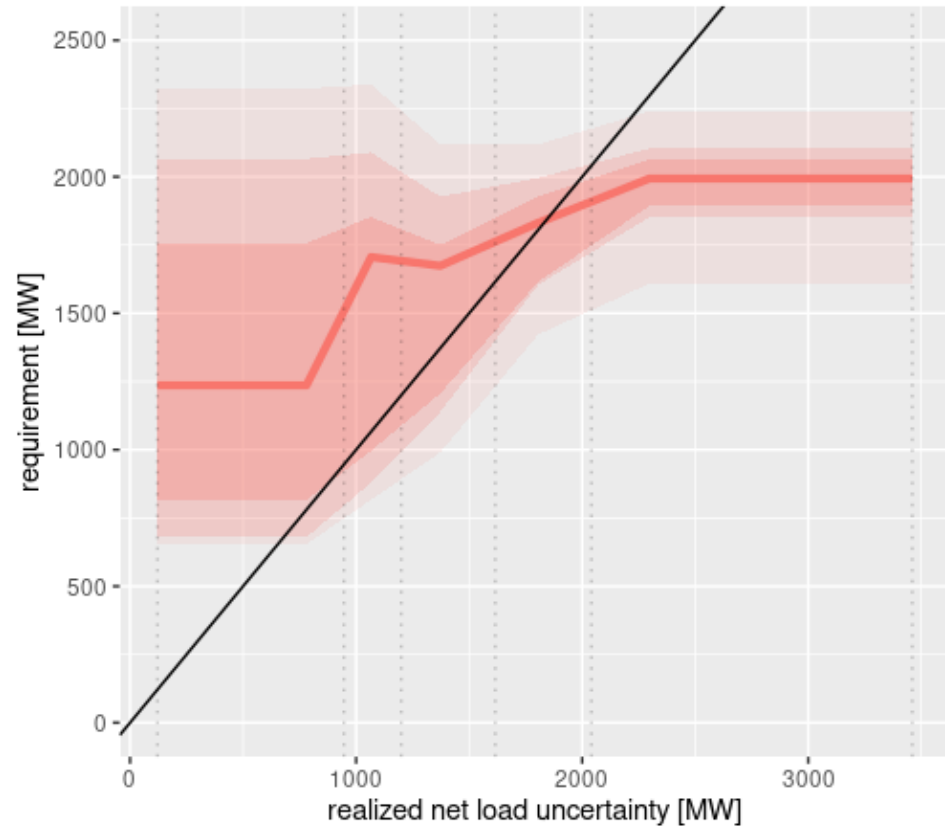
uncertainty exceeding mosaic and/or histogram (6am-9am)



summer 2023, CISO

## histogram

uncertainty exceeding mosaic and/or histogram (6am-9am)

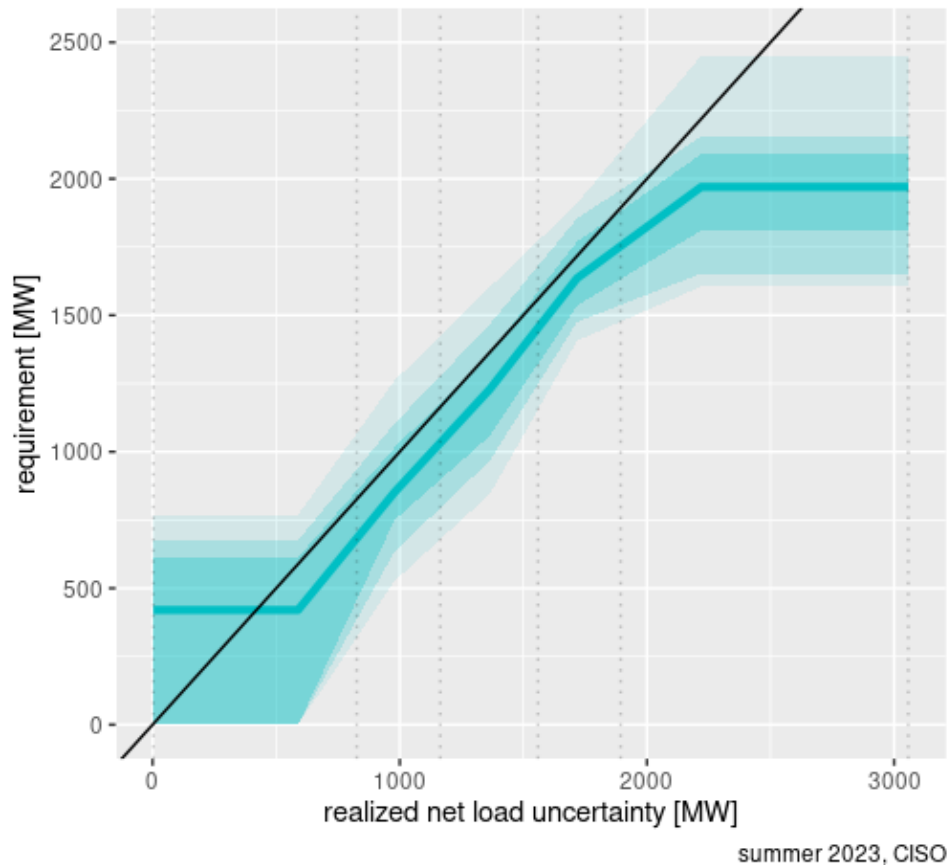


summer 2023, CISO

# Evening ramp (summer 2023, CISO)

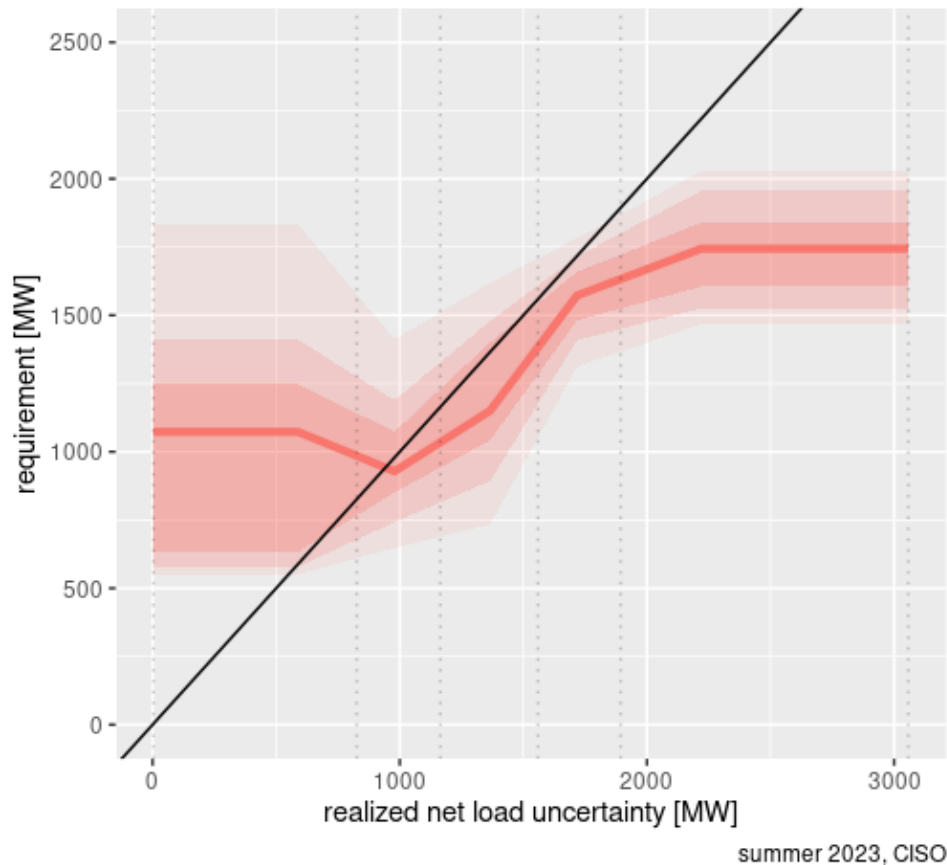
## mosaic

uncertainty exceeding mosaic and/or histogram (4pm-7pm)



## histogram

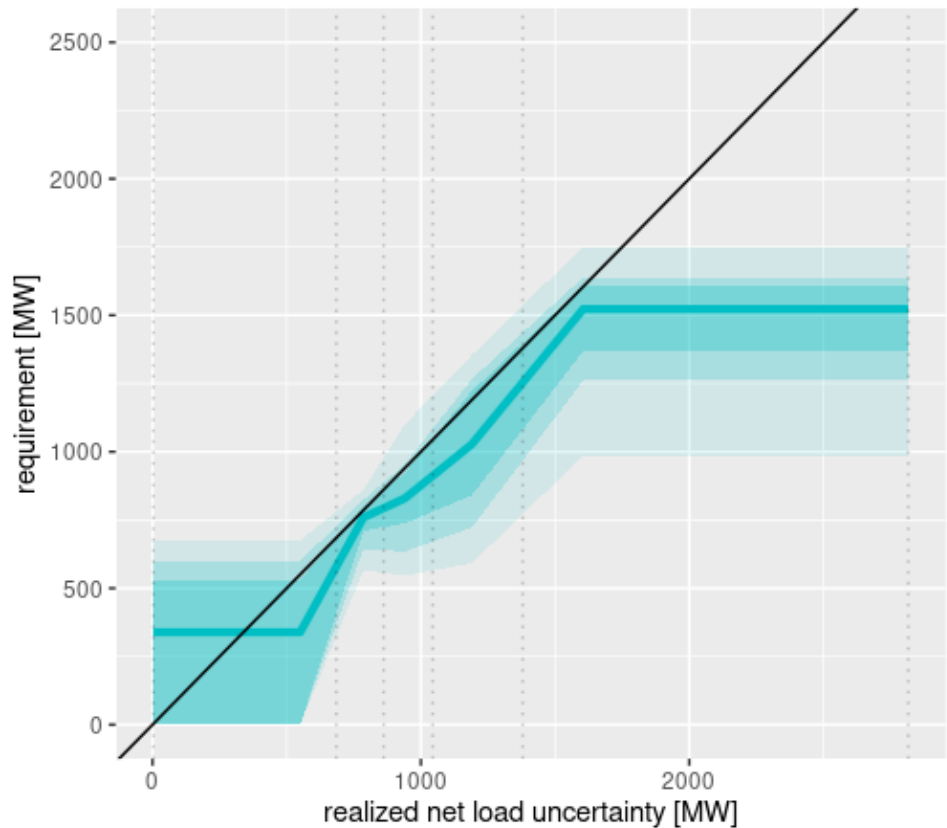
uncertainty exceeding mosaic and/or histogram (4pm-7pm)



# Evening peak (summer 2023, CISO)

## mosaic

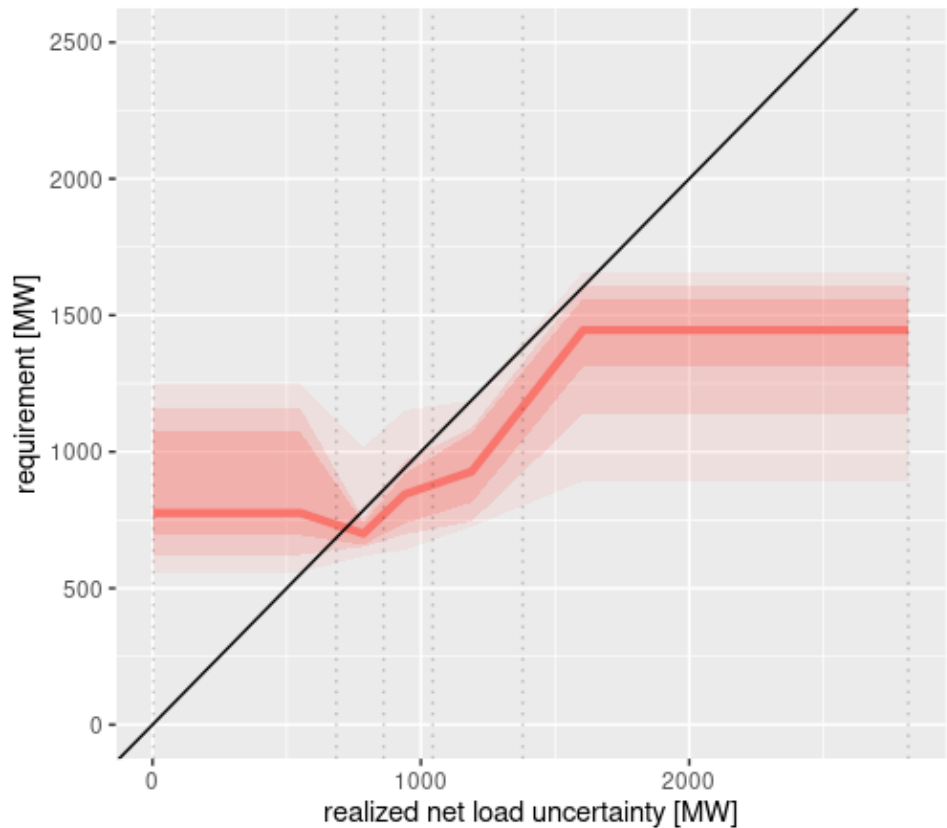
uncertainty exceeding mosaic and/or histogram (6pm-9pm)



summer 2023, CISO

## histogram

uncertainty exceeding mosaic and/or histogram (6pm-9pm)



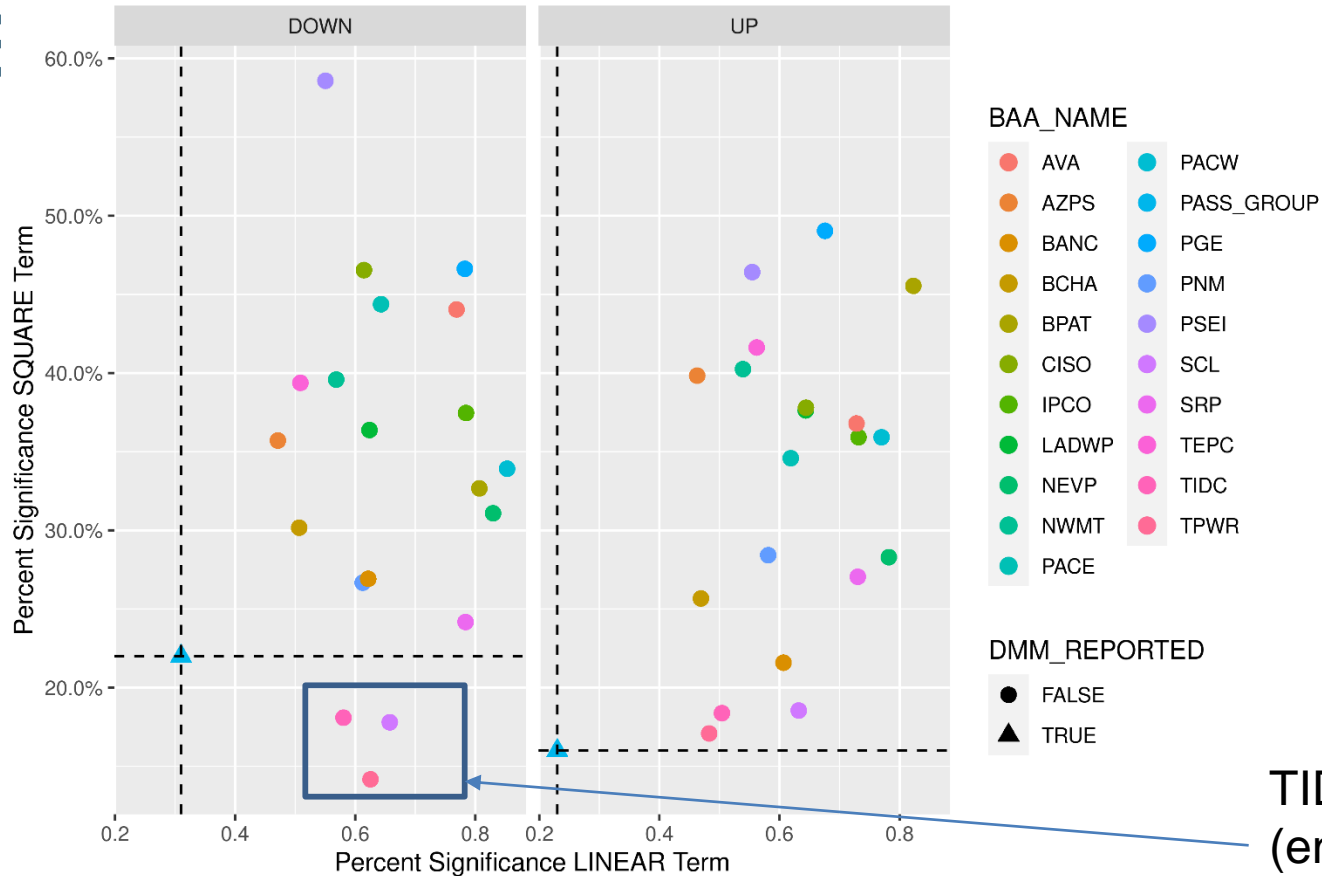
summer 2023, CISO

# STF BAA-level Replication of Percentage of Significant

Statistical Significance of Mosaic Coefficients All Hours (Period Mean)

BAA NAME (color) | DMM Reported (shape)

Inte



TID, TPWR, SCL  
(entities w/o  
wind or solar)



# Empirically Three Different Ways to Interpret Proposed Enhancements

1) More Reliability / Less Requirement

*Mosaic / Sample Scheme 4 / 90 days*

2) Better Model

*Require weighting criteria*

3) Hard Constraint

*Differs between peak and all periods*

