



California ISO

# Recreating Quarterly FRP Thresholds

With Data Available in OASIS

Short-Term Forecasting

# Outline

- FRP thresholds overview
  - Thresholds report in OASIS
- Static threshold
  - Example calculation for AVRN BAA
- Dynamic threshold
- Summary and additional references

# FRP thresholds overview

Threshold	Granularity	Update frequency	OASIS report label	Value *
Floor	Constant	None	Mosaic	0.1 MW
Dynamic	Hourly	Daily	Histogram	1 <sup>st</sup> and 99 <sup>th</sup> percentile from a sample that mirrors the mosaic calculation sample
Static	Constant	Quarterly	Mosaic	1 <sup>st</sup> and 99 <sup>th</sup> percentile from 90-day rolling sample

The **raw mosaic** results in FRU and FRD are compared to and constrained by static and dynamic thresholds. At an absolute minimum, flex ramp requirements are 0.1 MW. Assuming down requirements and thresholds are expressed as negative values, thresholds are applied as follows:

$$\text{Flex ramp up (FRU) requirement} = \max(\min(\text{FRU}_{\text{raw\_mosaic}}, \text{threshold}_{\text{dynamic}}, \text{threshold}_{\text{static}}), 0.1)$$

$$\text{Flex ramp down (FRD) requirements} = \min(\max(\text{FRD}_{\text{raw\_mosaic}}, \text{threshold}_{\text{dynamic}}, \text{threshold}_{\text{static}}), 0.1)$$

\* As of September 2024, the dynamic threshold is a 180-day day symmetric sample and the static threshold is a 90-day rolling sample. A rolling sample includes N days preceding the trade date. A symmetric sample is composed of an N/2 days preceding the trade date and N/2 days succeeding the trade date from one year prior.

# FRP threshold report on OASIS

[Top Right] Navigate to FRP Ramp Requirement Thresholds report

[Below] View of threshold report  
Select desired trade date, market, and BAA

The screenshot shows the OASIS navigation menu. The 'ENERGY' tab is selected. The dropdown menu includes options like 'Flexible Ramping', 'Convergence Bidding', 'Energy Imbalance Market', and 'Uplift'. The 'Flexible Ramping' option is expanded, showing a list of sub-items. 'Flexible Ramp Requirement Thresholds' is highlighted in yellow.

Date: 08/20/2024 Market/Process: RTPD BAA ID: CISO Apply Reset

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## Flexible Ramp Requirement Thresholds

Market	Opr Date	Balancing Authority Area ID	Ramp Type	Percentile	Data Type	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11	HE12	HE13	HE14	HE15
RTPD	08/20/2024	CISO	DOWN	HIGH	Histogram	768.93	599.95	575.82	609.06	645.81	796.25	2,165.25	3,334.45	2,283.72	1,677.02	1,790.15	1,294.40	1,501.49	1,421.00	1,780.00
RTPD	08/20/2024	CISO	DOWN	HIGH	Mosaic	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00	1,642.00
RTPD	08/20/2024	CISO	DOWN	LOW	Histogram	-458.67	-500.80	-493.29	-541.56	-386.19	-519.61	-405.31	-819.83	-870.52	-1,049.24	-841.46	-841.47	-1,085.63	-1,022.13	-1,220.00
RTPD	08/20/2024	CISO	DOWN	LOW	Mosaic	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10
RTPD	08/20/2024	CISO	UP	HIGH	Histogram	768.93	599.95	575.82	609.06	645.81	796.25	2,165.25	3,334.45	2,283.72	1,677.02	1,790.15	1,294.40	1,501.49	1,421.00	1,780.00
RTPD	08/20/2024	CISO	UP	HIGH	Mosaic	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00	2,365.00
RTPD	08/20/2024	CISO	UP	LOW	Histogram	-458.67	-500.80	-493.29	-541.56	-386.19	-519.61	-405.31	-819.83	-870.52	-1,049.24	-841.46	-841.47	-1,085.63	-1,022.13	-1,220.00
RTPD	08/20/2024	CISO	UP	LOW	Mosaic	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10	0.10

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Threshold	Ramp Type	Percentile	Data Type
Floor	Down/Up	Low	Mosaic
Dynamic	Down	Low	Histogram
	Up	High	Histogram
Static	Down/Up	High	Mosaic

# STATIC THRESHOLD

## Summary of steps

- Create historical sample of realized uncertainty
  - Calculate net demand forecasts
  - Calculate realized uncertainty from difference in advisory to binding net demand forecasts
  - 90 day sample
  - For RTPD, keep only minimum and maximum sample per FMM interval (this will eliminate ~1/3 of data)
- Group uncertainty samples by hour and calculate 1<sup>st</sup> and 99<sup>th</sup> percentile
  - Take the min and max to get static thresholds

## Example calculation

Static threshold for Avangrid (AVRN) updated in July 2024 to 463 MW up in FRU RTPD

- Gen-only BA
- Threshold calculated on 7/8/24
  - Historical 90-day sample used (4/9/24 to 7/7/24)
- No change to installed solar or wind capacity for AVRN BAA in that time period
- Focus on recreating the RTPD FRU static threshold (there are four static thresholds to calculate, FRU and FRD thresholds in RTD and RTPD)

# Navigate to OASIS report on historical forecasts

**ENERGY**    ANCILLARY SERVICES    CONGESTION REVENUE RIGHTS    PUBLIC BIDS    RES

- Schedule ▶
- System ▶
- Flexible Ramping** ▶
  - Flexible Ramp Requirements ▶
  - Uncertainty Movement by Category ▶
  - Flexible Ramp Aggregate Awards ▶
  - Flexible Ramp Surplus Demand Curves ▶
  - Flexible Ramp Requirements Inputs and Outputs ▶
  - Flexible Ramp Test Results Groups ▶
  - Flexible Ramp Forecasts** ▶
  - Flexible Ramp Requirement Thresholds ▶
  - Flexible Ramp Requirements Input Polynomials ▶
  - Flexible Ramp Requirements Uncertainty Histograms ▶
- Convergence Bidding ▶
- Energy Imbalance Market ▶
- Uplift ▶



# FRP forecasts report - RTPD

Date From: 07/07/2024 31 Market/Process: RTPD v BAA ID: AVRN v Apply Reset

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## Flexible Ramp Forecasts

1 - 12 of ???  

Market Opr Date	Balancing Authority Area ID	Run Type	Data Type	Interval	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11
RTPD 07/07/2024	AVRN	Advisory	Demand	1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTPD 07/07/2024	AVRN	Advisory	Solar	1	0.00	0.00	0.00	0.00	0.00	2.89	71.55	277.55	372.32	375.37	379.37
RTPD 07/07/2024	AVRN	Advisory	Wind	1	387.63	379.37	363.67	241.65	217.81	140.03	77.59	25.33	14.24	8.65	7.17
RTPD 07/07/2024	AVRN	Advisory	Demand	2	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTPD 07/07/2024	AVRN	Advisory	Solar	2	0.00	0.00	0.00	0.00	0.00	8.98	122.34	314.05	378.35	368.61	371.61
RTPD 07/07/2024	AVRN	Advisory	Wind	2	377.05	398.57	341.92	225.75	206.12	126.35	53.80	21.59	11.24	7.20	10.20
RTPD 07/07/2024	AVRN	Advisory	Demand	3	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTPD 07/07/2024	AVRN	Advisory	Solar	3	0.00	0.00	0.00	0.00	0.00	19.09	180.88	340.49	379.15	372.61	374.61
RTPD 07/07/2024	AVRN	Advisory	Wind	3	367.67	384.74	313.20	226.30	183.42	115.99	42.91	19.09	9.97	7.17	11.17
RTPD 07/07/2024	AVRN	Advisory	Demand	4	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTPD 07/07/2024	AVRN	Advisory	Solar	4	0.00	0.00	0.00	0.00	0.00	38.10	235.49	358.23	376.02	376.52	376.52
RTPD 07/07/2024	AVRN	Advisory	Wind	4	351.66	375.97	267.76	220.52	161.96	105.09	30.89	17.23	8.76	6.37	15.17

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# FRP forecasts report - RTD

Date From: 07/07/2024 31 Market/Process: RTD v BAA ID: AVRN v Apply Reset

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## Flexible Ramp Forecasts

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Market Opr	Date	Balancing Authority Area ID	Run Type	Data Type	Interval	HE01	HE02	HE03	HE04	HE05	HE06	HE07	HE08	HE09	HE10	HE11
RTD	07/07/2024	AVRN	Advisory	Solar	4	0.00	0.00	0.00	0.00	0.00	6.63	83.53	283.12	337.46	359.78	365.00
RTD	07/07/2024	AVRN	Binding	Solar	4	0.00	0.00	0.00	0.00	0.00	6.63	93.75	287.05	340.40	359.97	365.00
RTD	07/07/2024	AVRN	Advisory	Wind	4	467.12	474.10	341.14	306.14	187.59	78.09	26.46	10.45	4.11	2.04	0.00
RTD	07/07/2024	AVRN	Binding	Wind	4	486.35	466.85	324.85	298.98	177.58	70.80	24.64	9.15	4.37	1.55	0.00
RTD	07/07/2024	AVRN	Advisory	Demand	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTD	07/07/2024	AVRN	Binding	Demand	5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTD	07/07/2024	AVRN	Advisory	Solar	5	0.00	0.00	0.00	0.00	0.00	8.80	106.91	291.89	340.90	359.93	365.00
RTD	07/07/2024	AVRN	Binding	Solar	5	0.00	0.00	0.00	0.00	0.00	0.30	112.10	294.28	343.63	360.03	366.00
RTD	07/07/2024	AVRN	Advisory	Wind	5	486.35	466.85	324.85	298.98	177.58	70.80	24.64	9.15	4.37	1.55	0.00
RTD	07/07/2024	AVRN	Binding	Wind	5	493.56	459.41	319.16	297.42	170.62	63.74	21.34	7.48	3.88	1.49	0.00
RTD	07/07/2024	AVRN	Advisory	Demand	6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTD	07/07/2024	AVRN	Binding	Demand	6	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTD	07/07/2024	AVRN	Advisory	Solar	6	0.00	0.00	0.00	0.00	0.00	0.72	121.49	298.33	344.04	359.99	366.00
RTD	07/07/2024	AVRN	Binding	Solar	6	0.00	0.00	0.00	0.00	0.00	0.69	132.79	300.22	346.38	360.15	367.00
RTD	07/07/2024	AVRN	Advisory	Wind	6	493.56	459.41	319.16	297.42	170.62	63.74	21.34	7.48	3.88	1.49	0.00
RTD	07/07/2024	AVRN	Binding	Wind	6	501.17	454.08	315.54	287.89	166.74	56.70	19.76	6.28	3.71	1.40	0.00
RTD	07/07/2024	AVRN	Advisory	Demand	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTD	07/07/2024	AVRN	Binding	Demand	7	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
RTD	07/07/2024	AVRN	Advisory	Solar	7	0.00	0.00	0.00	0.00	0.00	1.51	146.73	303.48	346.75	360.11	367.00
RTD	07/07/2024	AVRN	Binding	Solar	7	0.00	0.00	0.00	0.00	0.00	1.56	150.65	305.44	348.89	361.21	368.00

Report Generated: 08/30/2024 19:53:21

# Calculate realized uncertainty in RTPD for period 08:20 – 08:25 on 7/7/24

See **yellow** highlighted values from two previous slides

RTPD advisory net demand forecast

$$-335.64 = 0 - 314.05 - 21.59$$

RTD binding net demand forecast

$$-347.51 = 0 - 343.63 - 3.88$$

Realized uncertainty in RTPD net demand for 08:20 to 08:25 on 7/7/24

$$-347.51 - (-335.64) = -11.87$$

# Calculate realized uncertainty in RTD for period 08:20 – 08:25 on 7/7/24

See **yellow** and **purple** highlighted values from RTD forecast report

RTD advisory net demand forecast

$$-345.27 = 0 - 340.90 - 4.37$$

RTD binding net demand forecast

$$-347.51 = 0 - 343.63 - 3.88$$

Realized uncertainty in RTD net demand for 08:20 to 08:25 on 7/7/24

$$-347.51 - (-345.27) = -2.24$$

## Helpful definitions for reference

Net demand forecast =

$$\text{Demand forecast} - \text{Solar forecast} - \text{Wind forecast}$$

### Realized uncertainty

RTPD uncertainty = RTD binding forecast – RTPD advisory forecast

RTD uncertainty = RTD binding forecast – RTD advisory forecast

RTPD advisory forecasts have one value per 15-minute interval (4 values per hour). RTD binding and advisory forecasts have one value per 5-minute interval (12 values per hour). Because realized uncertainty in both RTD and RTPD are dependent on RTD binding forecasts, both RTD and RTPD realized uncertainty samples have 12 values per hour.

# For RTPD uncertainty, only the minimum and maximum uncertainty is kept per RTPD interval

For the 15min market (FMM), the ISO will construct uncertainty based on the following measurements.

- The difference of the forecast the market used in the FMM for the first advisory RTUC interval and the maximum forecast the market used for the three corresponding RTD intervals.
- The difference of the forecast the market used in the FMM for the first advisory RTUC interval and the minimum forecast the market used for the three corresponding RTD intervals.

Screenshot from Market Operations BPM Appendix N

This describes the adjustment for RTPD uncertainty calculations (this does not apply to RTD realized uncertainty). This adjustment is made for the mosaic calculation and mirrored in the static and dynamic threshold calculations for RTPD thresholds.

RTPD uncertainty from the forecast for the period 08:15 – 08:30 on 7/7/24 has three uncertainty values coming from three RTD binding forecasts. These are calculated numerically on the next slide.

RTPD advisory (HE9, INT2)  
08:15 – 08:30

vs.

RTD binding (HE9, INT4)  
08:15 – 08:20

RTD binding (HE9, INT5)  
08:20 – 08:25

RTD binding (HE9, INT6)  
08:25 – 08:30

## RTPD uncertainty (RTD binding – RTPD advisory)

$$\text{RTD binding (HE9, INT4)} \\ 0 - 340.4 - 4.37 = -344.77$$

$$\text{RTD binding (HE9, INT5)} \\ 0 - 343.63 - 3.88 = -347.51$$

$$\text{RTD binding (HE9, INT6)} \\ 0 - 346.38 - 3.71 = -350.09$$

$$\text{RTPD advisory (HE9, INT2)} \\ 0 - 314.05 - 21.59 = -335.64$$

$$\text{RTPD uncertainty (HE9, INT2)} \\ -344.77 - (-335.64) = -9.13$$

$$\text{RTPD uncertainty (HE9, INT2)} \\ -347.51 - (-335.64) = -11.87$$

$$\text{RTPD uncertainty (HE9, INT2)} \\ -350.09 - (-335.64) = -14.45$$

RTPD uncertainty samples in **red**, the minimum and maximum for this RTPD interval (HE9, INT2), are preserved and used in the historical sample.

## RTD uncertainty (RTD binding – RTD advisory)

$$\text{RTD binding (HE9, INT4)} \\ 0 - 340.4 - 4.37 = -344.77$$

$$\text{RTD binding (HE9, INT5)} \\ 0 - 343.63 - 3.88 = -347.51$$

$$\text{RTD binding (HE9, INT6)} \\ 0 - 346.38 - 3.71 = -350.09$$

$$\text{RTD advisory (HE9, INT4)} \\ 0 - 337.46 - 4.11 = -341.57$$

$$\text{RTD advisory (HE9, INT5)} \\ 0 - 340.90 - 4.37 = -345.27$$

$$\text{RTD advisory (HE9, INT6)} \\ 0 - 344.04 - 3.88 = -347.92$$

$$\text{RTD advisory (HE9, INT4)} \\ -344.77 - (-341.57) = -3.20$$

$$\text{RTD advisory (HE9, INT4)} \\ -347.51 - (-345.27) = -2.24$$

$$\text{RTD advisory (HE9, INT4)} \\ -350.09 - (-347.92) = -2.17$$

All RTD uncertainty samples in **red** are used in the historical sample.

# Assemble 90-day sample for static threshold calculation

## Per 90-day sample

90 days x 24 hours/day x 12 samples/hour x 2/3 for min/max uncertainty filter = 17,280 expected samples

## Per hour bin

90 days x 1 hour/day x 12 samples/hour x 2/3 for min/max uncertainty filter = 720 expected samples



Calculate 1<sup>st</sup> and 99<sup>th</sup> percentile per hour interval over historical sample. Results below calculated for AVRN on RTPD realized uncertainty sample from 4/9/24 to 7/7/24

HE	1st	99th
1	-267.76	201.61
2	-263.54	281.28
3	-303.97	242.60
4	-212.07	247.62
5	-252.83	250.72
6	-245.88	263.55
7	-217.26	307.88
8	-265.00	314.73
9	-225.56	326.68
10	-242.47	344.20
11	-218.22	282.35
12	-216.40	302.92

HE	1st	99th
13	-217.07	312.58
14	-171.27	262.43
15	-170.71	348.32
16	-213.05	288.32
17	-231.77	300.58
18	-174.42	<b>463.33</b>
19	-210.17	326.16
20	-288.34	342.98
21	-237.60	336.04
22	<b>-312.82</b>	374.93
23	-173.25	380.56
24	-196.10	253.24

Percentiles are calculated per hour. **Maximum** and **minimum** values are taken as new static thresholds.

By modifying sample period, static thresholds can be estimated over time. Looking at realized uncertainty by forecast component (demand, solar, wind) can help identify causes of threshold movement.

# DYNAMIC THRESHOLD

# Summary of steps

Differences from static threshold calculation in blue

- Create historical sample of realized uncertainty
  - Calculate net demand forecasts
  - Calculate realized uncertainty from difference in advisory to binding net demand forecasts
  - 180 day symmetric sample
  - For RTPD, keep only minimum and maximum sample per FMM interval (this will eliminate ~1/3 of data)
- Group uncertainty samples by hour and calculate 1<sup>st</sup> and 99<sup>th</sup> percentile
  - Hourly percentiles used as histogram thresholds

# SUMMARY





# Results

- For AVRN example in the presentation, construction of the historical sample from data in OASIS recreates the exact static thresholds for RTPD implemented in July 2024 (-313 MW and 463 MW).
- Threshold calculations can be conducted on a rolling basis to monitor requirements and historical samples.
- There are two more factors that may cause actual thresholds to deviate from this calculation:
  - **Capacity factor adjustment**
    - If the installed capacity of solar or wind has changed within the historical sample, historical solar and wind forecasts are scaled proportional to the change in capacity (Appendix N, Market Operations BPM) before uncertainty is calculated.
  - Use of the **discard range** utility
    - For anomalous issues (e.g. solar eclipse, IT incidents), forecast samples may be removed from historical training.

# Additional references on FRP thresholds

- BPM Market Operations
  - Appendix N
- WEIM Quarterly Meeting December 2022
- FRP Deliverability Refresher Training
  - Navigate to Home > Stakeholder center > Training center > [Releases, initiatives and readiness notes](#)
  - Scroll to Training modules (2023)
  - Deliverability training plus MOSAIC calculation example

## Flexible ramping product refinements - deliverability refresher

- [Flexible ramping product refinements - deliverability refresher](#)  05/18/2024, 7:41 PM
- [Flexible Ramping Product Refinements OASIS Mosaic Calculation](#)  01/31/2023, 10:56 AM
- [Flexible Ramping Product Refinements OASIS Mosaic Calculation Companion Spreadsheet](#)  01/31/2023, 8:13 AM
- [Presentation - Flexible Ramping Product Refinements Deliverability Refresher Training](#)  01/26/2023, 9:18 AM

# For questions, please reach out to Short-Term Forecasting via CIDI

Recommended ticket details

Subject: FRP Thresholds Training

Category: Forecasts