California ISO

Refresher Training: Flexible Ramping Product (FRP) Refinements – Deliverability

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Customer Readiness

Updated: 1/26/2023

Housekeeping

Keep yourself muted to minimize background noise

Unmute to ask verbal questions or write questions in the chat pod

Raise your hand using WebEx interactivity tools

Agenda

- This training covers the following topics:

  – Review of project changes

  – Key points

  – Application-specific changes

  – Settlement charge code changes

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Acronyms

| Abbreviation	Term	Abbreviation	Term
BAA	Balancing Authority Area	LMCP	Locational Marginal Capacity Price
BAAOP	Balancing Authority Area Operations Portal	MRI-S	Market Results Interface - Settlements
CLAP	Custom Load Aggregation Point	OASIS	Open Access Same-Time Information System
CMRI	Customer Market Results Interface	ROC	Rate of Change
FMM	Fifteen-Minute Market	RSE	Resource Sufficiency Evaluation
FRD	Flexible Ramping Down	RTD	Real-Time Dispatch
FRP	Flexible Ramping Product	RTM	Real-Time Market
FRU	Flexible Ramping Up	RTPD	Real-Time Pre Dispatch
FRDMP	Flexible Ramping Down Marginal Price	TAC	Transmission Access Charge
FRUMP	Flexible Ramping Up Marginal Price	VER	Variable Energy Resource
LAP	Load Aggregation Point	WEIM	Western Energy Imbalance Market
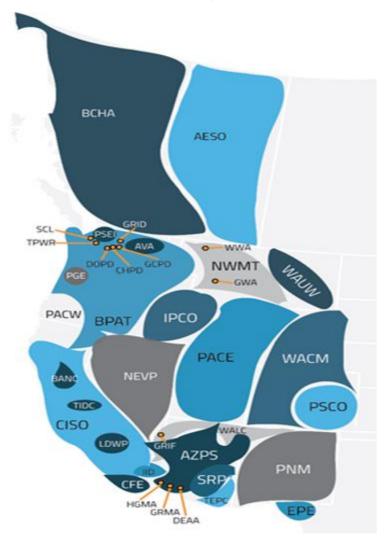
FRP Problem Statement

WHAT WAS THE CHALLENGE?

What challenge is this project addressing?

- To improve deliverability of flexible ramping product through nodal procurement

- Addresses concerns where flexible ramp capacity is awarded behind transmission constraints which are binding
  - *Binding transmission constraint prevents the flexible ramp capacity from being deployable if uncertainty materializes*
  - *Reliability concern because system is relying on capacity which is potentially undeliverable*
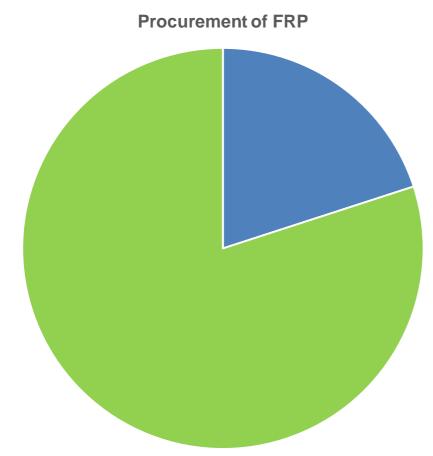
FRP Deliverability Solutions

WHAT IS CHANGING?

Pricing of FRP

- FRP will be modeled **by location of the nodes** that are in the ISO market's network model to ensure that FRP awards are *feasible to deliver* and *appropriately priced*

  - **Flexible Ramping Nodal Prices**

  - **Flexible Ramping Scheduling Point/Tie Nodal Prices**

- Locational modeling consists of:

  - the RTM considering transmission constraints

  - the energy flows that would occur when the RTM dispatches energy from capacity scheduled to provide FRP

Procurement of FRP in WEIM

Procurement of FRP

- Separate for BAAs that fail flex test
- Procured for entire group of BAAs among those that pass flex test

- ISO will maintain current RSE rules that limit WEIM energy transfers, when a BAA fails the RSE, to the amount scheduled in the market interval preceding the failure

- The RTM will only procure FRP from a failing BAA's own resources

- Procurement target will be the amount calculated to meet the BAA's individual uncertainty and forecasted ramping needs and would be feasible to deliver

- Target would not include the benefit of pooling uncertainty of all BAAs across the WEIM footprint; *This prevents a BAA with insufficient resources to meet its FRP needs from leaning on the capacity of other BAAs*

- When WEIM BAA is in contingency, the BAA will be removed from FLEX UP and FLEX DOWN passing group definition; *There will be no FRU/FRD procurement for that BAA*

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Key Points: Flexible Ramping Up (FRU) & Flexible Ramping Down (FRD)

- There are **no** capacity bids for FRU/FRD; they are priced at opportunity costs

- <u>Only</u> 5-min dispatchable resources are eligible for FRU/FRD awards

- Variable Energy Resources (VERs) are scheduled up to their forecast and they may be awarded FRU/FRD; VER FRU/FRD awards are deployed in the FRU/FRD deployment scenarios

- <u>All</u> physical transmission/transfer constraints that are enforced in the original market calculation (including base case and contingency constraints) are also enforced in the FRU/FRD deployment scenarios

> **Note:** Upon go-live only flowgates apply. Other constraints will be introduced over time.
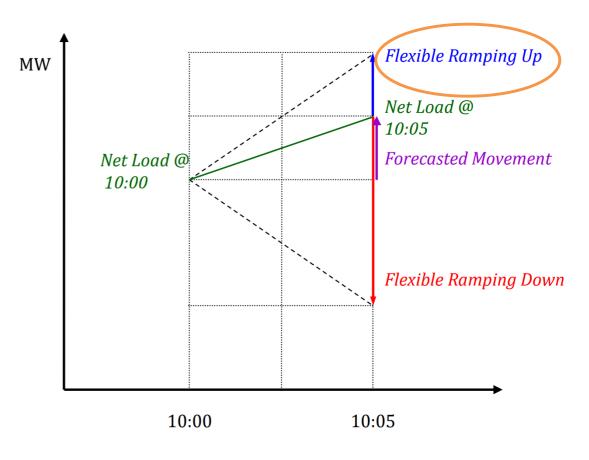
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Key Points: Flexible Ramping Up (FRU) & Flexible Ramping Down (FRD)

- Distribution of FRU/FRD requirements in FRU/FRD deployment scenarios in each BAA is divided among load, solar, and wind resources

  - Allocation factors are derived from historical data that reflect the relative contributions of these resource classes to the overall uncertainty

- FRU/FRD demand elasticity is achieved with FRU/FRD surplus variables with cost curves that reflect the expected cost of foregoing FRU/FRD procurement

  - Ensures that FRU/FRD is not procured at a higher cost than the benefit it provides

- FRU/FRD surplus variables are modeled as independent controls in each FRP surplus zone, effectively relaxing the distributed FRU/FRD requirements in the respective zone

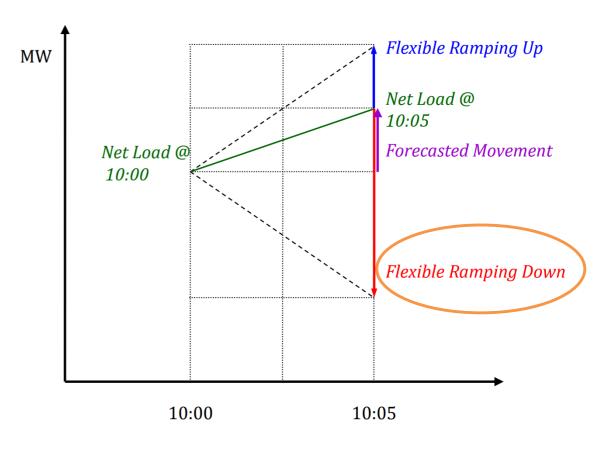# Flexible Ramping Up Deployment Scenario

- All FRU awards are deployed

- Demand/wind/solar forecast for each BAA that failed FRU sufficiency test is adjusted by FRU requirement for that BAA

- Demand/wind/solar forecast for group of BAAs that passed FRU sufficiency test is adjusted by FRU requirement for BAA group

- FRU surplus in each BAA that failed FRU sufficiency test is fully deployed

- FRU surplus in group of BAAs that passed FRU sufficiency test is fully deployed

MW

Flexible Ramping Up

Net Load @ 10:05

Net Load @ 10:00

Forecasted Movement

Flexible Ramping Down

10:00   10:05

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Flexible Ramping Down Deployment Scenario

- All FRD awards are deployed

- Demand/wind/solar forecast for each BAA that failed FRD sufficiency test is adjusted by FRD requirement for that BAA

- Demand/wind/solar forecast for group of BAAs that passed FRD sufficiency test is adjusted by FRD requirement for BAA group

- FRD surplus in each BAA that failed FRD sufficiency test is fully deployed

- FRD surplus in group of BAAs that passed FRD sufficiency test is fully deployed

Configuration of FRP Surplus Zones

- Define and maintain FRP surplus zones in each BAA in the WEIM area

- FRP surplus zones shall include generation and load nodes so that every generation and load in a BAA shall belong to only **one** FRP surplus zone
  - In the case of CAISO, this will include CAISO scheduling points

- FRP surplus zones shall be used in the market to distribute FRP surplus variables
  - Four FRP surplus zones for CAISO align with the four TAC areas
  - For WEIM BAAs, one FRP surplus zone for the entire BAA, except for BAAs with CLAPs (e.g., BANC, PSCO) where the FRP surplus zones shall align with the CLAPs

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Questions

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FRP Deliverability Enhancements

KEY POINTS

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As of 2/1/23, the calculations that determine FRP pricing will use a nodal pricing model requiring reporting changes in CMRI

Reports will no longer contain data:

- Fifteen-Minute Market (FMM) Flexible Ramp Price Breakdown
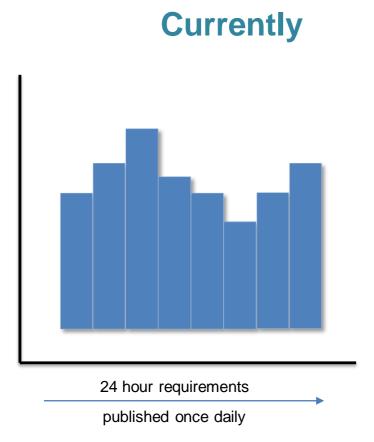- Real-Time Dispatch (RTD) Flexible Ramp Price Breakdown
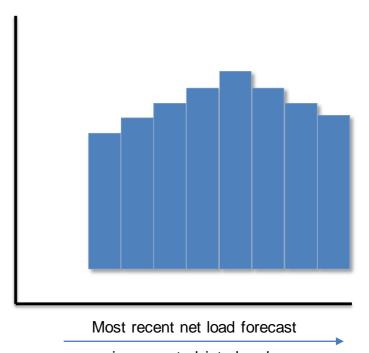
Reports will provide FRP pricing:

- Fifteen-Minute Market (FMM) Schedule Prices
- Real-Time Dispatch (RTD) Schedule Prices

FRP: Requirement calculation changing to provide greater accuracy prior to each operating hour

Currently

As of 2/1/23

24 hour requirements

published once daily

Most recent net load forecast

incorporated into hourly
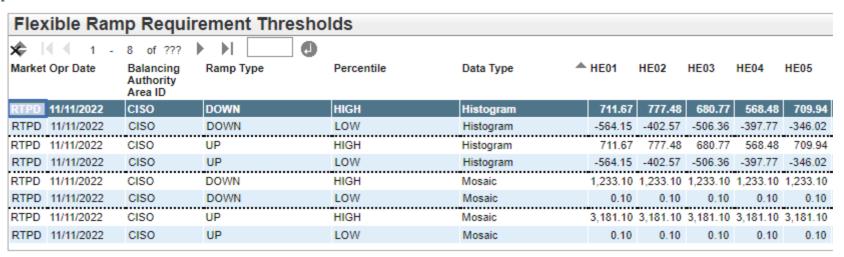flex ramp calculation
provided at T-75 & T-55

Multiple Threshold Layers with New FRP

- Threshold 1: Seasonal (Current capped thresholds will remain)
  - 1 Up value for all hours, 1 Down value for all hours
  - Calculated based on the past 90 days, however this may be adjusted
  - 99th percentile calculated for each hour; largest value used for Up Cap for all hours
  - 1st percentile calculated for each hour; largest value used for Down Cap for all hours

- Threshold 2: 180 Day Thresholds (New)
  - Values differ by hour
  - Calculated based on the past 180 days
  - 99th percentile for each hour used as Up Cap for respective hour
  - 1st percentile for each hour used as Down Cap for respective hour

- Market Operations BPM updates are in PRR 1473: Flexible Ramping Product Deliverability

Flex Requirement Thresholds Available in OASIS

Flexible Ramp Requirement Thresholds

Market Opr Date		Balancing Authority Area ID	Ramp Type	Percentile	Data Type	▲ HE01	HE02	HE03	HE04	HE05
RTPD	11/11/2022	CISO	DOWN	HIGH	Histogram	711.67	777.48	680.77	568.48	709.94
RTPD	11/11/2022	CISO	DOWN	LOW	Histogram	-564.15	-402.57	-506.36	-397.77	-346.02
RTPD	11/11/2022	CISO	UP	HIGH	Histogram	711.67	777.48	680.77	568.48	709.94
RTPD	11/11/2022	CISO	UP	LOW	Histogram	-564.15	-402.57	-506.36	-397.77	-346.02
RTPD	11/11/2022	CISO	DOWN	HIGH	Mosaic	1,233.10	1,233.10	1,233.10	1,233.10	1,233.10
RTPD	11/11/2022	CISO	DOWN	LOW	Mosaic	0.10	0.10	0.10	0.10	0.10
RTPD	11/11/2022	CISO	UP	HIGH	Mosaic	3,181.10	3,181.10	3,181.10	3,181.10	3,181.10
RTPD	11/11/2022	CISO	UP	LOW	Mosaic	0.10	0.10	0.10	0.10	0.10

For Histogram type (new 180 day thresholds)
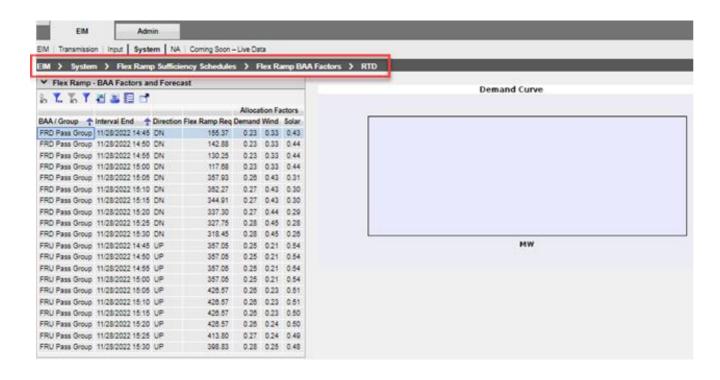
- High value is used to cap FRU
- Low value is used to cap FRD
- Updated daily at 6:00am PPT

For Mosaic type (existing seasonal thresholds)

- High value is used as cap
  - Ramp type UP shows cap for FRU
  - Ramp type DOWN shows cap for FRD (think of this as negative value when comparing to FRD)
- Low value is used as floor – currently set to 0.1 MW for all entities
- Updated quarterly

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Hourly Flex Requirement Available in BAAOP
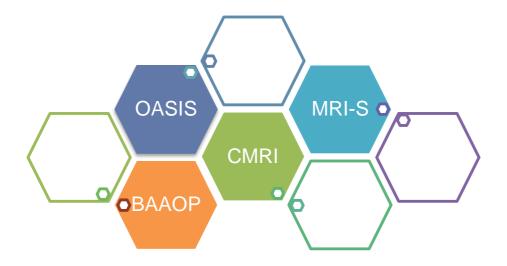
- If an entity passes the flex ramp sufficiency tests, it will be included in the FRU/FRD Pass Group
- If an entity fails the flex ramp sufficiency tests, it will be listed individually
- This data is updated hourly

Note: Flex ramp requirement will always be the lesser of the following numbers:
  – Flex requirement
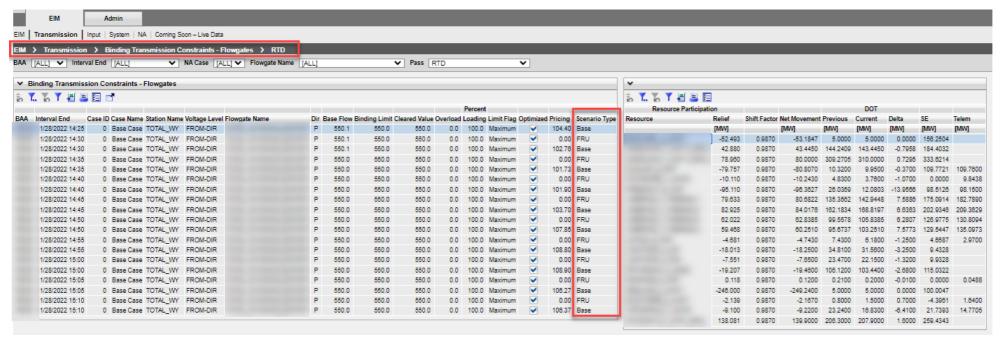 – Histogram threshold
  – Mosaic threshold

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Application Review

APPLICATION-SPECIFIC DETAILS

Change to existing display – Market: Real-time Binding Transmission Constraints

BAAOP

Additional column to indicate the constraint is binding and in which scenarios:
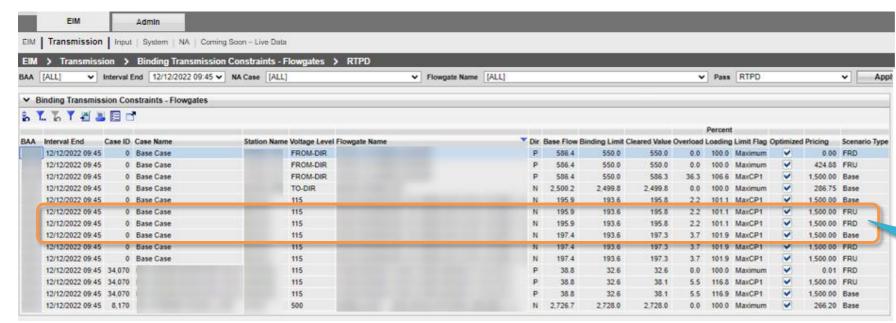
- BASE, FRU is FRU deployment scenario
- FRD is for FRD deployment scenario

Path: EIM > Transmission > Binding Transmission Constraints - Flowgates > RTD/RTPD/STUC

Real-time Binding Transmission Constraints: What does the Operator need to consider?

BASE, FRU & FRD all in same interval

Path: EIM > Transmission > Binding Transmission Constraints - Flowgates > RTD/RTPD/STUC
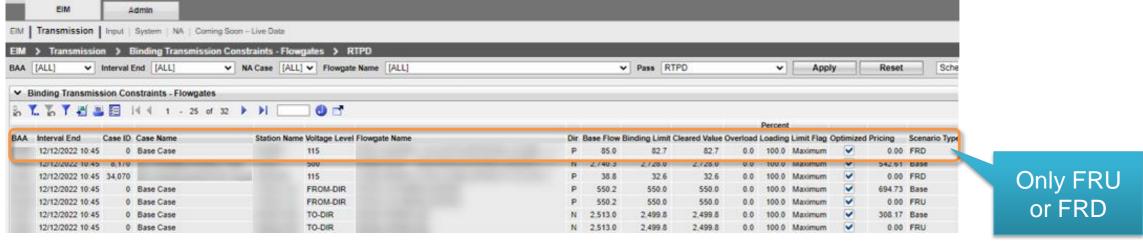
Example 1: All three types (BASE, FRD, FRU) exist in the same interval – same flowgate

- Since the Base type exists and the Cleared Value exceeds the Binding Limit, this should be considered exactly like today - the market sees an overload.

- The inclusion of the FRU and FRD indicates that FRP awards, if dispatched, would also be affected, as expected.

Real-time Binding Transmission Constraints: What does the Operator need to consider?

Path: EIM > Transmission > Binding Transmission Constraints - Flowgates > RTD/RTPD/STUC
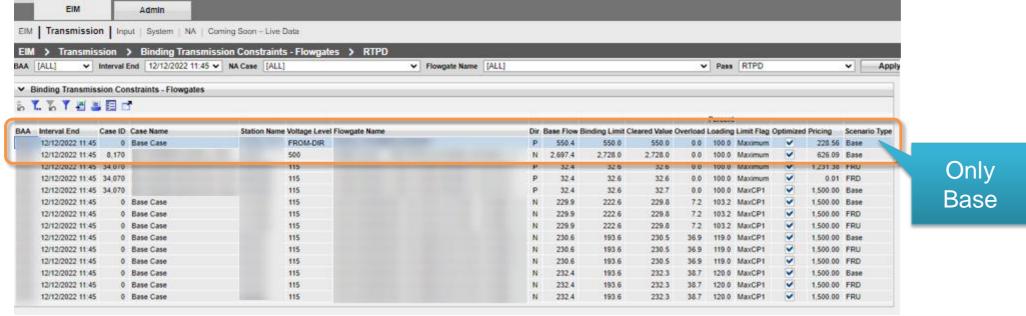
Example 2: Only an FRU or FRD record exists for a given flowgate and time interval

- If only an FRU or FRD record exists and the cleared value is still under the binding limit, <u>this may likely not require manual action</u>.

- FRU or FRD congestion is projected congestion that would occur if the uncertainty is realized and the FRP awards are dispatched.

- The market will strive to resolve this constraint and even make space for additional ramping capacity.

Real-time Binding Transmission Constraints: What does the Operator need to consider?

Path: EIM > Transmission > Binding Transmission Constraints - Flowgates > RTD/RTPD/STUC
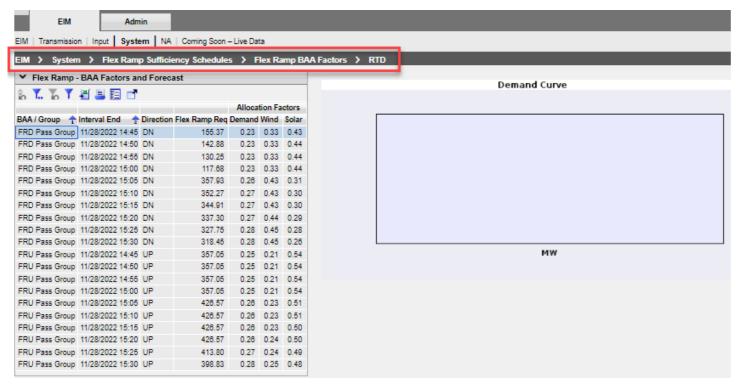
Example 3: Only Base exists for the given Flowgate and time interval

- If only Base exists, there are no uncertainty scenarios in which the congestion occurs as a result of dispatch of all available FRU/FRD for the given contingency.

- Either all the FRP ramping capacity is able to be dispatched without congestion or possibility the counter-flows of the FRP awards are contributing to the solution.

New display – Market: Real-time
BAAOP Flex Ramp Sufficiency Schedules, BAA Factors

Path: EIM > System > Flex Ramp Sufficiency Schedules > BAA Factors > RTD/RTPD/STUC
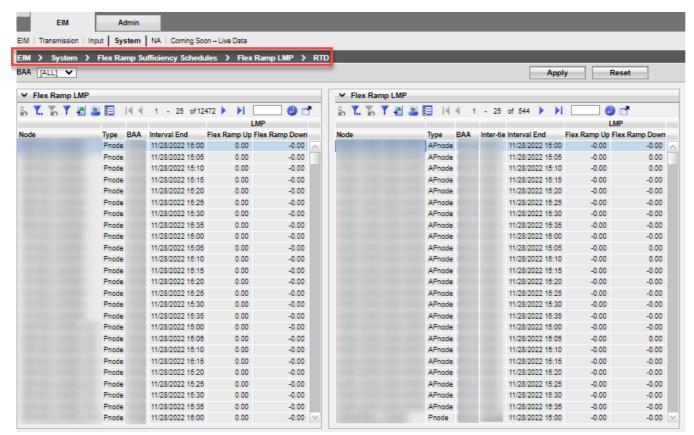
New UI to show:

- FRP requirement for individual BAA's requirement (when they fail the test in that direction)

- FRU/FRD_Pass group requirement for the remaining BAAs which pass the test in that direction

New display – Market: Real-time: Flex Ramp LMP

PATH: EIM > System > Flex Ramp Sufficiency Schedules > Flex Ramp LMP > RTD/RTPD/STUC

- ## New UI to show nodal FRP prices
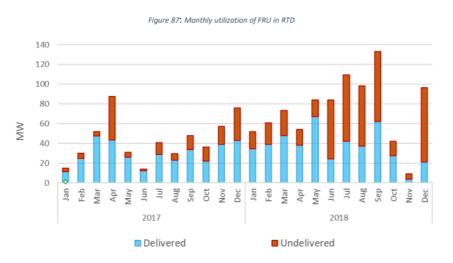
What does the Operator need to know?

- FRP LMPs are associated to P-nodes/AP-Nodes (like today's energy LMPs) and like ancillary services are settled separately.

- FRP LMP's are not decomposed into multiple components (Energy, Loss, Congestion), there is only a final Flex Ramp Up and Flex Ramp Down LMP, per location and time interval calculated in RTD/RTPD/STUC.

- Left side displays Resources, right-side by Interties. (Pricing Run only)

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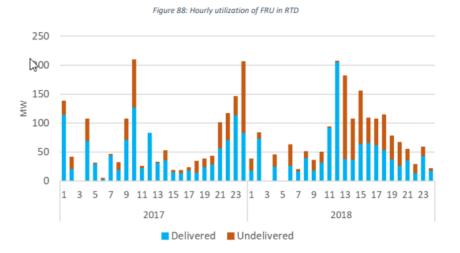
How will FRP Deliverability enhancements impact load biasing (aka imbalance conformance)

- With market uncertainty now deliverable based upon nodal constraints, Load Biasing should be more responsive

Figure 87: Monthly utilization of FRU in RTD

Monthly Aggregations:
Amount of Undeliverable FRU/FRD is significant.

Figure 88: Hourly utilization of FRU in RTD
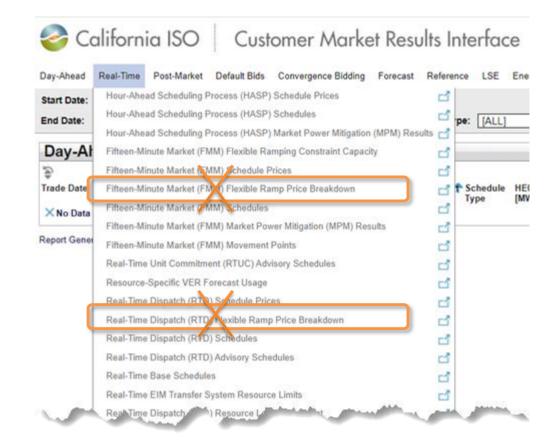
Hourly Aggregations:
Amount of Undeliverable FRU/FRD is significant.

CMRI **Real-Time** Menu: Flexible Ramp Price Breakdown Reports – no new data after 2/1/23
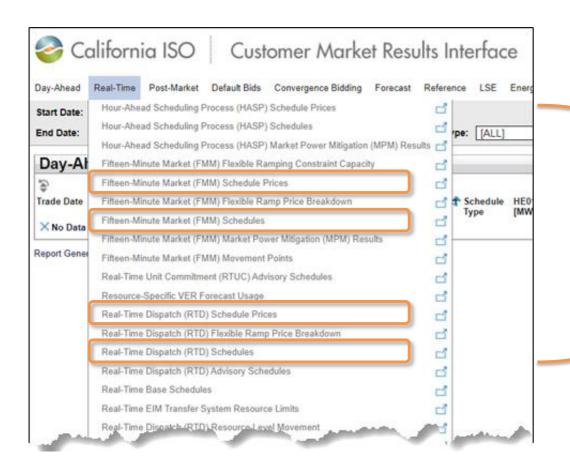
- The following reports will <u>not</u> contain future data as of 2/1/23:
  - Fifteen-Minute Market (FMM) Flexible Ramp Price Breakdown
  - Real-Time Dispatch (RTD) Flexible Ramp Price Breakdown

- Reports will remain available for prior trade dates

CMRI **Real-Time** menu: Reports containing updated FRP data as of 2/1/23
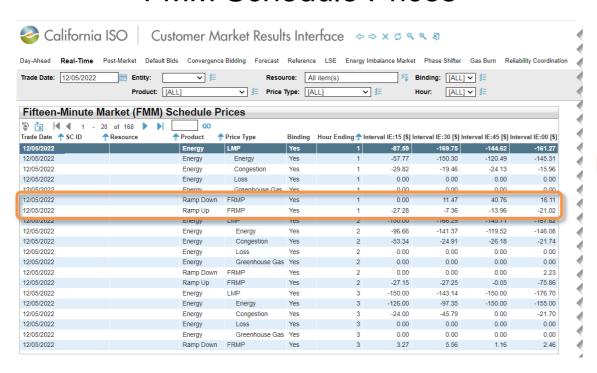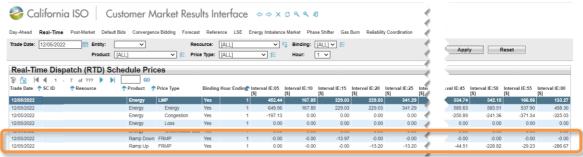
FRP awards data will be available in these existing reports

FMM Schedule Prices

RTD Schedule Prices

- Report columns and layout are the same
- Calculation of FRP pricing changes as of 2/1/23
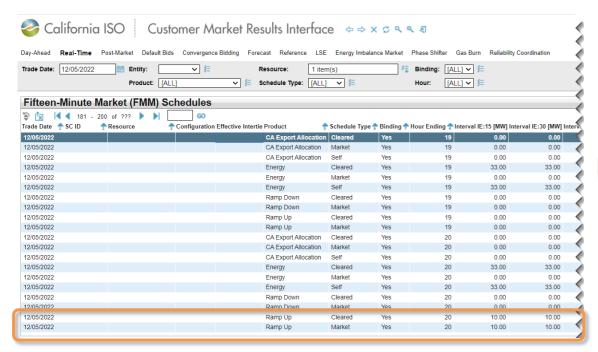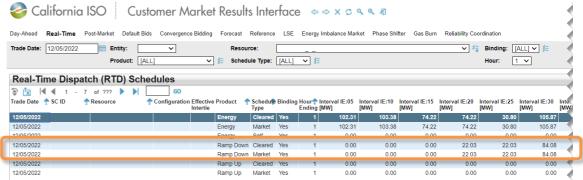
CMRI **Real-Time** menu: Reports containing FRP schedules
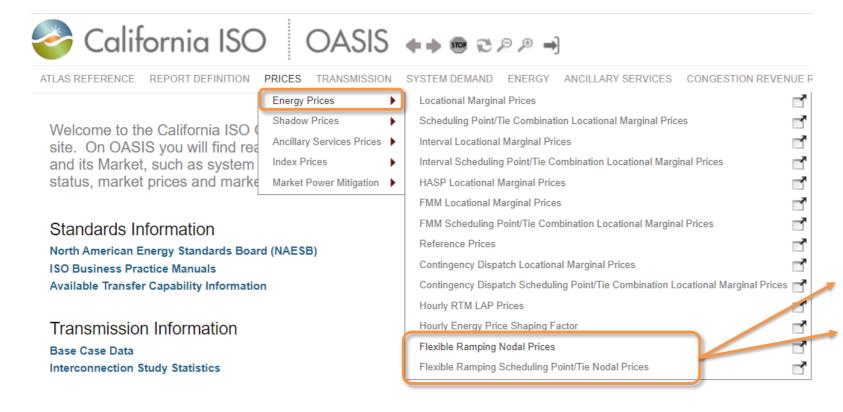
FMM Schedules

RTD Schedules

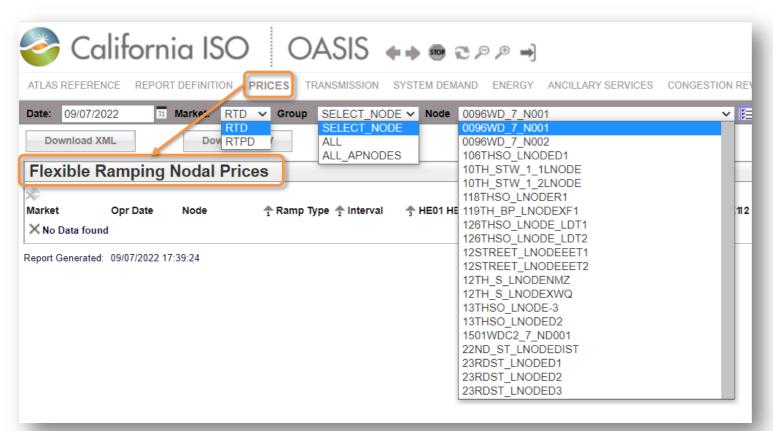- Report columns and layout are the same

- Flexible Ramping Nodal Prices

- Flexible Ramping Scheduling Point/Tie Nodal Prices
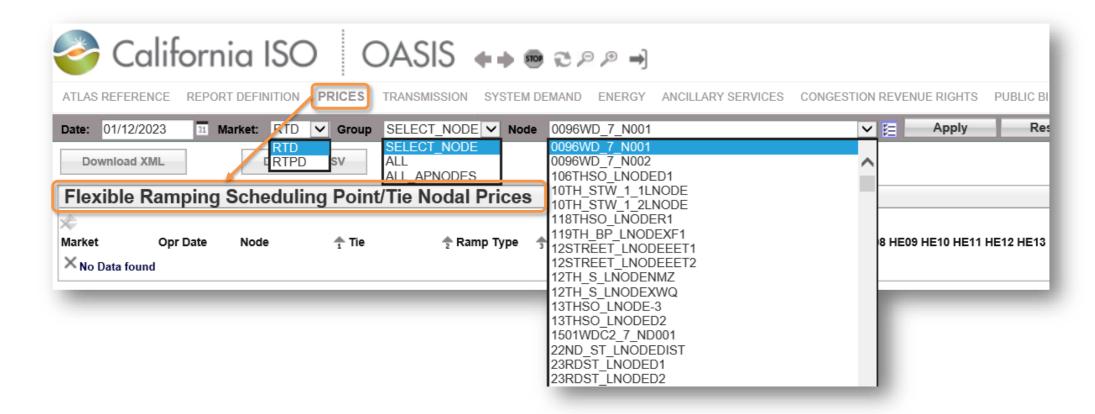
OASIS: Flexible Ramping Nodal Prices

OASIS

- FRU/FRD Nodal prices at the Pnode level for all:
  - P-nodes,
  - SP-ties
  - AP-nodes

- Calculated by the RTD and RTPD binding market run

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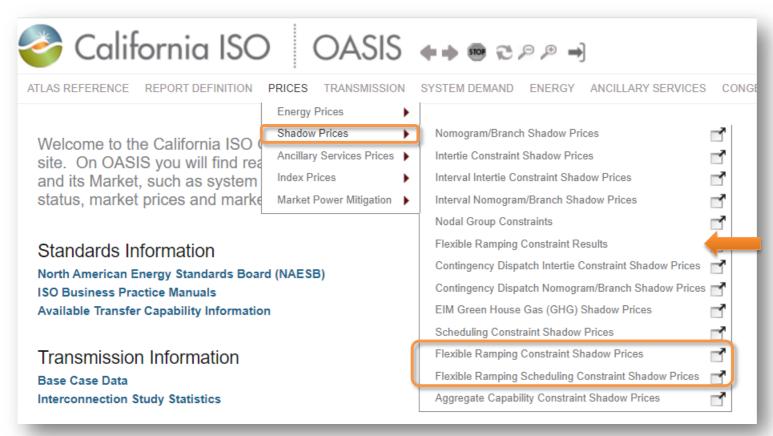# OASIS: Flexible Ramping Scheduling Point/Tie Nodal Prices

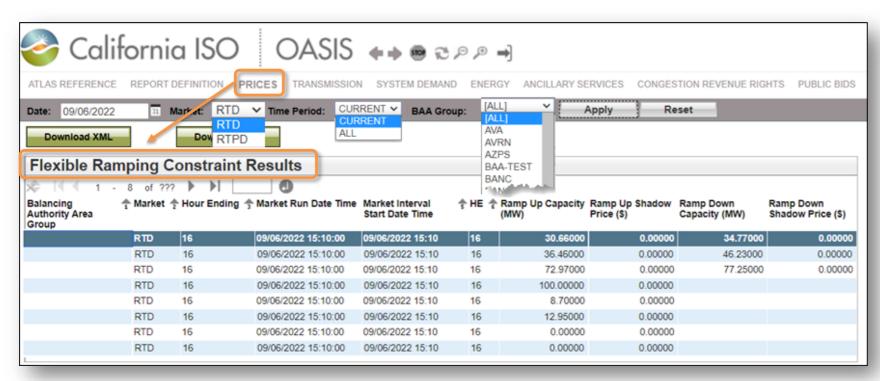# OASIS **Prices** Menu > **Shadow Prices** list: New Reports

OASIS

Existing report

New reports

OASIS: Flexible Ramping Constraint Results (existing report)

OASIS

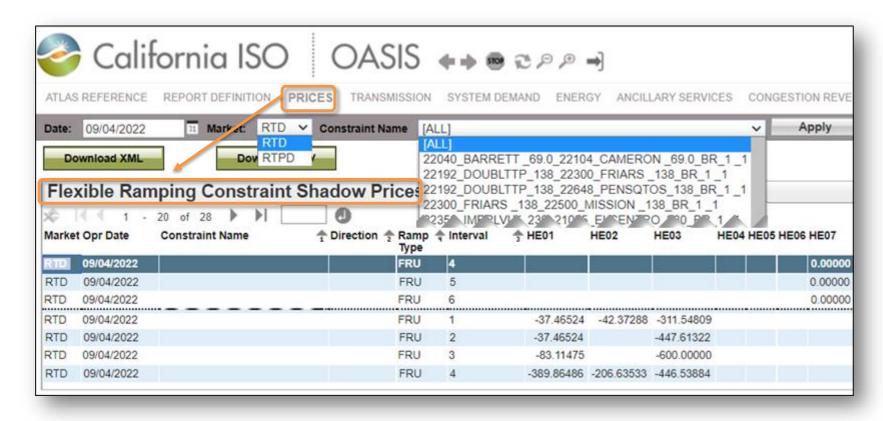- FRU/FRD shadow price and requirement for BAAs that fail the RSE and for the FRU/FRD passing group

- Calculated by market runs
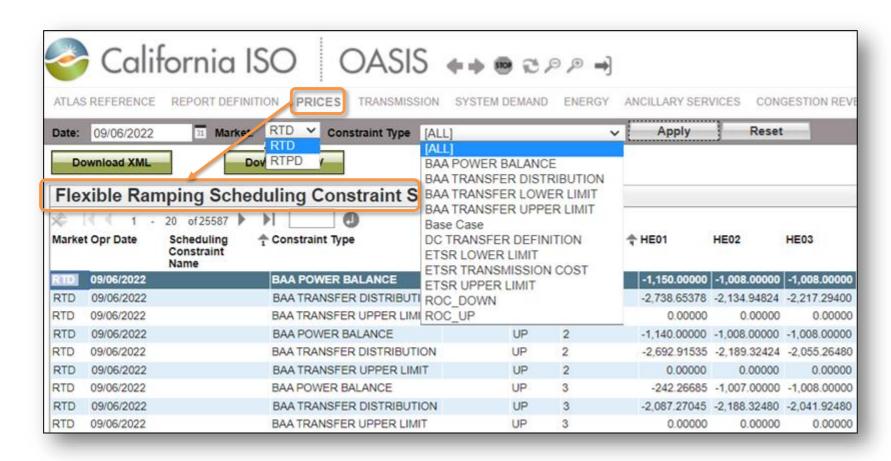
OASIS: Flexible Ramping Constraint Shadow Prices

- Transmission constraint shadow prices for FRU/FRD deployment scenarios in RTPD/RTD

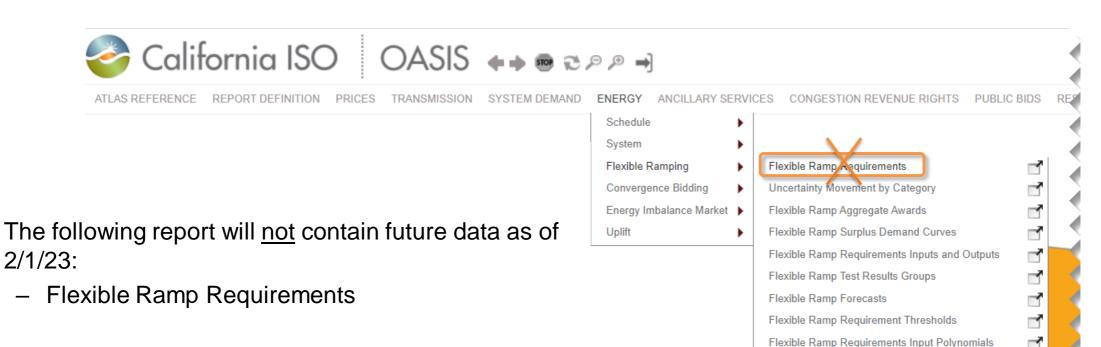# OASIS: Flexible Ramping Scheduling Constraint Shadow Prices

OASIS

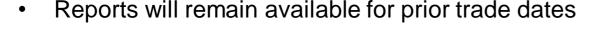- Scheduling constraint shadow prices for FRU/FRD deployment scenarios in RTPD/RTD

OASIS **Energy** Menu: Flexible Ramping list: Flexible Ramp Requirements Report – no new data after 2/1/23

- The following report will <u>not</u> contain future data as of 2/1/23:
  - Flexible Ramp Requirements

- Reports will remain available for prior trade dates

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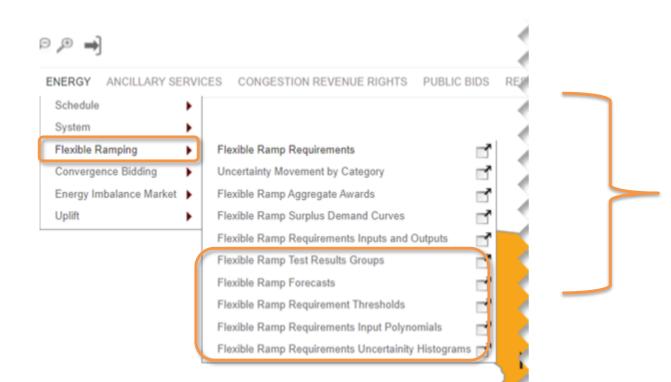
The following reports provide data that can be used to calculate flex ramp requirements
- Flexible Ramp Requirement Thresholds
- Flexible Ramp Requirements Uncertainty Histograms
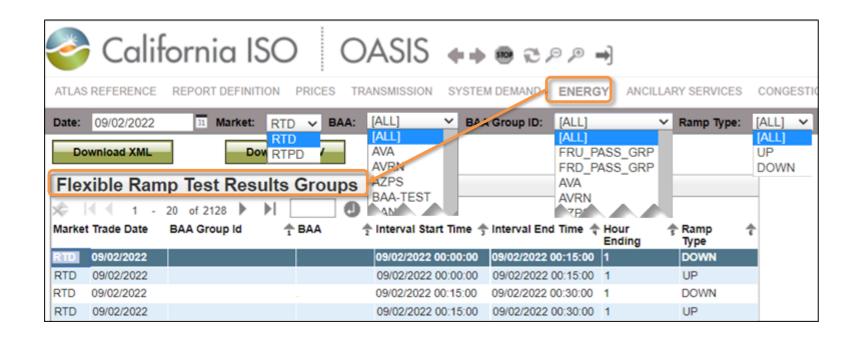
Note: In order to calculate FRP requirement, entity will also need forecast data for each 15 minute interval of the trade date (for solar, wind, demand)

OASIS: Flexible Ramp Test Results Groups
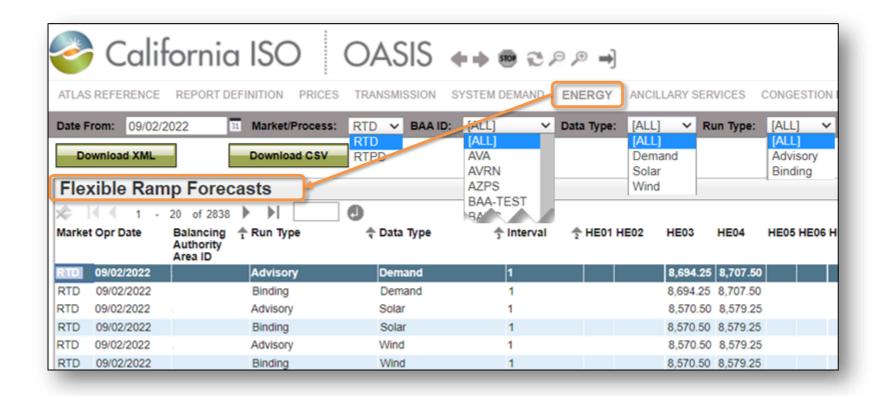
RTPD/RTD passing group ID & failing entities:

- Report provides the ability to determine which entities are part of the WEIM area requirement

OASIS: Flexible Ramp Forecasts
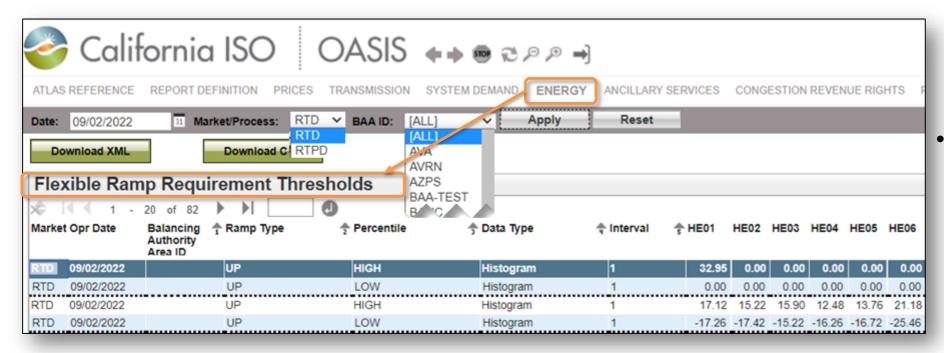
- Total RTD/RTPD binding & advisory resource forecast grouped by WEIM entity by tech type for solar/wind

- Report will also have a demand forecast component

OASIS: Flexible Ramp Requirement Thresholds
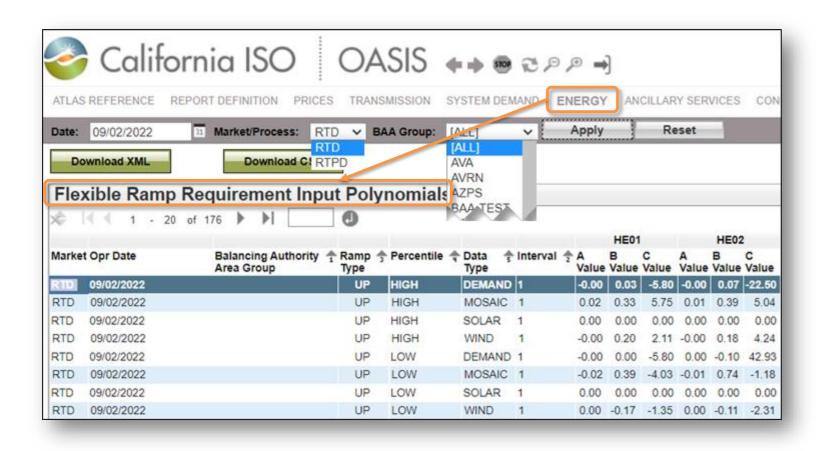
- Threshold value for FRU/FRD requirement for each BAA/WEIM area

OASIS: Flexible Ramp Requirement Input Polynomials
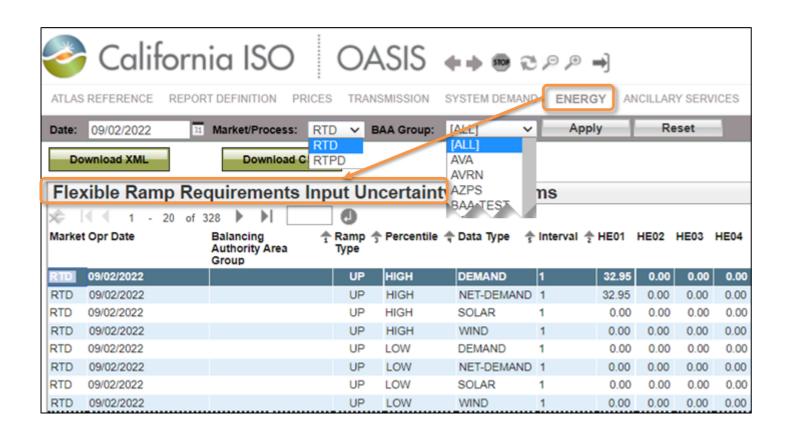
- 5- & 15- minute, low and high, polynomial coefficients for these forecasts:
  - Mosaic
  - Wind
  - Solar
  - Demand

- Forecast by WEIM entity/area

OASIS: Flexible Ramp Requirements Input Uncertainty Histograms

OASIS
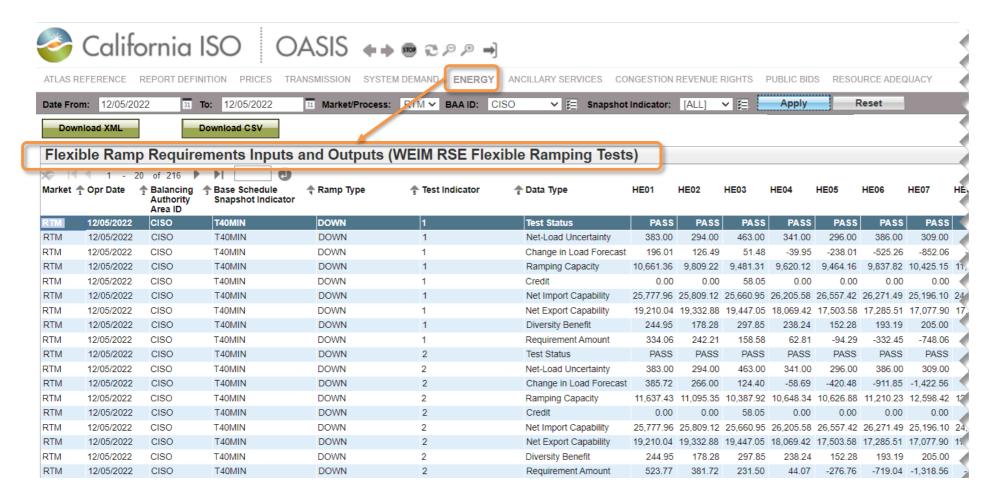
- 5- & 15- minute, low and high, uncertainty histogram values for these forecasts:
  - Mosaic
  - Wind
  - Solar
  - Demand

- Forecast by WEIM entity/area

OASIS: Flexible Ramp Requirements Inputs and Outputs (existing report)

- Note that you can see the 15-min net load uncertainty on this report along with other information

- PU: set of BAAs that pass the FRU sufficiency test
- PD : set of BAAs that pass the FRD sufficiency test
- $FRUS/FRDS$: FRU/FRD demand elasticity

$$\sum_{j \in PU} \sum_{i \in BAA_j} FRU_i + FRUS_{PU} = FRUR_{PU}$$

$$\left.\begin{array}{c} \sum_{i \in BAA_j} FRU_i + FRUS_j = FRUR_j \\ T_j \geq \tilde{T}_j \end{array}\right\}, \forall j \notin PU$$

$$\sum_{j \in PD} \sum_{i \in BAA_j} FRD_i + FRDS_{PD} = FRDR_{PD}$$

$$\left.\begin{array}{c} \sum_{i \in BAA_j} FRD_i + FRDS_j = FRDR_j \\ T_j \leq \tilde{T}_j \end{array}\right\}, \forall j \notin PD$$

Settlements

CHARGE CODE UPDATES
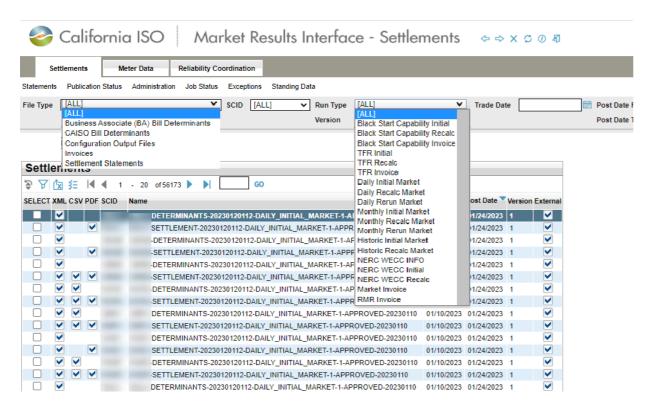
The shift to FRP nodal pricing requires the mechanics for cost allocation pricing to change
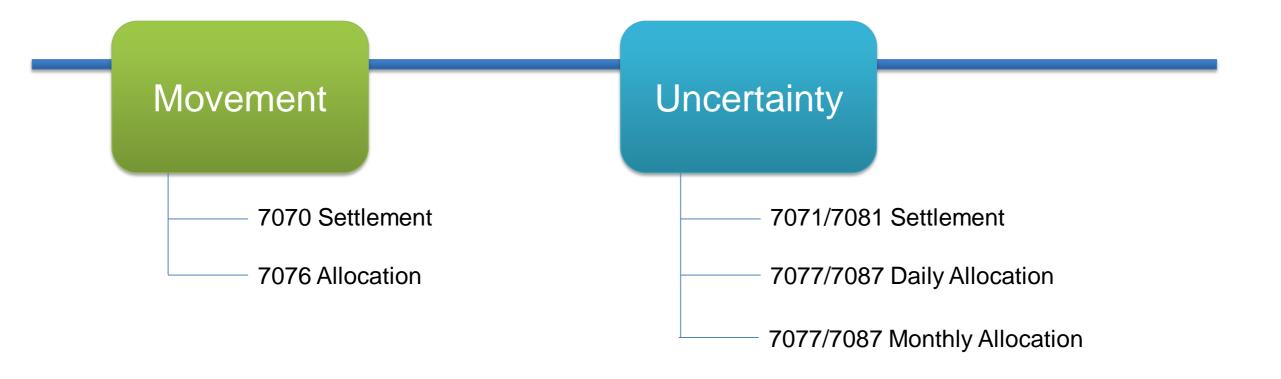
- For all WEIM entities that pass either FRU or FRD settlements will derive the total quantity of each category

- CMRI, OASIS and BAAOP provide reports and data that result in settlement statements located in MRI-S

- Processes are not changing, however the charge code calculations that feed into settlement results will have slight modifications

What will be **settled** for both Movement and Uncertainty?

Movement

Uncertainty

7070 Settlement

- Use nodal FRUMP & FRDMP

- Distinguish between Up and Down Awards

- Incorporate Passing Group Indication (Q") in Movement amounts in preparation for allocation through the use of the Flex Ramp Test Results Flag

7071/7081 Settlement (Up/Down)

- FMM FRU/FRD Uncertainty Award settlement is at the resource specific FRUMP/FRDMP

- RTD FRU/FRD Uncertainty Award settlement is a deviation settlement from FMM at the resource specific FRUMP/FRDMP

- Prices no longer carry Q" or constraint ID
  - Updated formulas to reflect above change

- Q" will now be introduced using the Flex Ramp Test Results Flag instead

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What will be **allocated** for Movement?

Movement

7076 Allocation

- Apply new allocation methodology (Pass vs Fail Flex Ramp Sufficiency Test)

    - If BAA Passes, allocation of movement award costs will be across all WEIM entities that belong to PASS group

    - If BAA Fails, allocation of movement award costs will be isolated to the metered demand of the respective BAA

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What will be **allocated** for Uncertainty?

Uncertainty (daily)

Uncertainty (monthly)

7077/7087 DAILY Allocation (Up/Down)
- Remains a 2-Tier Cost Allocation by resource category methodology
- Allocation based on passed group:

PASS

FAIL

Triggered across all BAAs that Pass

Allocated to metered demand of isolated BAA

7078/7088 Allocation (Up/Down)
- **Allocation based on Peak and Off-Peak Hours**
- Remains a 2-Tier Cost Allocation by resource category methodology
- Allocation based on passed group:

PASS

FAIL

Triggered across all BAAs that Pass

Allocated to metered demand of isolated BAA

EXAMPLES: SETTLEMENT OF FRP FORECASTED MOVEMENT

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Forecasted Movement Settlement – Example 1: BAA Passes both FRU and FRD RSE Tests

- Forecasted Movement Settlement is product of resource's forecasted movement and the difference between nodal FRUMP – FRDMP

- The BAA total Forecasted Movement Costs shall be allocated across to that BAA Group Metered Demand
  - Prorate BAA Metered Demand / Total BAA Group Metered Demand

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Forecasted Movement Settlement – Example 2:
BAA Failed both FRU and FRD RSE Tests

- Forecasted Movement Settlement is product of resource's forecasted movement and the difference between nodal FRUMP – FRDMP

- The BAA total Forecasted Movement Costs shall be allocated locally to that BAA Metered Demand
  - Prorate BAA Metered Demand / Total BAA Metered Demand

Forecasted Movement Settlement – Example 3:
Passed FRU RSE Test/Failed FRD RSE Test

- All resources within that BAA are paid/charge their forecasted movement and the difference between nodal FRUMP – FRDMP

- Forecasted Movement Allocation is split:
  - Forecasted Movement costs/revenue associated with FRUMP shall be allocated to BAA Group Metered Demand because the BAA Passed FRU RSE
  - Forecasted Movement costs/revenue associated with FRDMP shall be allocated to BAA Metered Demand because the BAA Failed FRD RSE

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Forecasted Movement Settlement – Example 4:
Failed FRU RSE Test/Passed FRD RSE Test

- All resources within that BAA are paid/charge their forecasted movement and the difference between nodal FRUMP – FRDMP

- Forecasted Movement Allocation is split:
  - Forecasted Movement costs/revenue associated with FRUMP shall be allocated to BAA Metered Demand because the BAA Failed FRU RSE
  - Forecasted Movement costs/revenue associated with FRDMP shall be allocated to BAA Group Metered Demand because the BAA Passed FRD RSE

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Final Questions

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Thank you for your participation!

For more detailed information on anything presented, please visit our website at:
www.caiso.com

Or send an email to:
CustomerReadiness@caiso.com

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REFERENCE MATERIAL

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Reference Material: September Training Session

Flexible Ramping Product (FRP) Refinements – Deliverability Training – September 7, 2022

- Presentation: https://www.caiso.com/Documents/Presentation-Flexible-Ramping-Product-Refinements-Deliverability-Training.pdf

- Video: https://youtu.be/kIVPJNo5ww0

Reference Material: Project Documentation

- Business Practice Manual changes:
  - [BPM Change Management](#) – look for changes to Market Instruments and Market Operations BPMs

- Business Requirements Specification:
  - https://www.caiso.com/Documents/BusinessRequirementsSpecifications12-FlexibleRampingProduct-Deliverability.pdf
  - https://www.caiso.com/Documents/BusinessRequirementsSpecifications12-FlexibleRampProduct-RequirementsEnhancements.pdf

- Initiative webpage:
  - https://stakeholdercenter.caiso.com/StakeholderInitiatives/Flexible-ramping-product-refinements

Reference Material: Project Documentation

- Market Simulation Structured Scenarios:
  - https://www.caiso.com/Documents/Market-Simulation-Structured-Scenarios-Flexible-Ramping-Product.pdf

- Tariff amendment to refine FRP:
  - https://www.caiso.com/Documents/Aug15-2022-TariffAmendment-FlexibleRampingProductRefinements-ER22-2661.pdf

- Technical Specifications – located on the ISO's Developer Site which provides detailed descriptions of the API changes for:
  - CMRI
  - OASIS