Day-Ahead Market Enhancements Straw Proposal

Stakeholder Meeting

February 10, 2020

Agenda

Time	Topic	Presenter
10:00 – 10:05 AM	Welcome and Introductions	Kristina Osborne
10:05 – 10:30 AM	Background & Stakeholder Comments	Megan Poage
10:30 AM – 12:00 PM	Proposed Day-Ahead Market Enhancements	Megan Poage
12:00 – 1:00 PM	Lunch	
1:00 – 3:45 PM	Proposed Day-Ahead Market Enhancements	James Friedrich & Perry Servedio
3:45 – 4:00 PM	Next Steps	Kristina Osborne

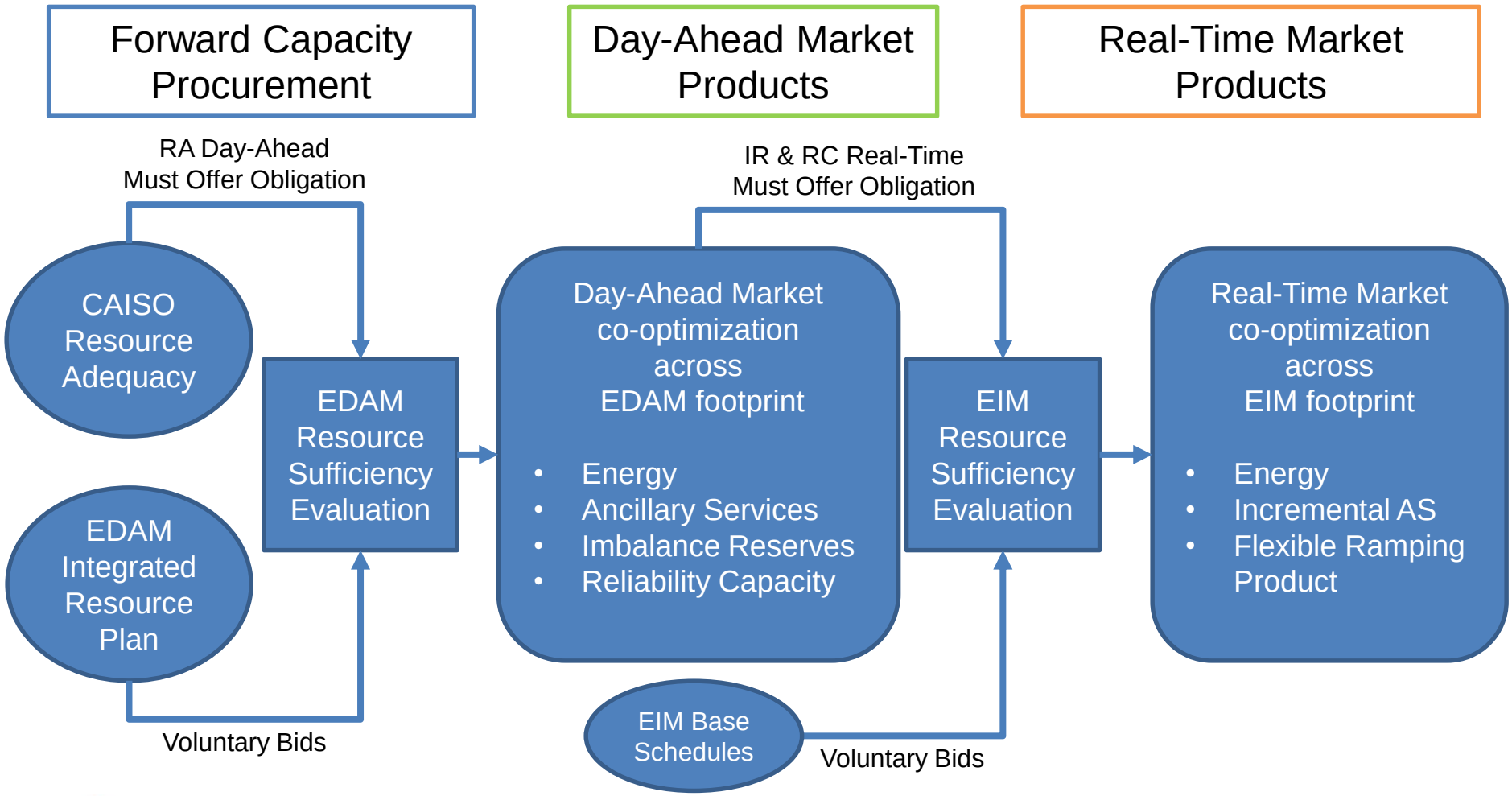
Day-Ahead Market Enhancements

BACKGROUND & STAKEHOLDER COMMENTS

The objective of this initiative is to enhance the California ISO's (CAISO's) day-ahead market to efficiently schedule resources to:

- Meet the load forecast and accommodate the uncertainty of real-time net load and its rate of variability.
- Appropriately compensate resources that provide flexible capacity to meet this net load uncertainty and variability.
- Optimally clear and price energy and other market products in the day-ahead market, including incorporating actions into the market that system operators currently take outside of the market.
- Respect transmission constraints so that resource schedules are deliverable.

Overview of RA, DAME & EDAM relationship with CAISO market runs



CAISO and stakeholder audience completed technical workshops to inform direction of DAME

- Stakeholder working group meetings in 2019 discussed day-ahead market design options
  - **Option 1**: only use bid-in demand to clear supply and imbalance reserves in the day-ahead market
  - **Option 2**: use bid-in demand *and* the system operator forecast to clear supply, imbalance reserves, and reliability capacity in the day-ahead market
- The CAISO has since revised the proposals to ensure deliverability of imbalance reserves.

CAISO has completed internal review of DAME objectives and stakeholder feedback

- Many stakeholders, particularly EIM entities, support Option 2
  - Incorporates all costs to meet the load forecast and uncertainty needs
- Other stakeholders prefer option 1
  - Option 2 is overly complex
  - Load may have less transparent and predicable pricing due to the scheduling of reliability energy
- Some stakeholders requested a complete proposal before making a final determination

The CAISO proposes enhancements to the day-ahead market using the Option 2 design

- Option 2 ensures schedules procured by the market will always meet the system forecast and will include all costs
- Option 2 allows hourly resources, and hence a larger resource fleet, to be used to meet the difference between cleared demand and the system forecast
- Option 2 will result in more efficient and economic unit commitment

Option 2 will result in more efficient and economic unit commitment by:

- Including commitment costs for the difference between cleared demand and the operator forecast
- Including commitment costs from what are currently met through out-of-market actions
- Recognizing the capacity value of physical resources relative to virtual resources
- Optimal unit commitment when the system operator forecast is different than cleared bid-in demand

QUESTIONS?

Day-Ahead Market Enhancements

PROPOSED DAY-AHEAD MARKET ENHANCEMENTS

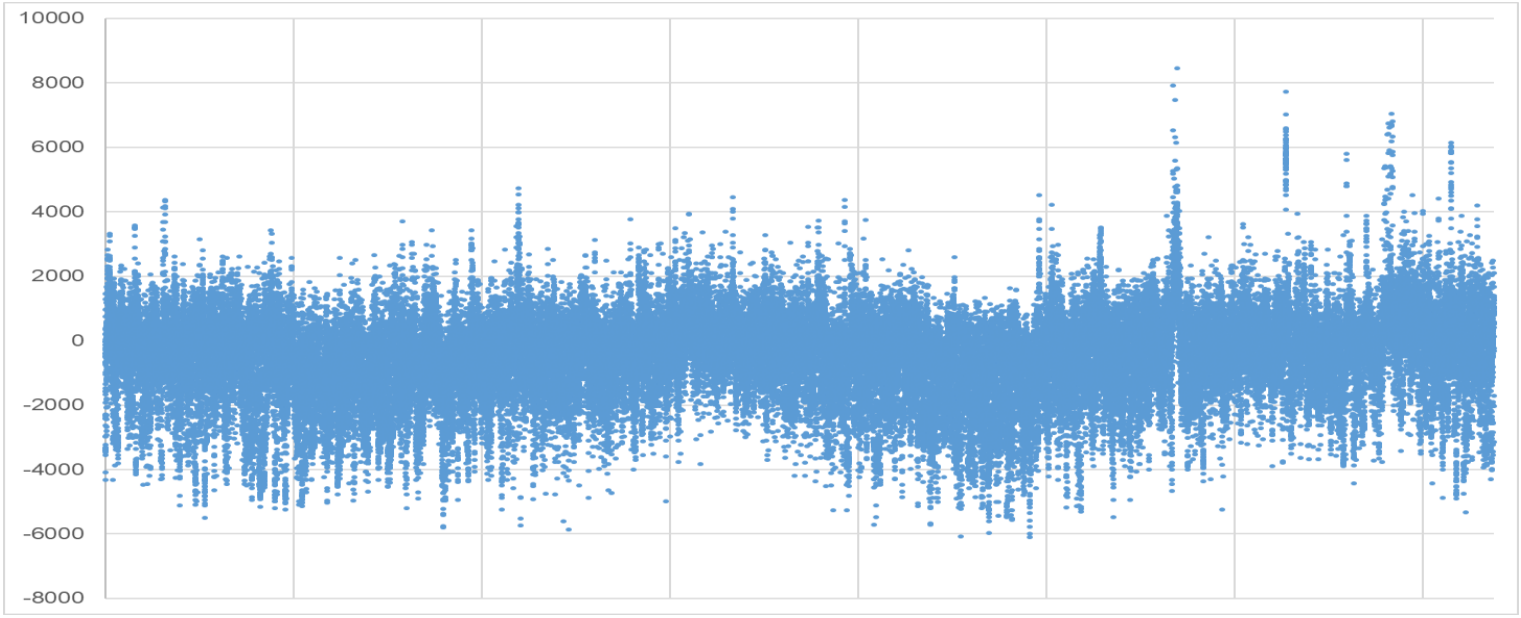
The CAISO proposes new day-ahead market products to reserve real-time dispatch capability

- **Reliability Energy** (REN) and associated **Reliability Capacity Up and Down** (RCU/RCD):
  - Replaces the existing residual unit commitment process
  - Hourly schedules based on hourly ramp capability

- **Imbalance Reserves Up and Down** (IRU/IRD):
  - Ensures the day-ahead market schedules sufficient real-time dispatch capability to meet net load imbalances that materialize between the day-ahead and real-time markets
  - Hourly awards based on fifteen-minute ramp capability

Net load imbalance varies greatly

Net load imbalance from Jan 2017 – Mar 2019



Each data point is the quantity of imbalance (between FMM and IFM) for each FMM interval of Jan 2017 – Mar 2019

This need will be meet with the introduction of the new day-ahead products

Summary of proposed, planned, and existing day-ahead market products (1 of 2)

Title	Acronym	Purpose	Eligibility	Status
Energy	EN	Energy schedules cleared to meet bid-in demand	All resources	Existing
Reliability Energy	REN	Physical resources cleared to meet the load forecast	60-minute dispatchable physical resources, award based on 60-minute ramp capability	Proposed
Reliability Capacity, Up	RCU	Incremental capacity procured to meet the positive difference between the load forecast and cleared demand	As above	Proposed
Reliability Capacity, Down	RCD	Decremental capacity procured to meet the negative difference between load forecast and cleared demand	As above	Proposed
Imbalance Reserves, Up	IRU	Incremental capacity procured relative to the load forecast to meet the upward uncertainty requirement	15-minute dispatchable physical resources, award based on 15-minute ramp capability	Proposed
Imbalance Reserves, Down	IRD	Decremental capacity procured relative to the load forecast to meet the downward uncertainty requirement	As above	Proposed

Summary of proposed, planned, and existing day-ahead market products (2 of 2)

Title	Acronym	Purpose	Eligibility	Status
Ancillary Services	AS	Incremental capacity procured and reserved to meet real-time regulation and contingency reserve requirements	Resources certified to provide the respective service	Existing
Corrective Capacity, Up	CCU	Incremental capacity procured and reserved for corrective action after specific corrective transmission contingencies	All 5-minute dispatchable resources, award based on 20-minute ramp capability	Planned
Corrective Capacity, Down	CCD	Decremental capacity procured and reserved for corrective action after specific corrective transmission contingencies	As above	Planned

Day-ahead energy schedules are equivalent to the current integrated forward market

- Market determines energy schedules by clearing physical and virtual supply against bid-in demand
- Energy is priced at each node resulting in a LMP for energy
- Resources with day-ahead energy schedules will be able to re-bid (self-schedule or economically bid) in the real-time market

Reliability energy replaces and provides enhancements compared to the residual unit commitment process

- Reliability energy will be scheduled for physical supply, imports and exports to meet the system operator forecast

- Including energy and reliability energy in the same market optimization allows the market to more efficiently co-optimize products
  - Optimization will consider transmission constraints to ensure energy and reliability energy are deliverable

Reliability capacity represents physical resource capacity scheduled to account for the difference between cleared bid-in demand and the operator forecast

$$REN = EN + RCU - RCD$$

- A resource can have the following types of schedules:
  - REN that corresponds to its EN schedule
  - RCU, which is unloaded REN above a resource's EN schedule
  - RCD, which is loaded REN below a resource's EN schedule

- Reliability capacity awards result in an obligation to economically bid the capacity range into the real-time market

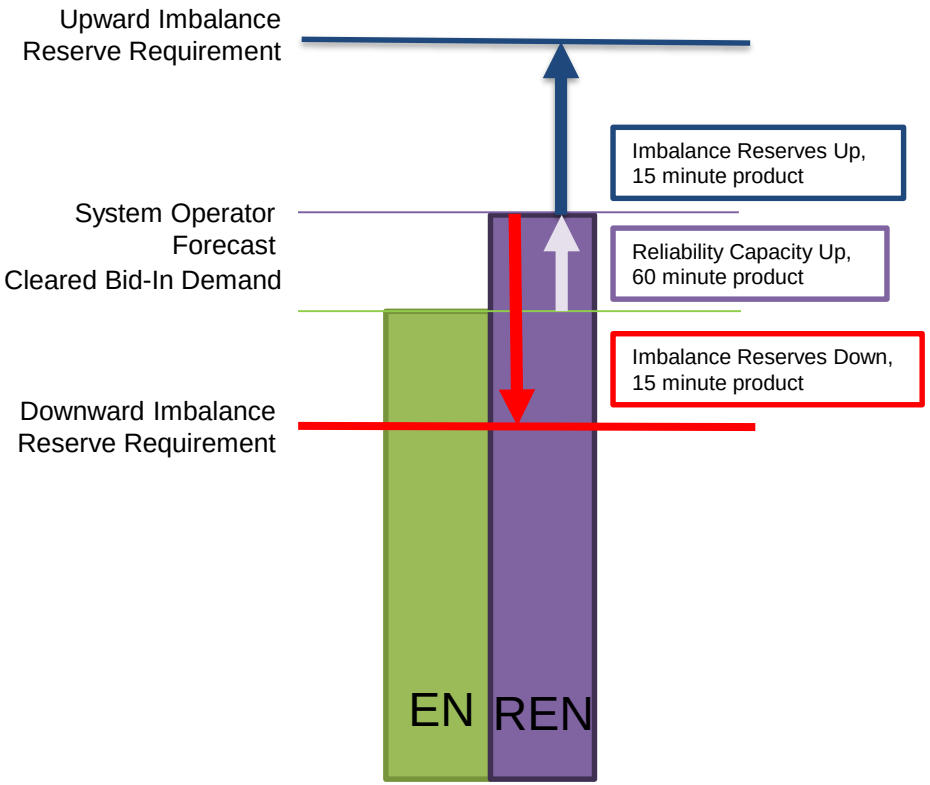
- A resource can be awarded either RCU or RCD, not both

Imbalance reserves ensure the day-ahead market schedules sufficient real-time dispatch capability to cover net load uncertainty

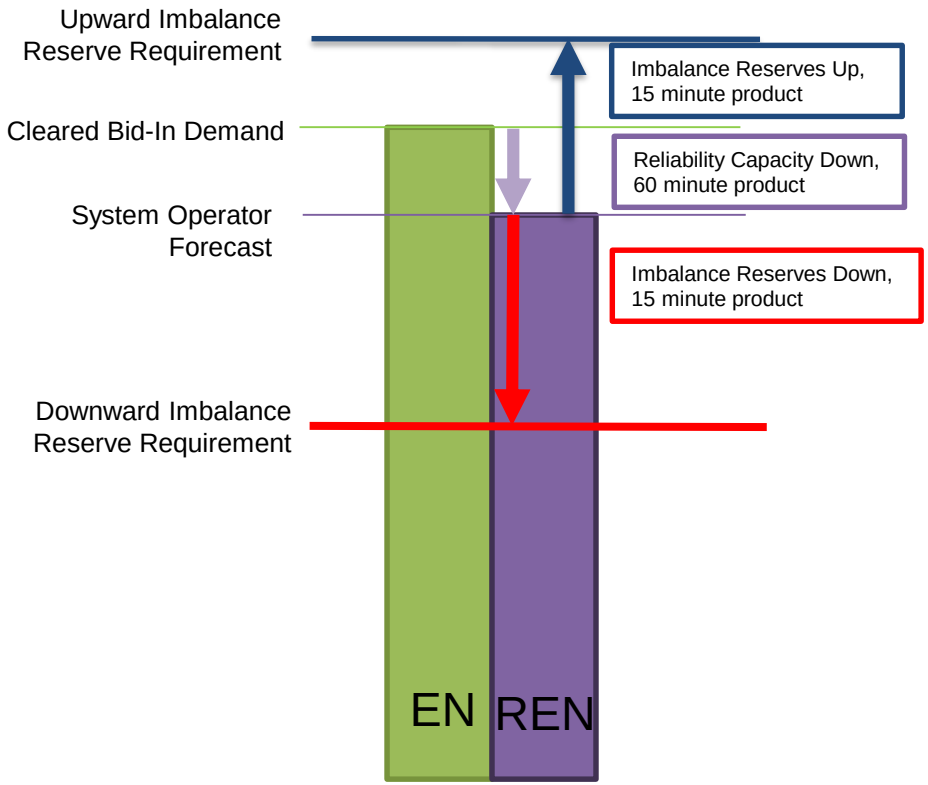
- Co-optimization with energy and reliability energy will ensure optimal solution for all market products
  - Considers transmission constraints to ensure imbalance reserves are deliverable
- Imbalance reserves put current out-of-market actions into the market solution
- Imbalance reserve awards result in an obligation to economically bid the capacity range into the real-time market

Co-optimization of bid-in demand and system forecast will result in the efficient procurement of energy and capacity products

Forecast > Cleared Demand



Forecast < Cleared Demand



The day-ahead market will produce two day-ahead schedules and prices

1. Day-ahead energy schedule for physical and virtual resources based on cleared bid-in demand.
   - Results in day-ahead energy LMP and settlement

2. Reliability energy schedule for physical resources based on system operator forecast.
   - Results in a REN LMP with separate settlements for each of its components (EN, RCU and RCD) because of the need for different cost allocations for each component

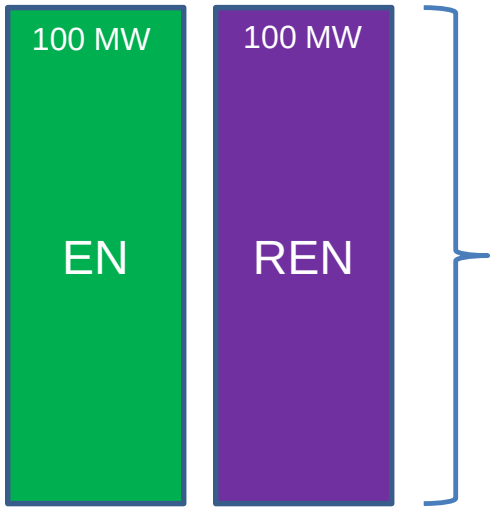
QUESTIONS?

The CAISO proposes the following day-ahead market bidding rules

- Market participants will submit separate bids for energy, RCU, RCD, IRU, IRD, CCU, CCD and ancillary services
- Bids must be submitted by 10AM and can have 24-hourly bids
- Capacity products have a single bid quantity/price:
  - No bid, or
  - Greater than 0 MW, and are
  - Capped by the certified MW amount based on the resource's ramp capability

Physical generator with $30/MWh energy bid: Example #1

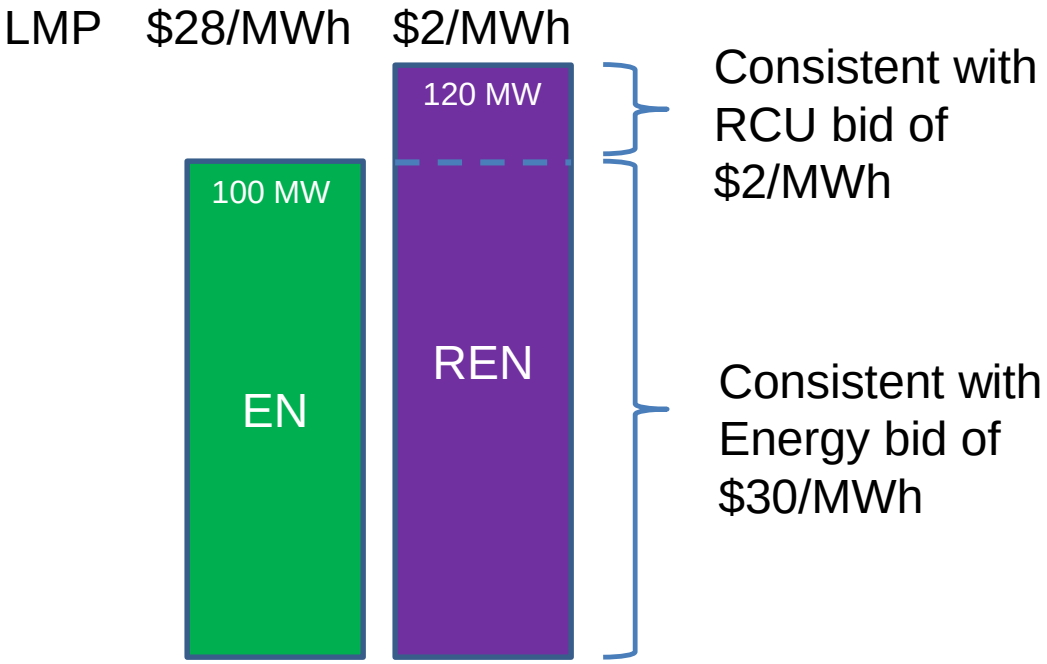
LMP $28/MWh $2/MWh



Consistent with Energy bid of $30/MWh

Schedule Type	Schedule Quantity	LMP	Payment
EN	100 MW	$28/MWh	$2800
REN: EN	100 MW	$2/MWh	$200
REN: RCU/RCD	0 MW	$2/MWh	$0
		Total	$3000

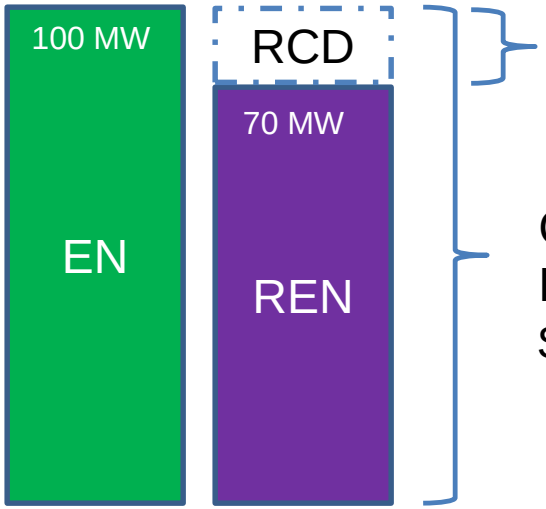
Physical generator with $30/MWh energy bid: Example #2



Schedule Type	Schedule Quantity	LMP	Payment
EN	100 MW	$28	$2800
REN: EN	100 MW	$2	$200
REN: RCU	20 MW	$2	$40
		Total	$3040

Physical generator with $30/MWh energy bid: Example #3

LMP $32/MWh -$2/MWh



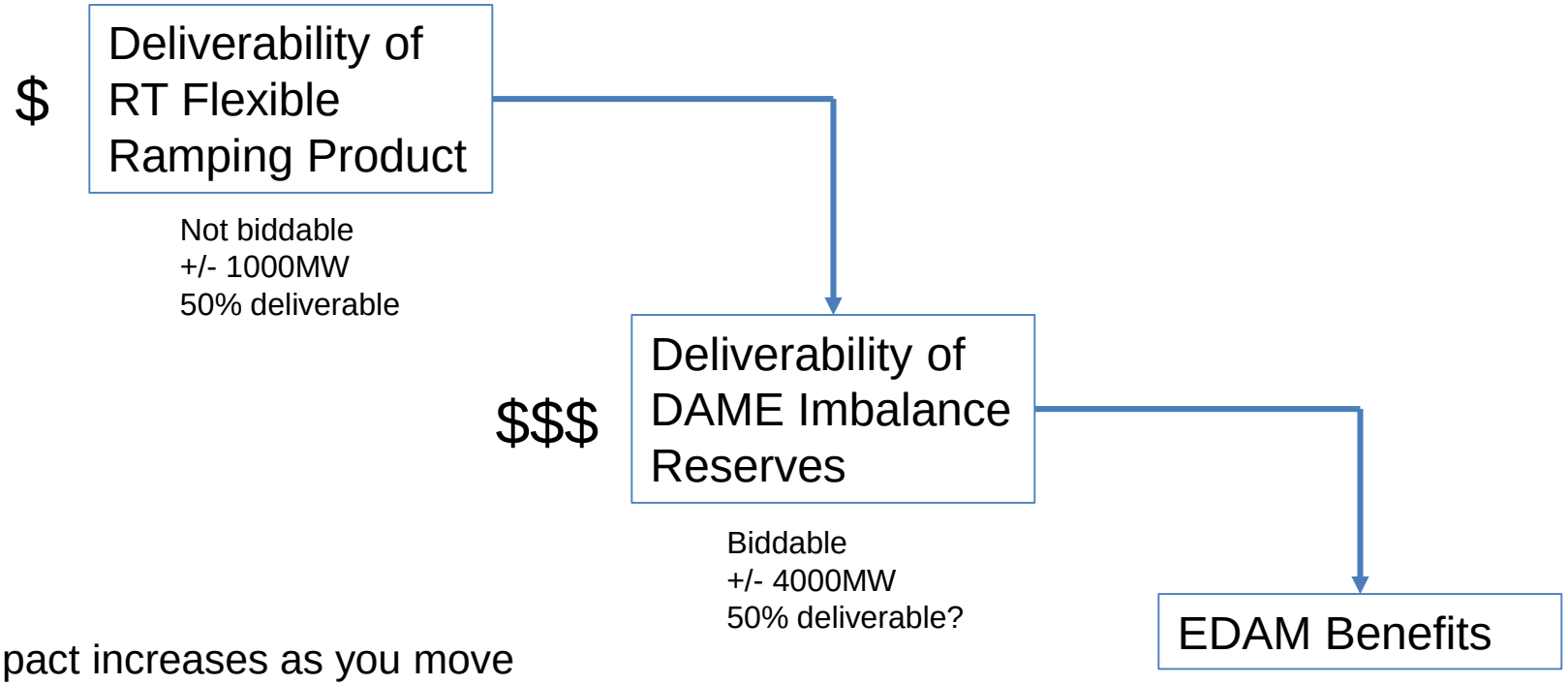
Consistent with $30/MWh Energy bid + $2/MWh RCD bid

Consistent with Energy bid of $30/MWh

Schedule Type	Schedule Quantity	LMP	Payment
EN	100 MW	$32	$3200
REN: EN	100 MW	–$2	–$200
REN: RCD	30 MW	$2	$60
		Total	$3060

QUESTIONS?

Undeliverable products lead to current and future market inefficiencies and operational challenges



Impact increases as you move from real-time to EDAM

Price Performance Analysis identified need to improve deliverability of market products

Improve deliverability by not awarding to resources that have a zero opportunity cost because of congestion

- Upward products to resources behind constraint
  - Next market run unable to dispatch higher than current output
- Downward products to resource providing counterflow
  - Next market run unable to dispatch lower than current output

CAISO proposes mechanisms to allow new products to be priced and deliverable at a nodal level

- Reliability energy and imbalance reserves will be scheduled based on a transmission constrained power flow
  - Reliability energy power flow will be based on the load forecast
  - Imbalance reserve up power flow will be based on 97.5 percentile load forecast
  - Imbalance reserve down power flow will be based on 2.5 percentile load forecast

Efficient procurement of imbalance reserves and reliability capacity should consider the energy and capacity costs of the resource

- Considering energy *and* capacity costs when awarding capacity is an existing shortfall of RUC
  - Market does not distinguish between two resources with the same RUC availability bids, even if the energy bid cost is different

- Imbalance reserves and reliability capacity should be awarded to resources with lowest combined energy and capacity costs

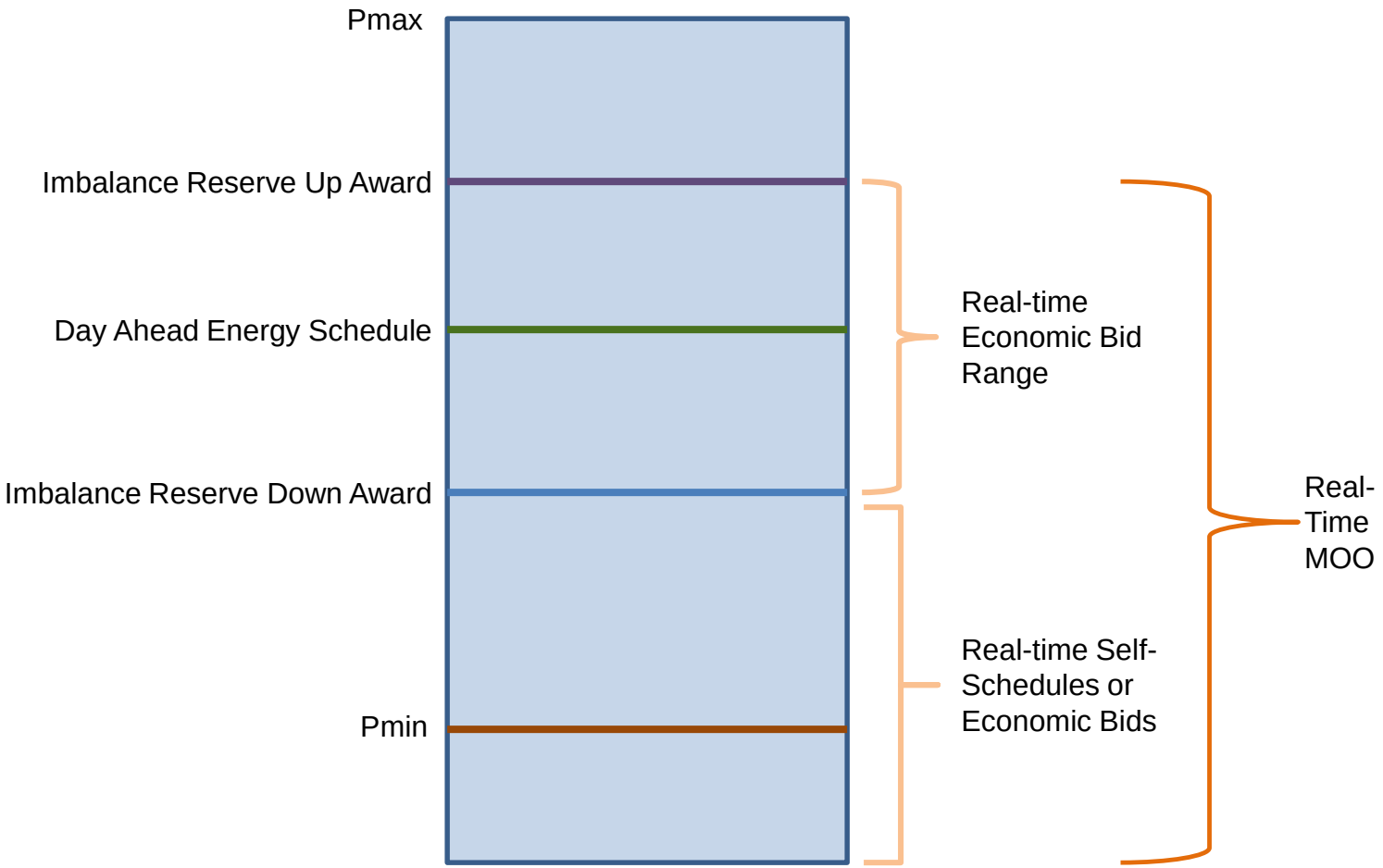
- CAISO is considering mechanisms to reflect combined energy and capacity costs

Resources with day-ahead capacity awards will have real-time bidding obligations

- Resources with reliability capacity or imbalance reserves awards must economically bid the full range of their RCU/RCD or IRU/IRD awards into the real-time market

- Real-time obligations apply in the hourly intervals that a resource has an RCU/RCD or IRU/IRD schedule

Real-time bidding obligations based on day-ahead awards



Resource Adequacy day-ahead bidding obligation for energy, reliability capacity, and imbalance reserves

	DA Bid (SS or Economic) for Energy	DA Bid (Economic) for Reliability Capacity	DA Bid (Economic) for Imbalance Reserves
System RA	Yes	Yes	Not required
Local RA	Yes	Yes	Not required
Flex RA	Yes (economic)	Yes	Yes

Real-time bidding obligation will be determined by day-ahead awards

QUESTIONS?

The forecast for variable energy resources will be used to determine the reliability energy schedule

- CAISO proposes to limit the upper economic limit of VERs to the system operator day-ahead forecast
  - Ensures energy schedule does not exceed forecast

- Virtual bids can be used to account for the difference between their desired day-ahead energy position and the system operator forecast
  - Resource forecast > CAISO forecast → virtual supply
  - Resource forecast < CAISO forecast → virtual demand

If a VER does not elect to economically patriciate in the day-ahead market, the CAISO does not want to schedule the resource for reliability capacity because of the corresponding real-time offer obligation

No bid: cleared EN = 0 MW, REN = forecast (not settled)

Self-Schedule: cleared EN = REN = forecast

Economic bid: cleared EN + RCU – RCD = REN <= forecast

No bid: cleared EN = 0 MW, REN = N/A

- VER submits no bid, market optimization will use the system operator forecast to schedule reliability energy
  - This would result in a reliability capacity up award
  - RCU award would be paid the reliability energy price and would also be subject to the real-time offer obligation
- CAISO does not believe it's appropriate to subject a resource that did not want to participate in the DAM to a RTM obligation
  - Therefore, CAISO proposes to not pay a resource that does not bid into the day-ahead market for its RCU award
  - Will reduce RCU cost allocation

Self-Schedule: cleared EN = REN = forecast

- VER submits self-schedule into the day-ahead market
  - Cleared energy and reliability energy are equal (at the system operator forecast)
  - No reliability capacity award, and therefore no RTM offer obligation
- If the VER wants to take an energy position that differs from the system operator forecast, they can use virtual bids
  - Market participant's desired position = 80 MW
  - System operator's forecast = 100 MW
  - Virtual demand bid = 20 MW

Economic bid: cleared EN + RCU – RCD = REN <= forecast

- Only VERs that submit economic bids will be scheduled to provide reliability capacity or imbalance reserves
  - Will result in RTM bidding obligation

- If market participants forecast is higher than system operators forecast, a virtual supply bid is needed for the difference
  - The difference between the forecasts will not be paid for reliability energy because the system operator does not believe this supply is physical because the operator forecast is lower

QUESTIONS?

The CAISO proposes the following day-ahead settlements for energy and reliability energy

- All physical supply resources, imports, and exports are settled at LMPs for energy and reliability energy
- Virtual resources are settled at the energy LMP and are allocated the cost of reliability energy
- Bid-in load is settled at the energy LMP and is allocated the cost of reliability energy

The CAISO proposes the following day-ahead settlements for eligible resources that are awarded imbalance reserves or reliability capacity

- Resources that receive imbalance reserve awards will be settled at the LMP for imbalance reserves (up or down)
- Resources that receive reliability capacity awards will be settled at the LMP for reliability capacity (up or down)

The reliability energy cost allocation will be broken down into the reliability energy components

- REN (EN) cost allocated to cleared virtual supply/demand and bid-in load

- REN (RCU, Tier 1) cost allocated to net virtual supply and under-scheduled load
- REN (RCU, Tier 2) cost allocated to metered demand

- REN (RCD, Tier 1) cost allocated to net virtual demand and over-scheduled load
- REN (RCD, Tier 2) cost allocated to metered demand

The CAISO proposes the following cost allocation for imbalance reserves

- IRU, Tier 1 costs allocated to net negative demand devotion and net virtual supply
- IRU, Tier 2 costs allocated to metered demand

- IRD, Tier 1 costs allocated to net positive demand deviation between day-ahead and real-time, and net virtual demand
- IRD, Tier 2 costs allocated to metered demand

The CAISO proposes the following changes to bid cost recovery

- Day-ahead bid cost recovery will now include the following revenues
  - Energy, reliability energy, imbalance reserves, corrective capacity, and AS
- Day-ahead bid cost recovery will now include the following costs
  - Energy bids, reliability capacity bids, imbalance reserve bids, corrective capacity bids, AS bids, and commitment costs
  - Reliability capacity bid cost is limited to RCU and RCD schedules
- RTM BCR will no longer include RUC uplift

QUESTIONS?

The CAISO proposes to use a regression approach to determine the imbalance reserve requirement

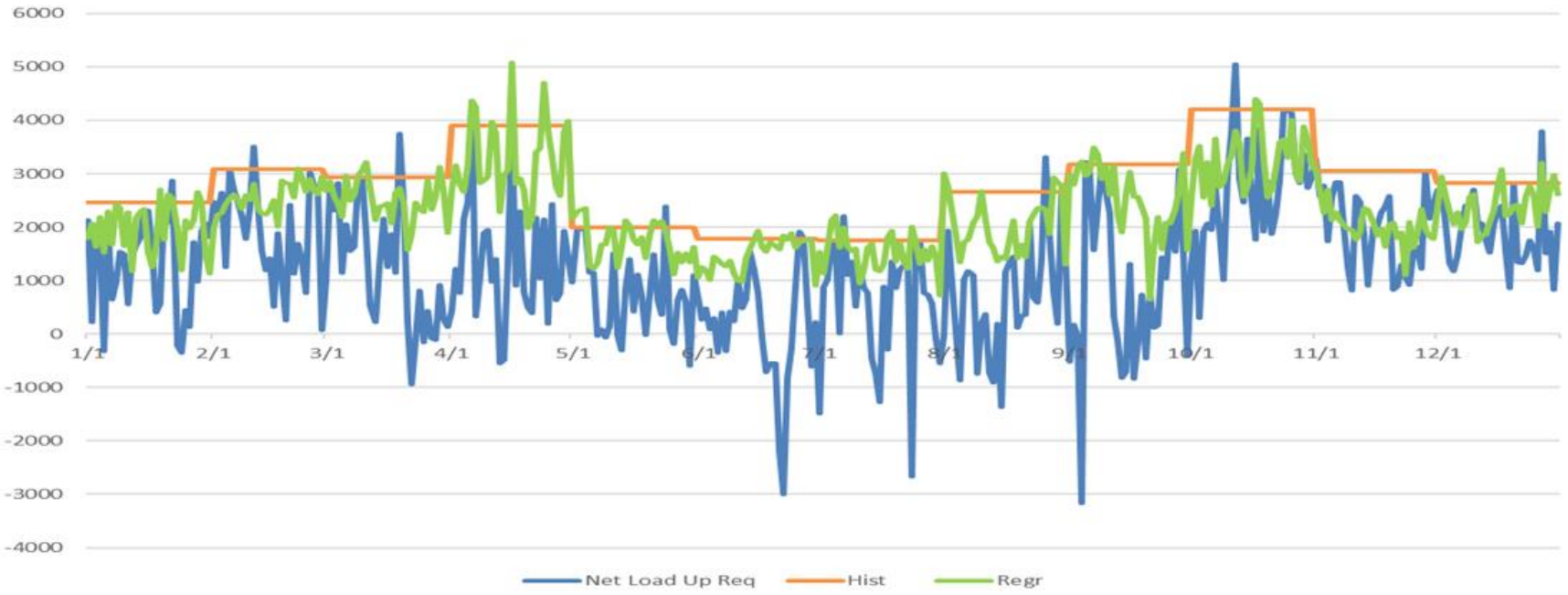
- Currently, a histogram methodology is used to procure capacity products like real-time flexible ramping product
- Using a regression model based on forecasted amounts of load, wind and solar will result in a more accurate imbalance reserve requirement amount
  - This model can be shaped to better capture variation of imbalance to forecasted values
- The CAISO proposes a “safety net” to allow system operators to adjust the requirement, if needed for reliability reasons

Calculating the imbalance reserve up requirement under the regression approach will require the following steps:

1. Use quantile regression to estimate parameters of load forecast, month, and hour on the 97.5 percentile of load imbalance
2. Use quantile regression to estimate parameters of wind forecast, month, and hour on the 2.5 percentile of wind imbalance
3. Use quantile regression to estimate parameters of solar forecast, month, and hour on the 2.5 percentile of solar imbalance
4. Combine estimated parameters from steps 1-3 using the identity Net Load = Load – Wind – Solar
5. Use an adjustment ratio to avoid systematic over-estimation at the 97.5% of net load imbalance

Benefits of regression vs. histogram approach for determining the imbalance reserve procurement target

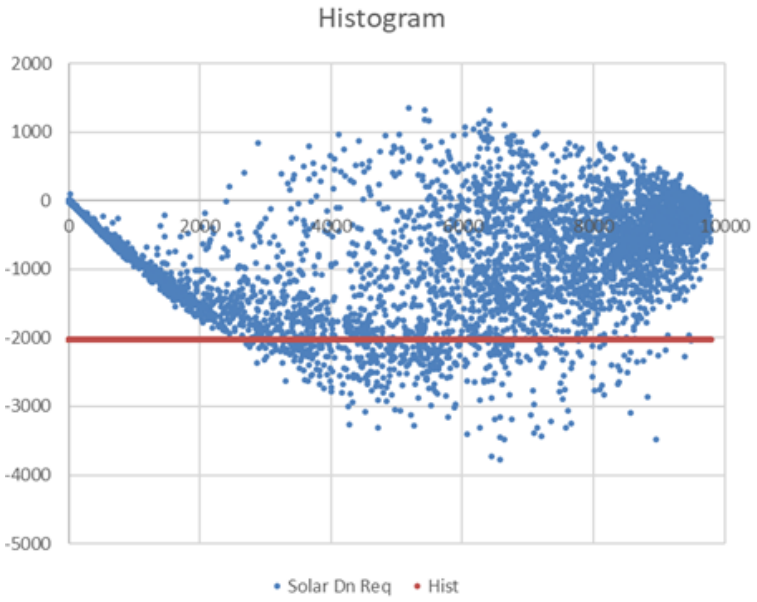
Imbalance reserve up requirement: histogram vs. regression for 2017 for HE17

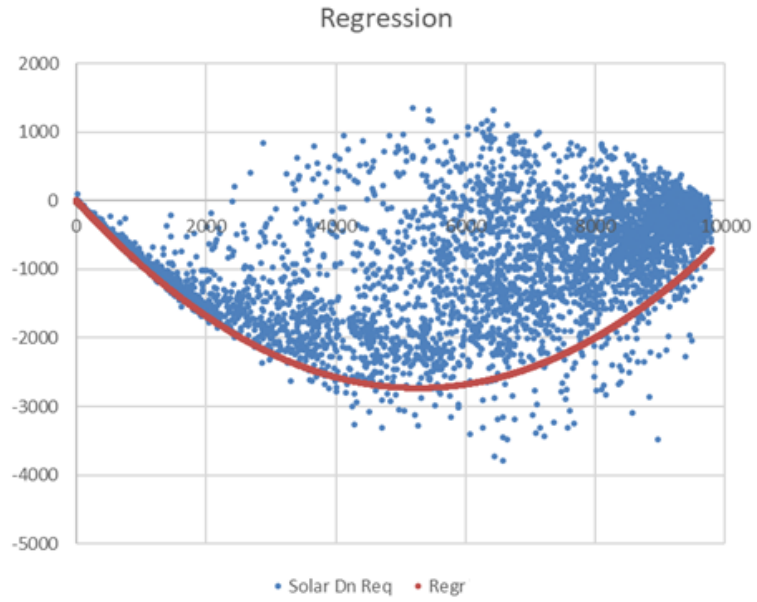


Regression approach more closely follows materialized imbalance

Benefits of regression vs. histogram approach for determining the imbalance reserve procurement target

Solar imbalance down values compared to day-ahead solar forecast



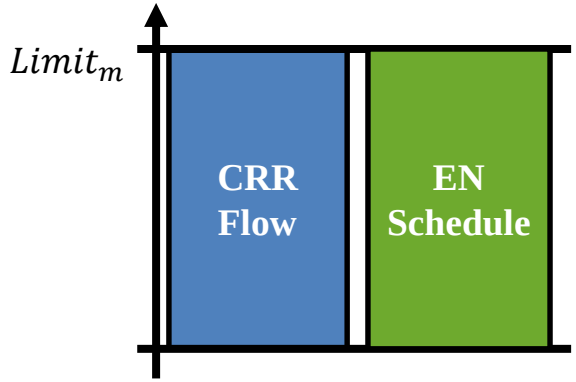


Regression approach is shaped to better capture variance of imbalance to forecast values

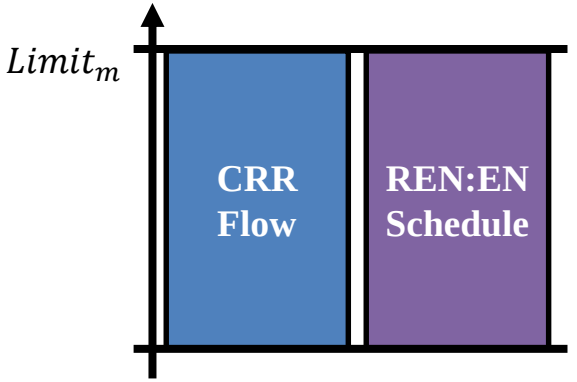
QUESTIONS?

Market participants can use a single CRR to hedge congestion resulting from EN and REN:EN schedules

- Constraints can be congested due to *energy* schedules, *reliability energy* schedules, or *imbalance reserve* awards
  - Today, a CRR from location A to location B is paid the congestion associated with *energy* schedules on constraints between location A and B
  - The CAISO proposes to also pay CRRs congestion associated with the energy portion of the reliability energy schedules between location A and B



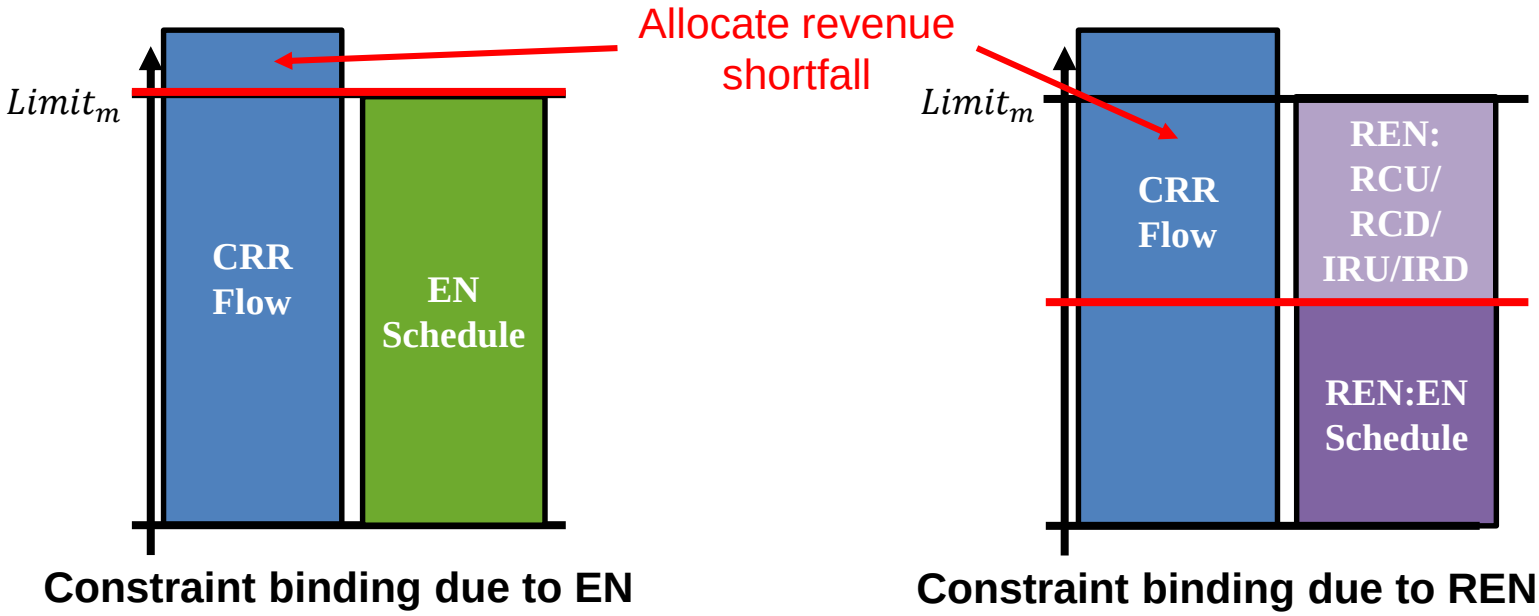
Constraint binding due to EN



Constraint binding due to REN

CRRs are settled on a constraint-by-constraint basis when the constraint collects enough revenue to fund the CRRs

- Congestion revenue rights will not provide a congestion hedge for day-ahead market locational capacity awards



Constraint binding due to EN **Constraint binding due to REN**

QUESTIONS?

CAISO proposes to extend local market power mitigation to reliability capacity and imbalance reserve bids

- Suppliers will offer to sell energy, reliability capacity, and imbalance reserves in the day-ahead market
- A supplier may be able to exercise market power in providing reliability capacity or imbalance reserve awards
- CAISO proposes to evaluate constraints for uncompetitive conditions and mitigate reliability capacity and imbalance reserve offers effective on binding constraints
  - Enhance the DCPA to evaluate competitiveness of the new products
  - Need to come up with a way to have default bids for these new products

QUESTIONS?

Day-Ahead Market Enhancements

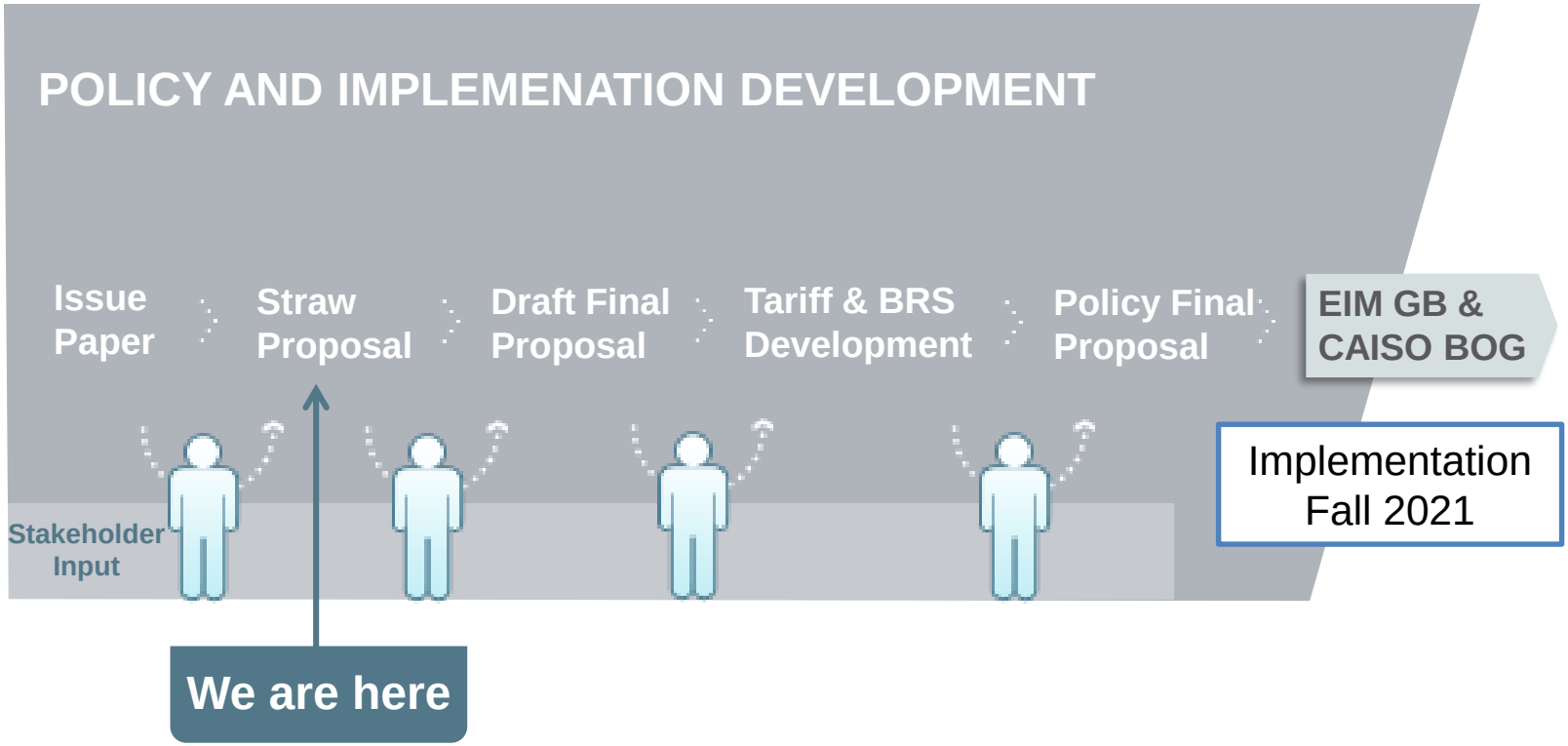
NEXT STEPS

EIM Governing Body classification

- The CAISO proposes the EIM Governing Body have an **advisory role** in the approval of the day-ahead market enhancements initiative

- Stakeholders encouraged to submit responses to the EIM classification within written comments

CAISO development process for DAME



DAME policy development schedule

Item	Date
Post Straw Proposal	February 3, 2020
Stakeholder Conference Call	February 10, 2020
Stakeholder Comments Due	March 2, 2020
Post Revised Straw Proposal	March 25, 2020*
Stakeholder Conference Call	April 1, 2020*
Stakeholder Comments Due	April 22, 2020*
Post Draft Final Proposal	June 10, 2020*
Stakeholder Conference Call	June 23, 2020*
Stakeholder Comments Due	July 14, 2020*

**Dates are tentative and subject to change*

DAME implementation development schedule

- Straw Proposal – February 2020
- Revised Straw Proposal – April 2020
- Draft Final Proposal – June 2020
- Tariff & BRS Development – Q3 & Q4 2020
- Policy Final Proposal – Q4 2020
- EIM GB and BOG decision – Q1 2021
- Implementation – Fall 2021

Next steps

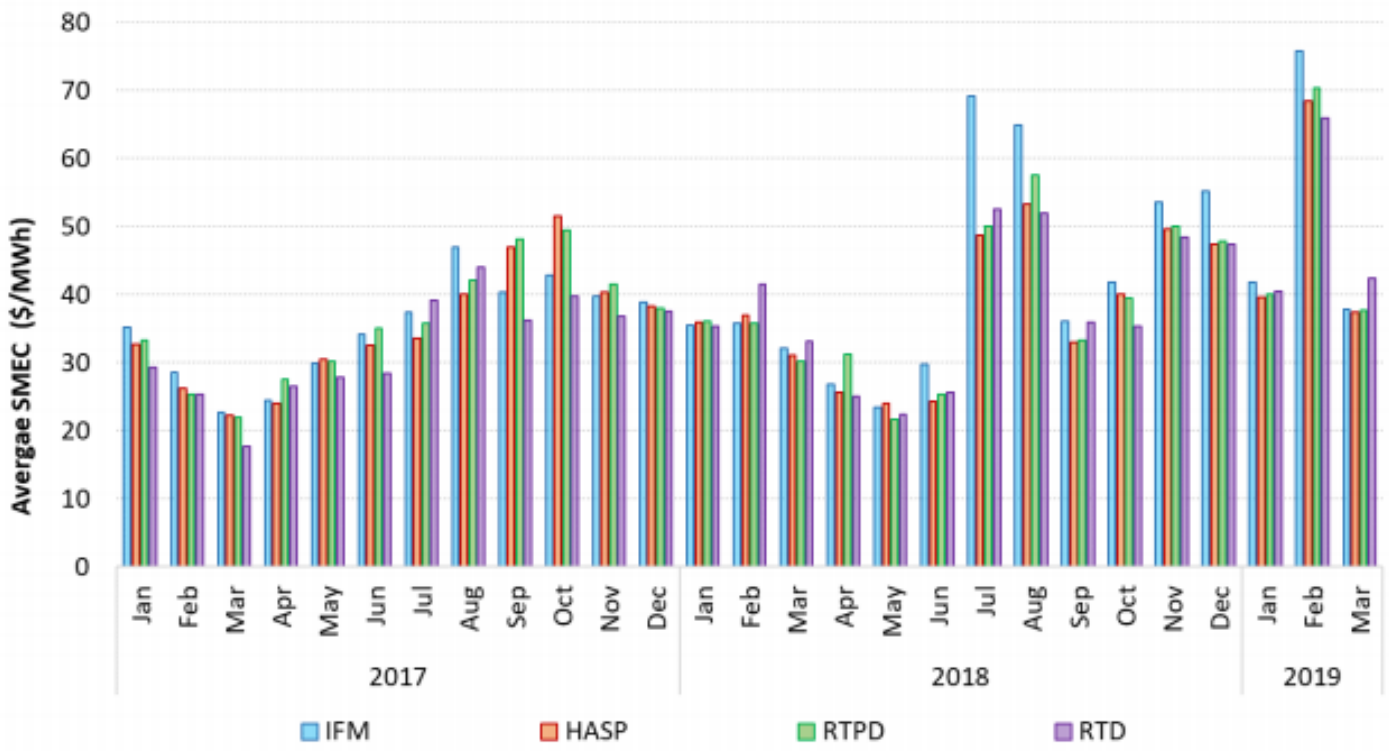
- Stakeholders should comments on the DAME straw proposal by March 2, 2020
- Submit comments using the template provided on the CAISO's initiative webpage located here: http://www.caiso.com/StakeholderProcesses/Day-ahead-market-enhancements
- Comments should be submitted to: InitiativeComments@caiso.com

Day-Ahead Market Enhancements

APPENDIX: DATA ANALYSIS

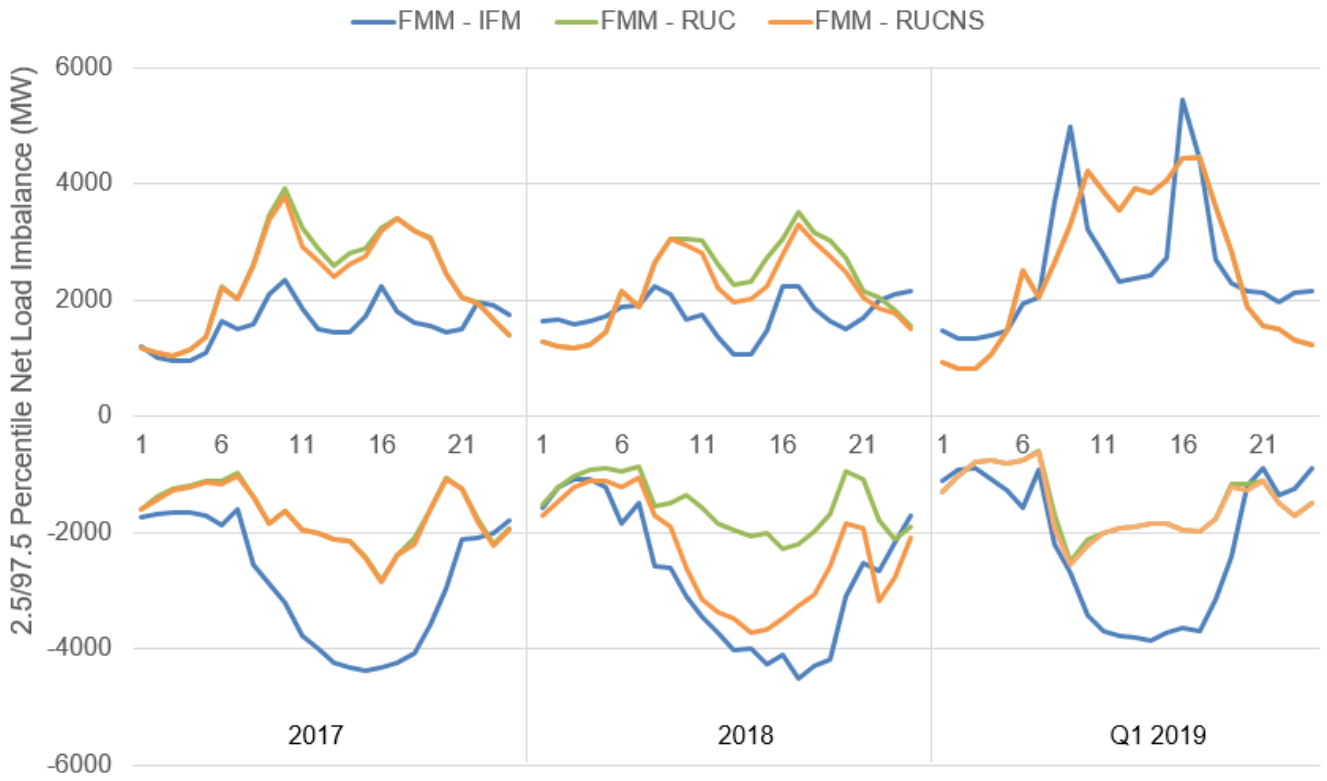
Pricing differences across markets indicate enhancements to the day-ahead market are needed

Pricing differences across markets from 2017 – Q1 2019



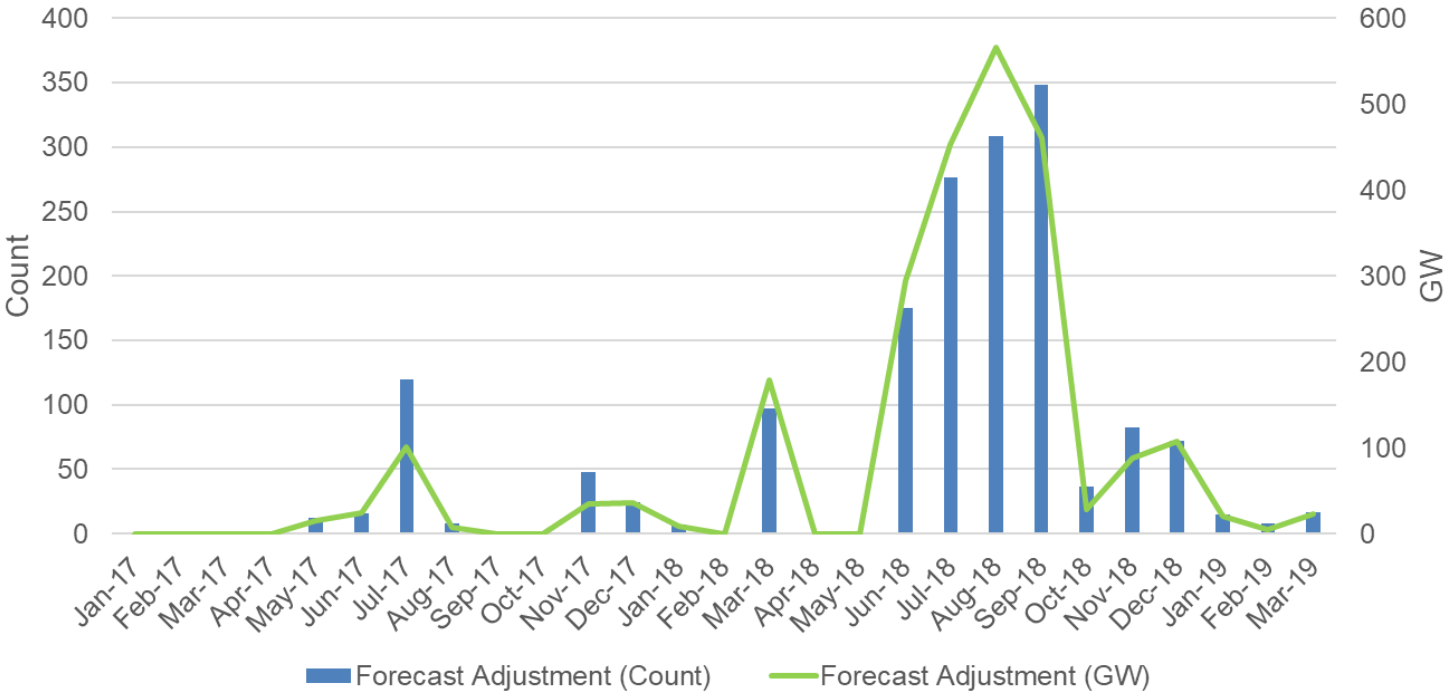
Upward and downward net load imbalances vary significantly

Historical net load imbalance 2017 – Q1 2019

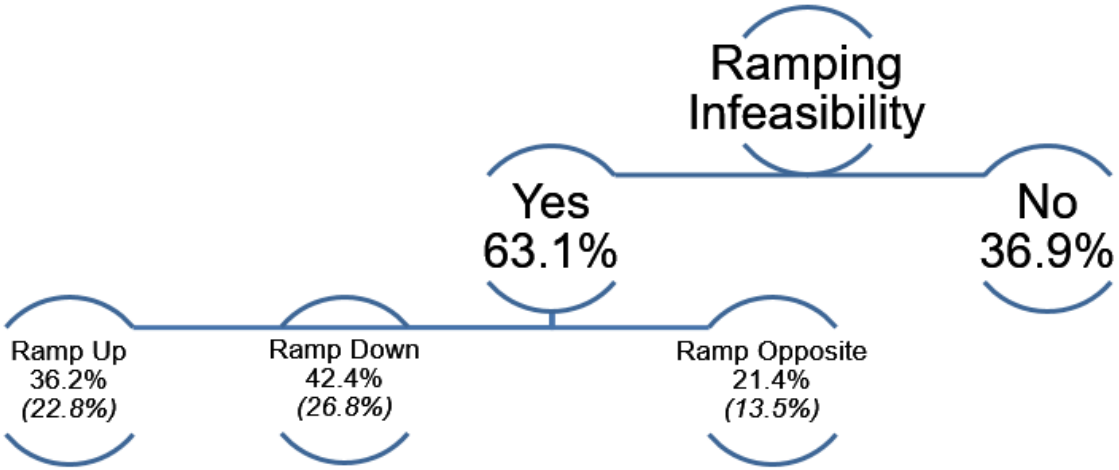


Operators are currently required to take out-of-market actions and complete adjustments to address imbalance

Operator forecast adjustments (in RUC) from 2017 – Q1 2019



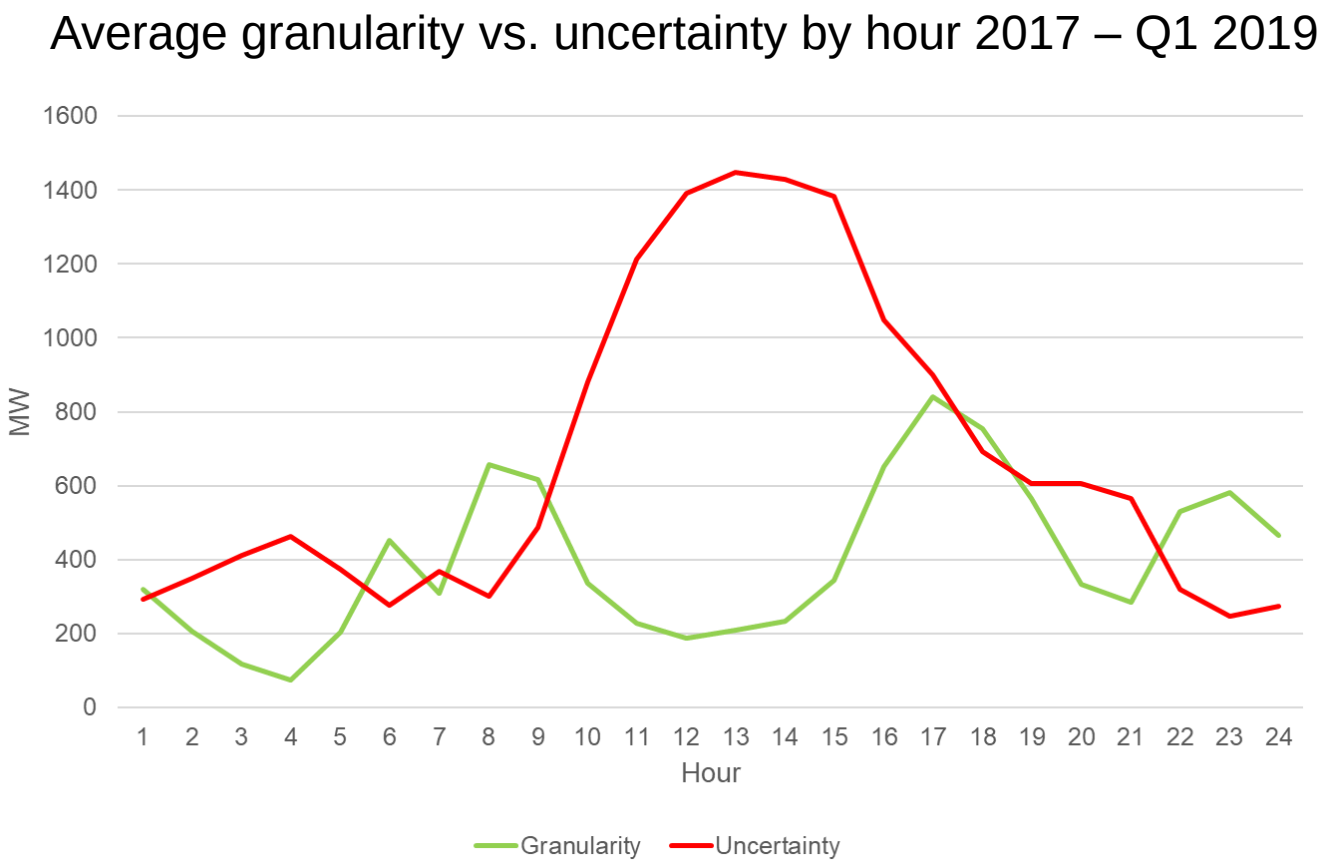
Hourly scheduling granularity results in “infeasibilities” between fifteen-minute intervals



Percentile	Ramp Up (MW/min)	Ramp Down (MW/min)	Ramp Opposite (MW/min)
99%	59.9	-60.3	54.6
95%	40.7	-39.6	34.0
90%	32.2	-30.6	25.4
75%	20.3	-18.7	14.2
50%	10.6	-9.5	2.8
25%	4.6	-4.0	-15.1
10%	1.8	-1.5	-28.9
5%	0.9	-0.7	-38.3
1%	0.2	-0.2	-57.2

When a day-ahead ramp infeasibility occurs, the real-time market must re-dispatch energy and/or capacity to ensure fifteen-minute schedule is ramp-feasible from one interval to the next

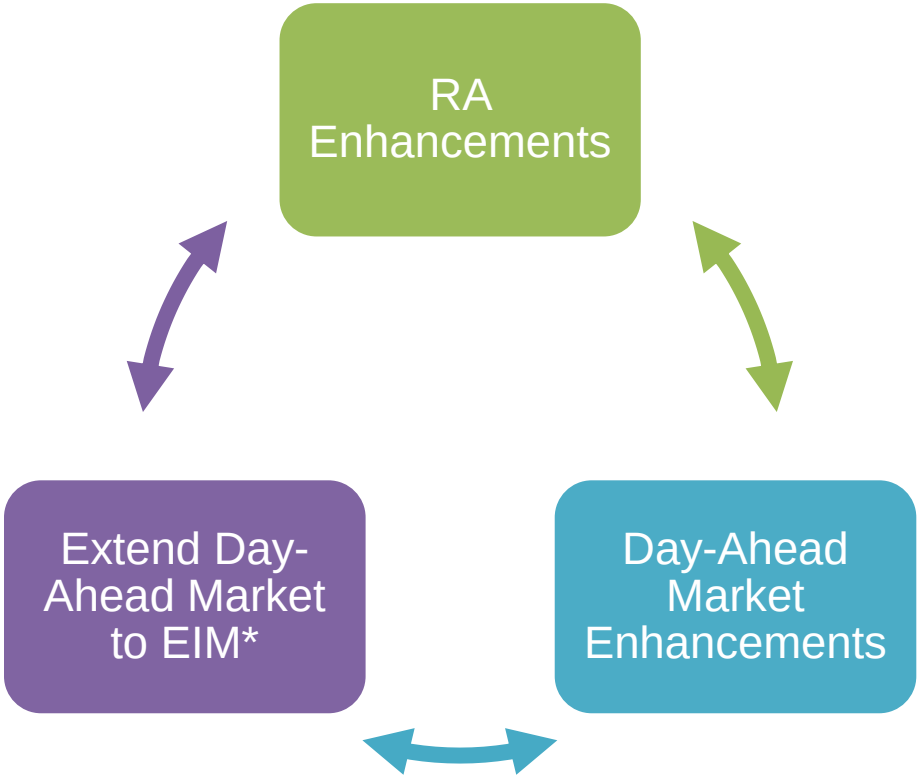
Imbalances categorized by granularity differences and net load uncertainty



Day-Ahead Market Enhancements

APPENDIX: RA ENHANCEMENTS, DAME, EDAM ALIGNMENT

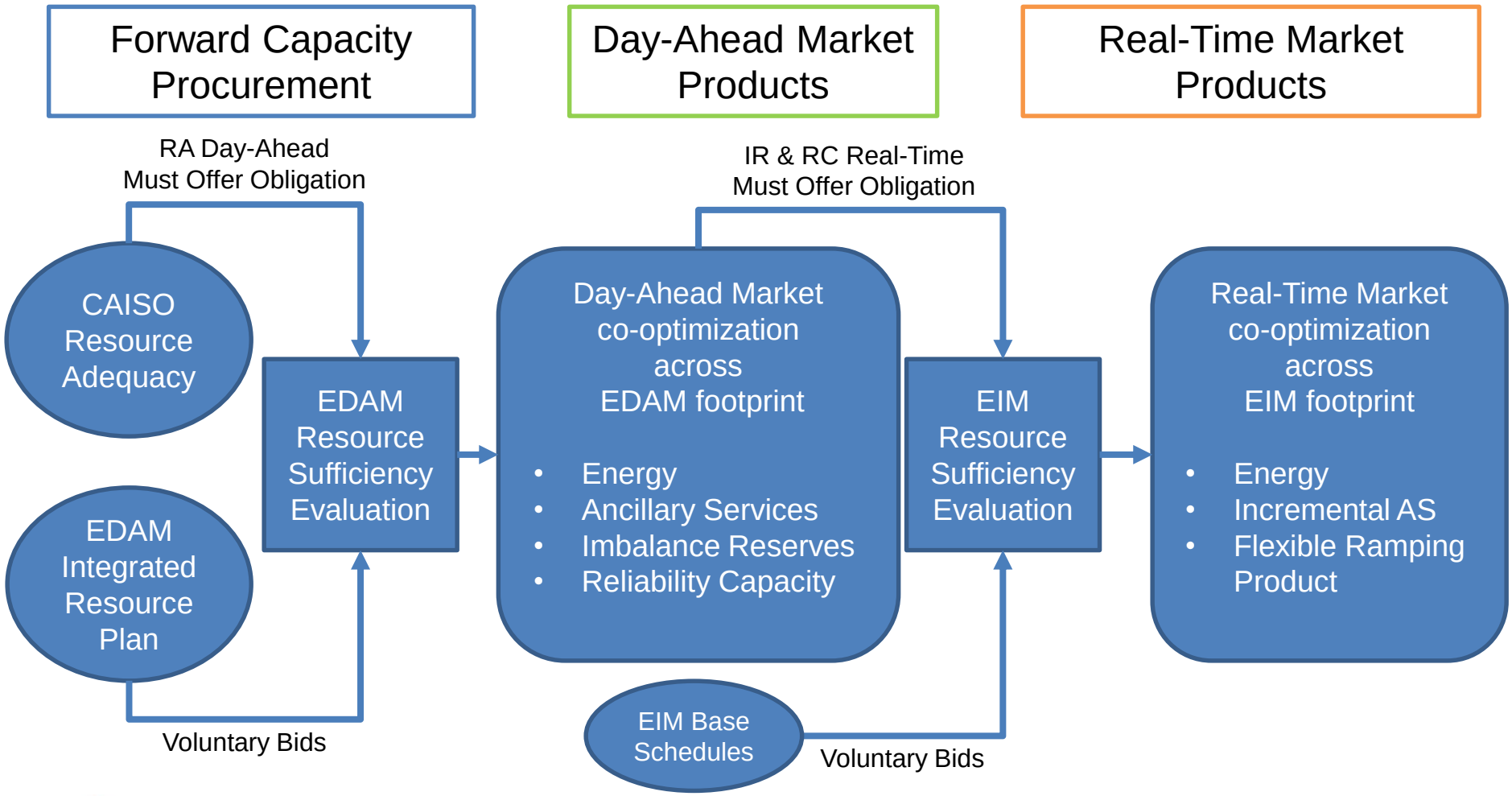
The CAISO will be implementing RA Enhancements, DAME, and EDAM* simultaneously in Fall 2021



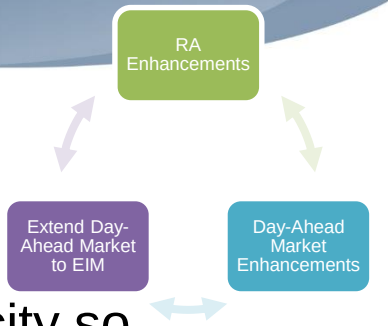
Need to consider interactions between initiatives during policy development

* Commencing initiative is dependent upon feasibility assessment

Overview of RA, DAME & EDAM relationship with CAISO market runs



Each effort has a specific goal and purpose



Resource Adequacy ensures forward procurement of capacity so adequate supply is available and bid in to meet CAISO's load and reliability requirements

- **RA Enhancements** will align the RA requirements with the transforming needs of the CAISO grid

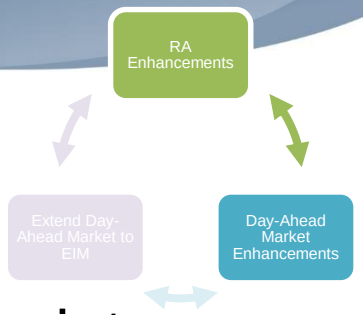
Day-Ahead Market co-optimizes energy and ancillary services to meet daily load and reliability requirements

- **Day-Ahead Market Enhancements** introduces imbalance reserves to meet ramping and uncertainty needs between the day-ahead and real-time markets and appropriately compensate resources to be available for real-time dispatch

Regional Markets allow multiple entities to share resources across a larger footprint to capture diversity and efficiency benefits

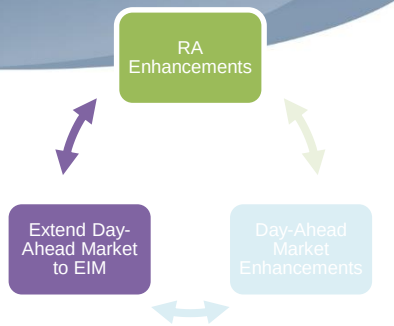
- **Extend Day-Ahead Market to EIM**, if commenced, will develop provisions to allow participation in the day-ahead market by EIM entities, e.g. recognizing different planning and procurement paradigms

RA Enhancements & DAME relationship



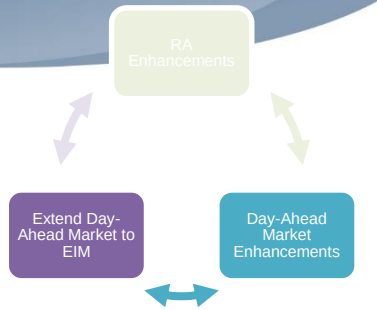
- RA establishes requirement to bid/self-schedule into the day-ahead market
- DAME proposes to introduce a real-time must offer obligation for awarded imbalance reserves
  - Imbalance reserves will replace the need for a resource adequacy real-time market must offer obligation
- Imbalance reserves will cover the incremental cost of making capacity available between the day-ahead and real-time market that is currently embedded in RA contracts

RA Enhancements & EDAM relationship



- Need to avoid double counting of resources in the resource sufficiency evaluation and in RA procurement
- RUC availability bids will be replaced with biddable imbalance reserves
- RA resources will not be required to provide imbalance reserve bids at $0 (as is done today for RUC) to enable efficient scheduling of capacity resources across the footprint

DAME & EDAM relationship



- Benefit of EDAM is to utilize resources in multiple EIM balancing authority areas to more efficiently meet load and operational needs
- Imbalance reserves are necessary to facilitate success of EDAM
  - Need to establish the resource sufficiency evaluation requirements
  - Enables efficient scheduling of energy/AS/imbalance reserves across the footprint
  - Identifies resources that are responsible for the real-time must offer obligation
- Imbalance reserves allow resources in one balancing authority area to be compensated when providing flexibility to another BA