



California ISO Market and EDAM Overview

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Course overview

Agenda

- ISO Market Operation
 - Day-Ahead and Real-Time
- Market Pricing
- Supplier Bidding Examples
- Overview of Upcoming Market Changes
 - EDAM
 - DAME

Materials

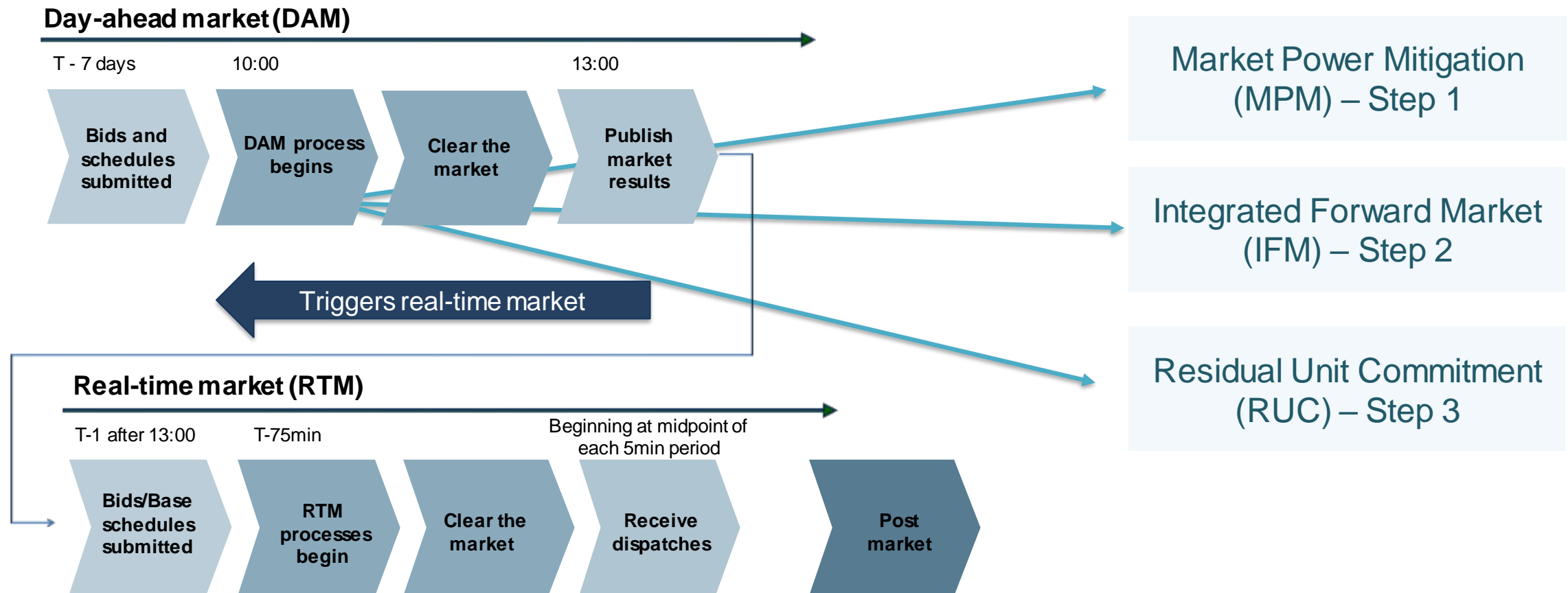
- Course Slides
- Reference material (via email)



ISO Market Operation

Day-Ahead Market Processes

Today's ISO market operates in a day-ahead and real-time scope



How does the Market decide which resources to commit?



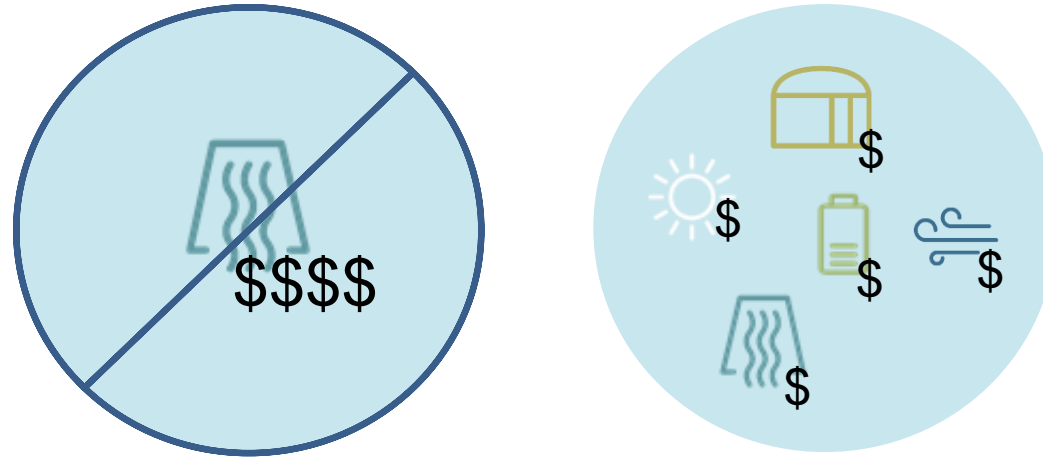
Three-part energy bid includes:

- Start-up cost (one time)
- Minimum load cost (hourly)
- Energy bid curve above minimum load (\$/MWh)

**Security Constrained
Unit Commitment**

Market power mitigation (MPM)

- Ensures units cannot exercise market power by nature of where they reside



- NOTHING is scheduled or dispatched as a result of this process
- May result in mitigated bids based on predetermined calculations

DAM Processes Step 1

What do we do if Market power is determined?

ISO replaces bid with the higher of their default energy bid or the competitive LMP for generating resources and participating loads

ISO Tariff
Section
39.7.1

Calculation of
default energy bid

- Variable Cost Option | LMP Option
- Negotiated Rate Option | Variable Cost Option + Bid Adder
- Temporary Default Energy Bid | DEB for RMR
- Hydro DEB | Storage Resource Option

DAM Processes Step 1

Elements of the ISO's **day-ahead market** - Integrated forward market (IFM)

Clears bid-in supply against bid-in demand

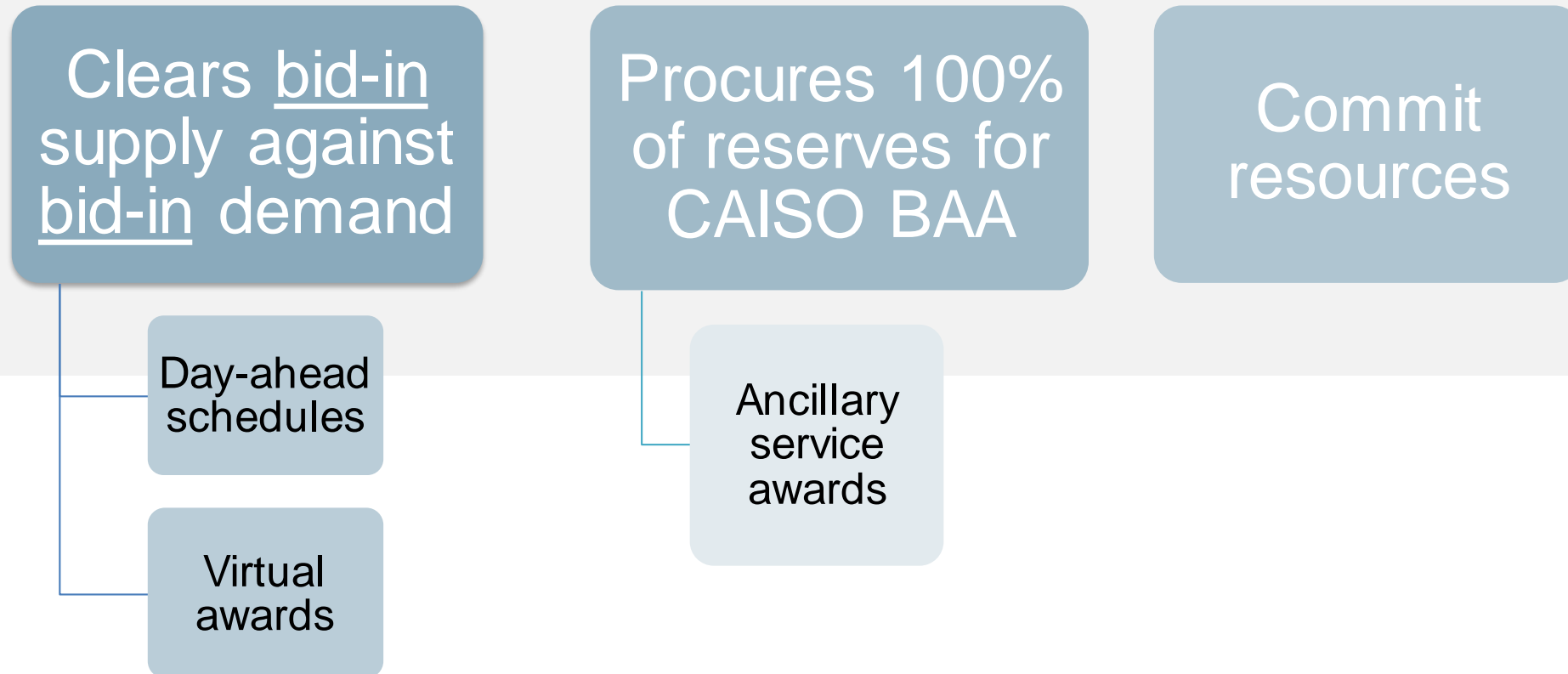
- As a result, sufficient capacity may not be committed to meet forecast demand
- More on this during Step 3 (RUC)

Day-ahead
schedules

Virtual
awards

DAM Processes Step 2

Integrated forward market (IFM)

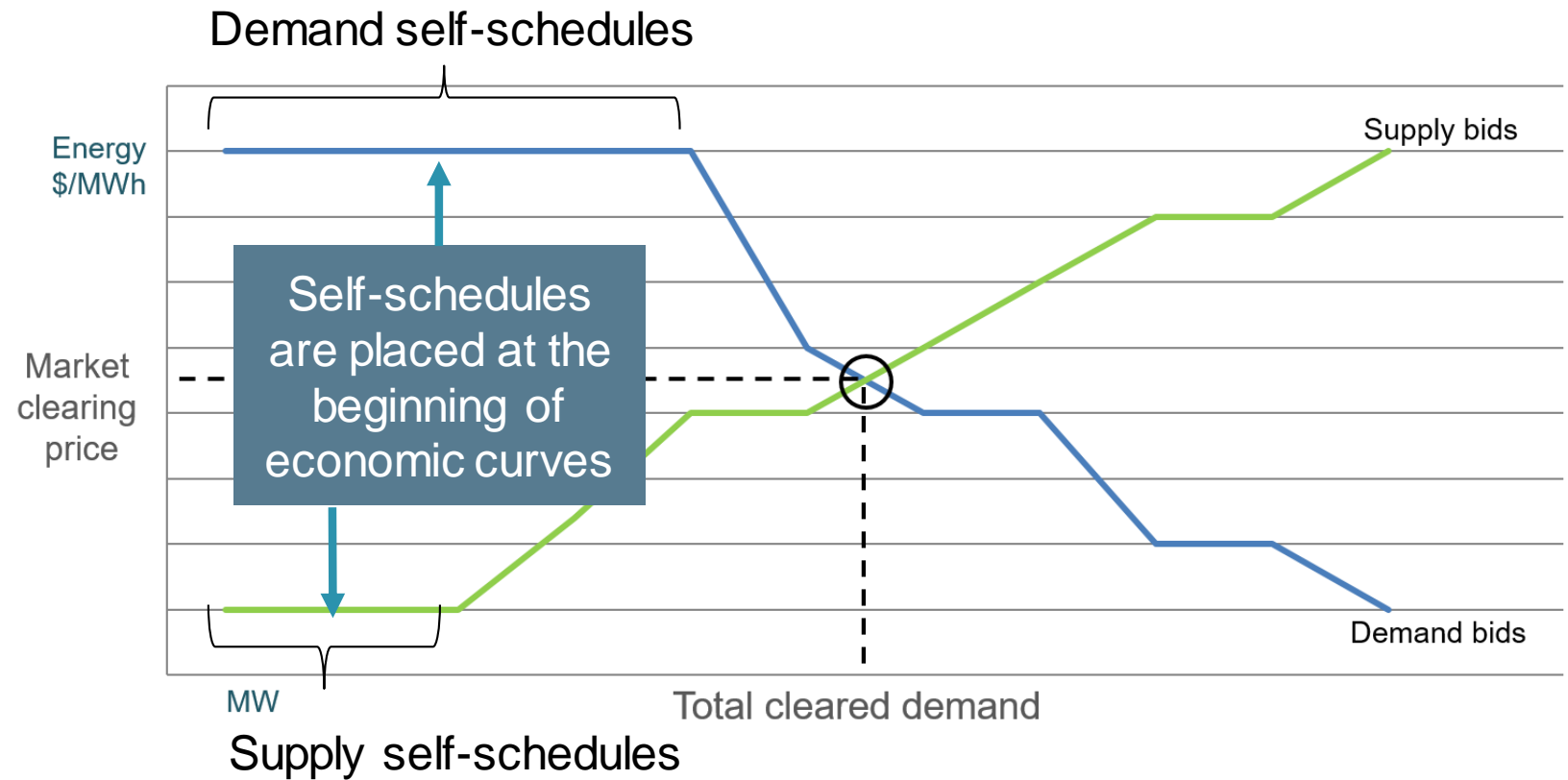


DAM Processes Step 2

What clears in the IFM?

Day-ahead supply bids clear against demand bids

Real-time supply clears against ISO load forecast



DAM Processes Step 2

Residual unit commitment (RUC)

Reliability

Ensures grid reliability

Resource Sufficiency

Selects from resource adequacy and other capacity bids

Capacity Procurement

Capacity procurement from additional Day-Ahead supply for Real-Time

Real-Time Energy Market

Awarded resources must submit an energy bid in the Real-Time Markets

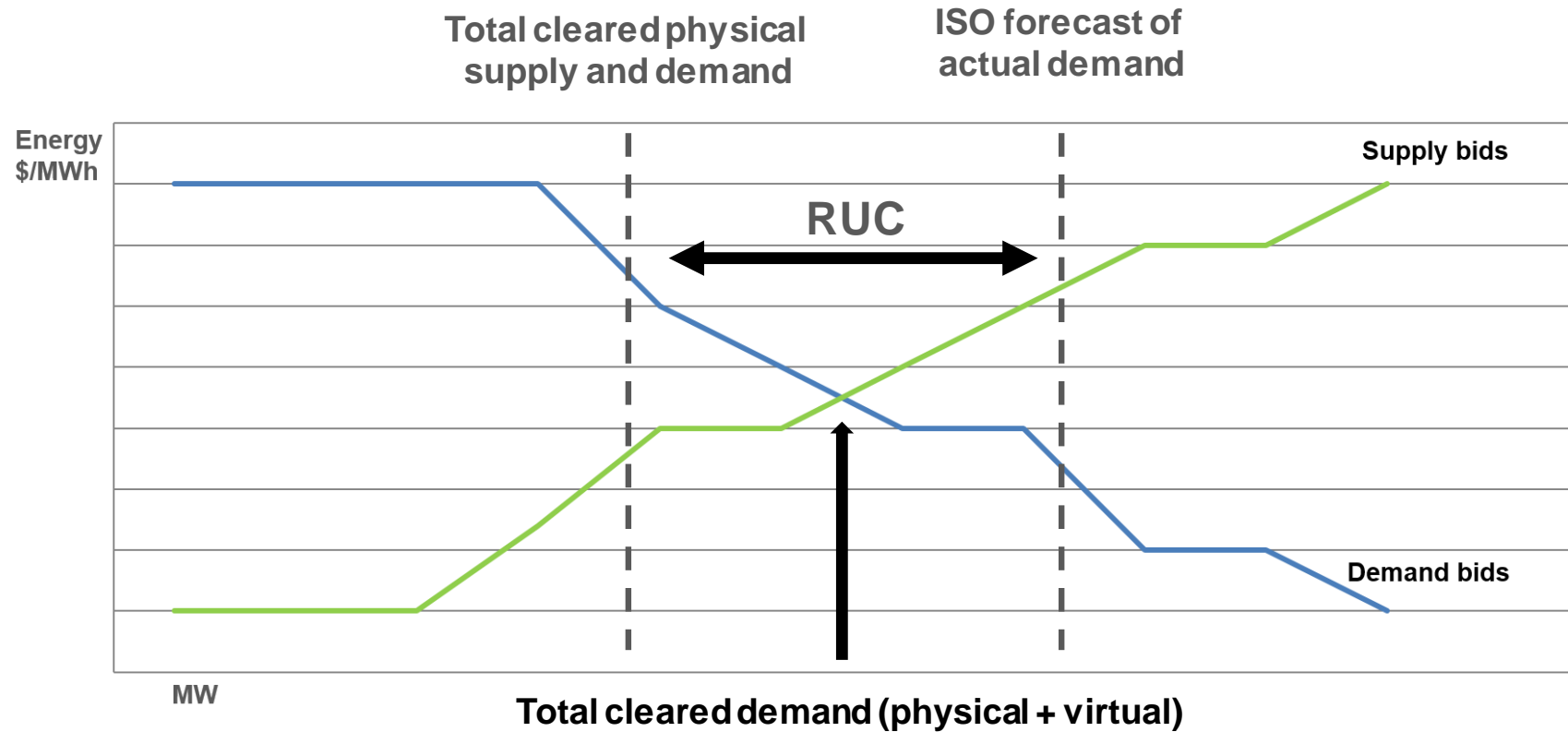
DAM Processes Step 3

Residual unit commitment (RUC)

- Uses the same SCUC optimization as IFM
- Set up to meet high confidence demand forecast
- Removes virtual supply & demand bids from calculation
- Introduces ISO forecast for variable energy resources

How does RUC work?

Ensures sufficient capacity is available to meet **forecast demand** that was not committed in IFM



DAM Processes Step 3

RUC looks out further than the next trade date

- Extremely long-start commitment (ELC) process applies to:
- Resources with start times >18 hours
- Contractual intertie resources that must receive commitment instructions by 0600 hours one day ahead
- Commitments are generated by RUC or manually notified by the ISO operator and the process considers bids in the Day-Ahead Market up to two days out





ISO Market Operation

Real-Time Market Processes

Elements of the ISO's real-time market

Hourly
Resource
Sufficiency
Evaluation

- Larger market footprint that including WEIM participants
- WEIM participation is for energy only and does not include ancillary services
- Load forecasts for each entity drive market awards
- Each entity ensures sufficiency of resources available for their area on an hourly basis



Balancing



Bid Capacity



Flex Ramp



Feasibility

Real-Time Market

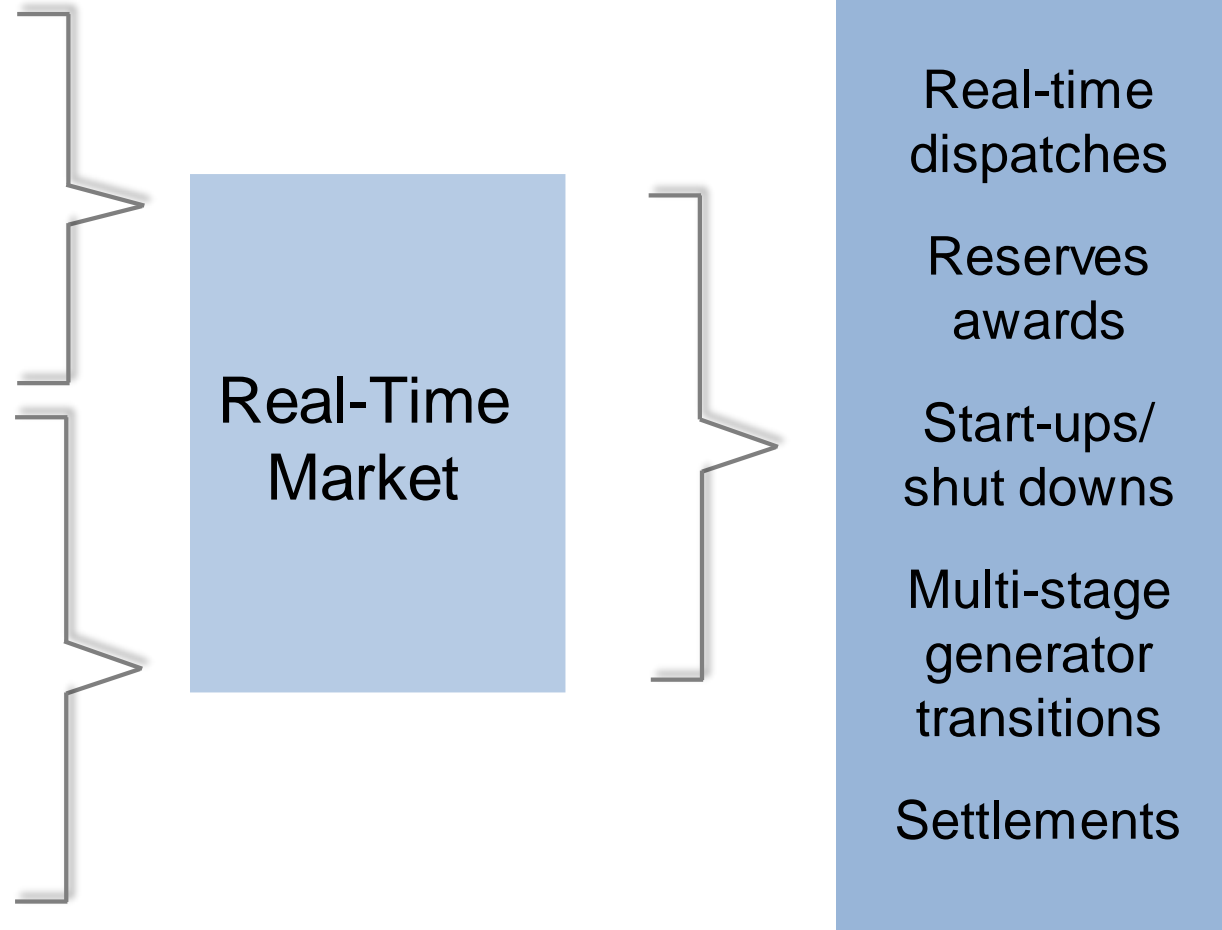
Inputs and outputs of the Real-Time Market

From **Day-Ahead**:

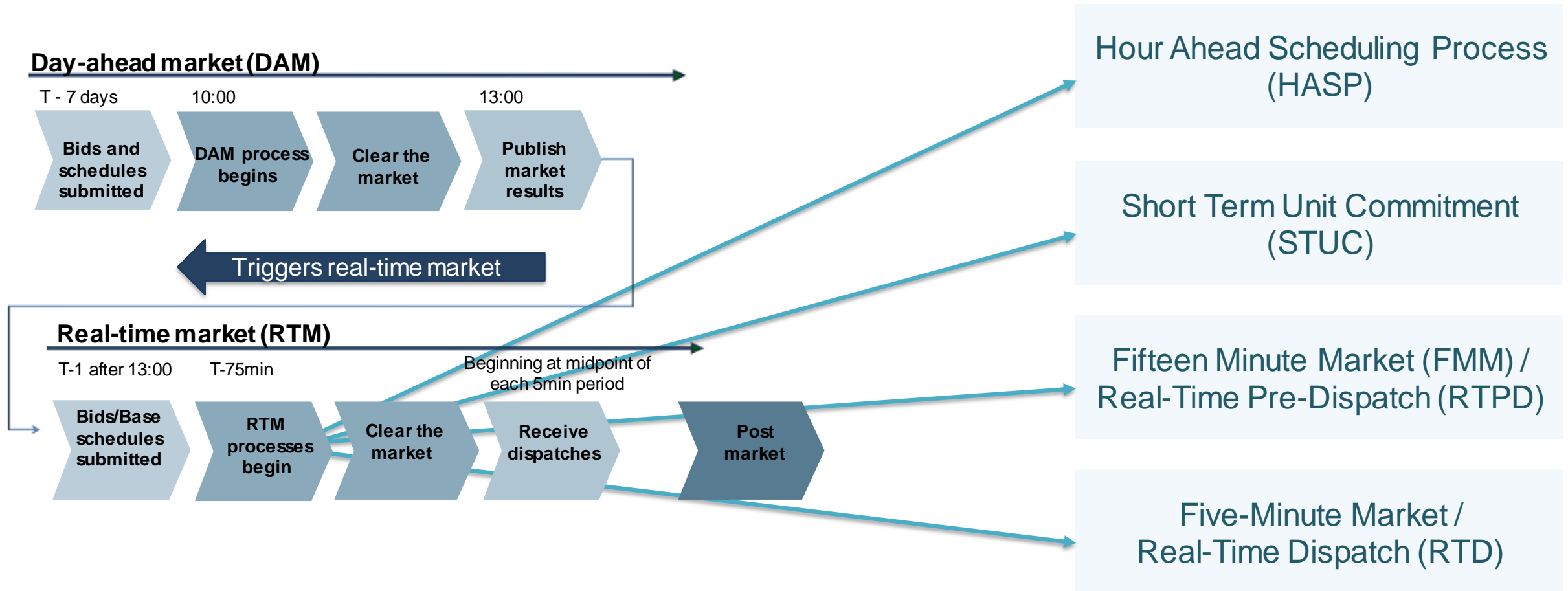
- System info
- Energy schedules
- Reserves awards
- Master file

From **Real-Time**:

- State estimator
- Supplemental energy & ancillary service bids
- Base schedules
- Outages
- Transmission limits



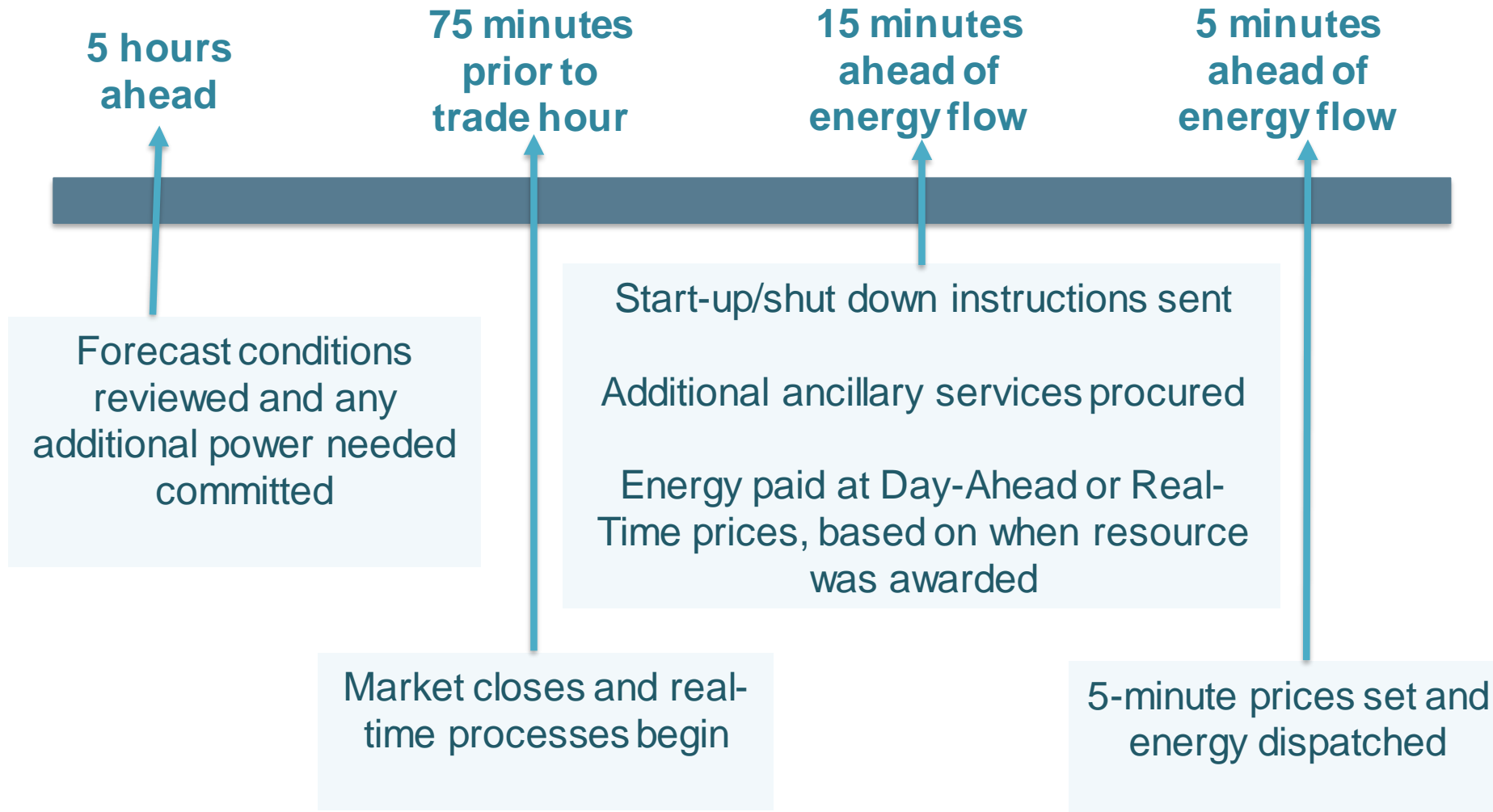
Market process timelines: Real-Time



Market process timelines: Real-Time

<p>Hour Ahead Scheduling Process (HASP)</p>	<ul style="list-style-type: none">• Produces HASP advisory schedules and advisory AS awards• Binding HASP intertie schedules with hourly block bids• Advisory schedules for internal resources and intertie resources that do not have hourly block bids/schedules
<p>Short Term Unit Commitment (STUC)</p>	<ul style="list-style-type: none">• Occurs once per trade hour• Examines the potential demand requirements for the next 4 ½ trade hours• Issues start up/shut down instructions to short start resources to meet anticipated demand
<p>Fifteen Minute Market (FMM) / Real-Time Pre-Dispatch (RTPD)</p>	<ul style="list-style-type: none">• Issues start-up/shut down instructions to short and fast start units, and transition instructions to multi-stage generators• Procures ancillary services as needed• Provides advisory instructions for as many as 7 future 15-min intervals
<p>Five-Minute Market / Real-Time Dispatch (RTD)</p>	<ul style="list-style-type: none">• Occurs every five minutes to meet energy imbalances• Resources dispatched in real-time• Provides advisory dispatch instructions for as many as 12 future dispatch intervals

Real-time milestones



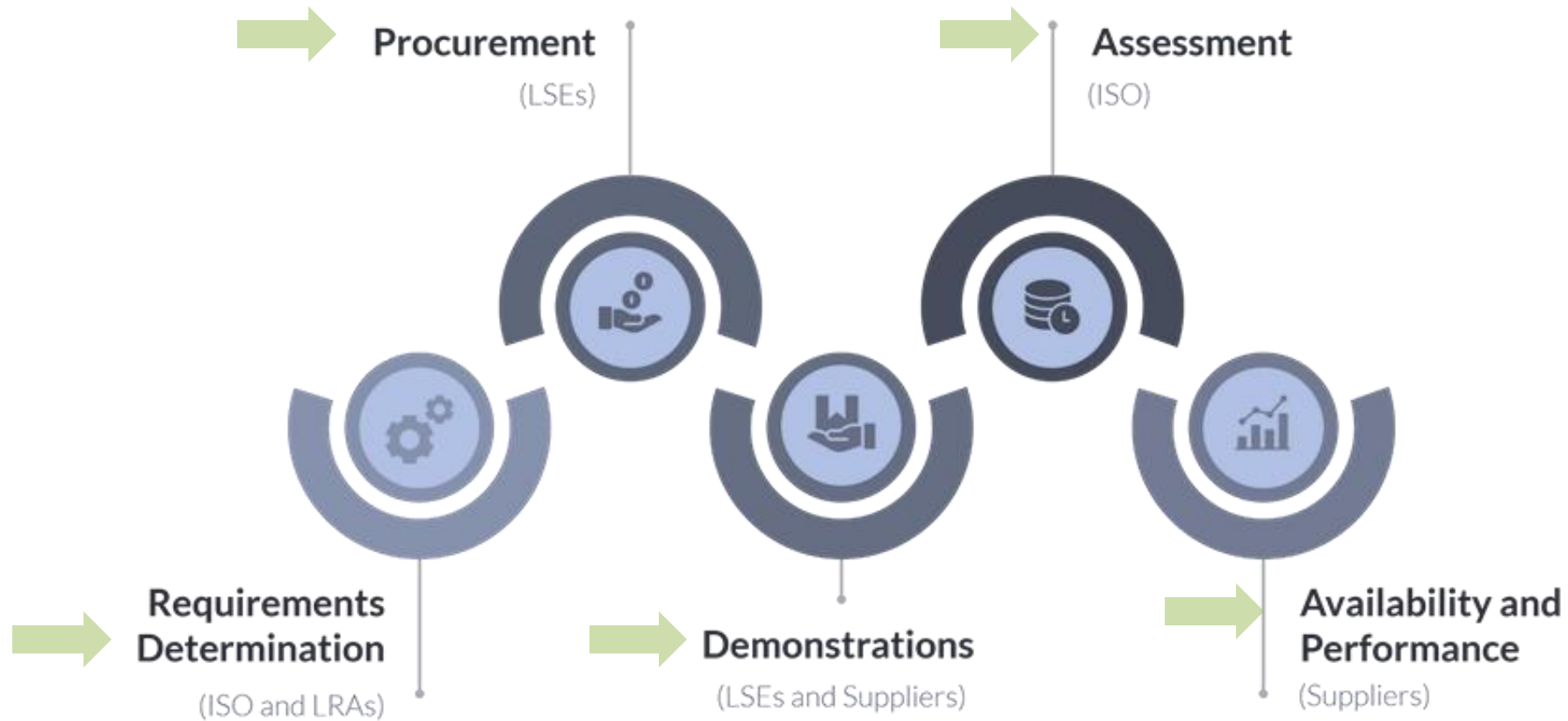


ISO Market Operation

Resource Adequacy (RA) / Forward Contracting

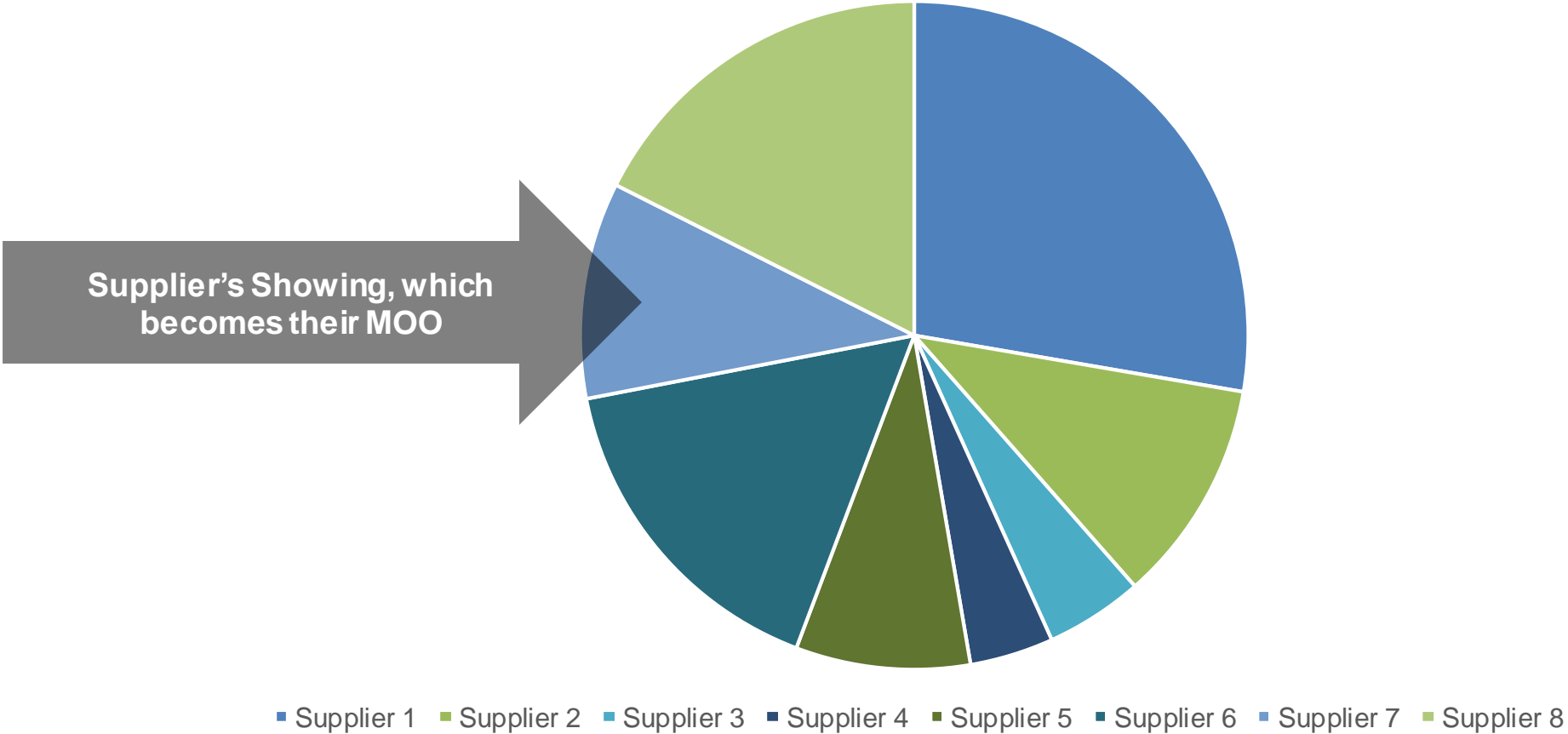
Resource Adequacy

Purpose: Forward planning and procurement process to ensure sufficient capacity is made available to energy Markets in the right places and at the right times



Load Serving Entity's RA Obligation vs. Supplier's RA Showing

LSE's RA Obligation





Pricing and Bidding

Locational Marginal Pricing, Scarcity Pricing & Transmission Constraints

What does the Tariff say?

ISO Tariff
Appendix A

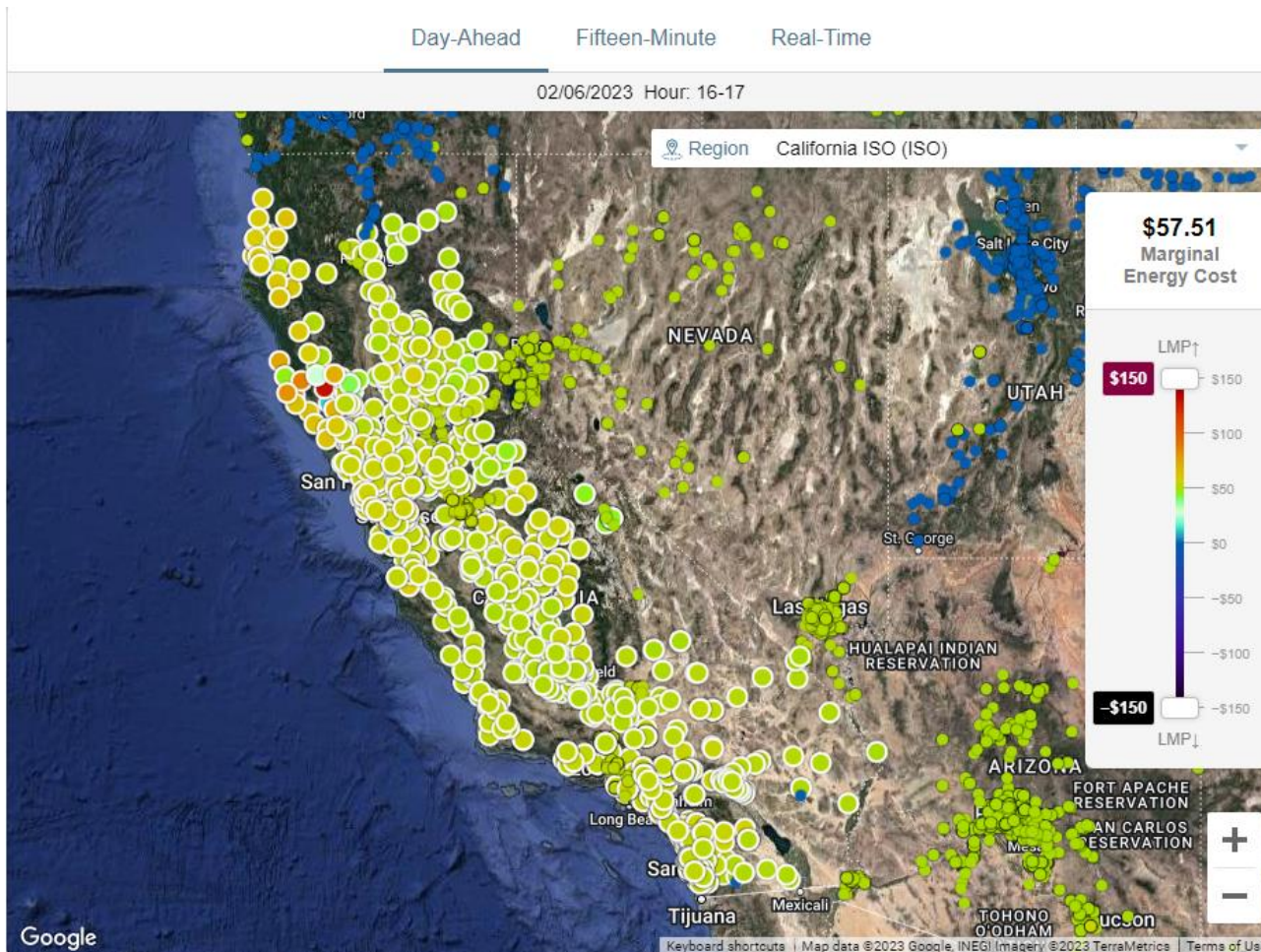
California Independent System Operator Corporation
Fifth Replacement Tariff

Locational Marginal Price (LMP)

The marginal cost (\$/MWh) of serving the next increment of Demand at that PNode consistent with existing Transmission Constraints and the performance characteristics of resources.

ith

There are thousands of price nodes throughout the system



SUPPLY RESOURCES

Price calculated based on their location on the system

DEMAND

Generally charged at a price associated with a load aggregation point (LAP), an average of the demand node prices within specific zones

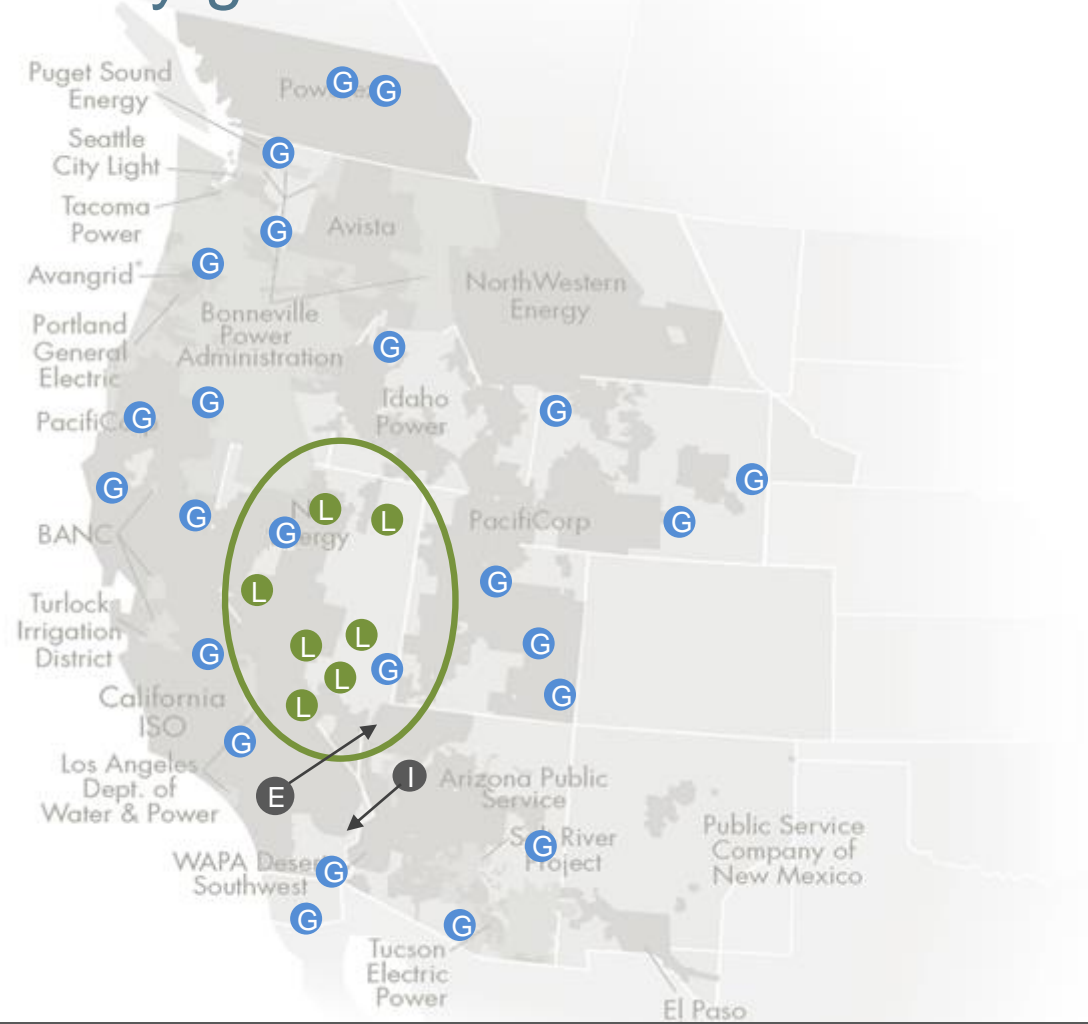
ISO Price Map on Today's Outlook

Nodal pricing is the price paid for electricity generated or consumed at a specific location

Resources are paid the nodal price

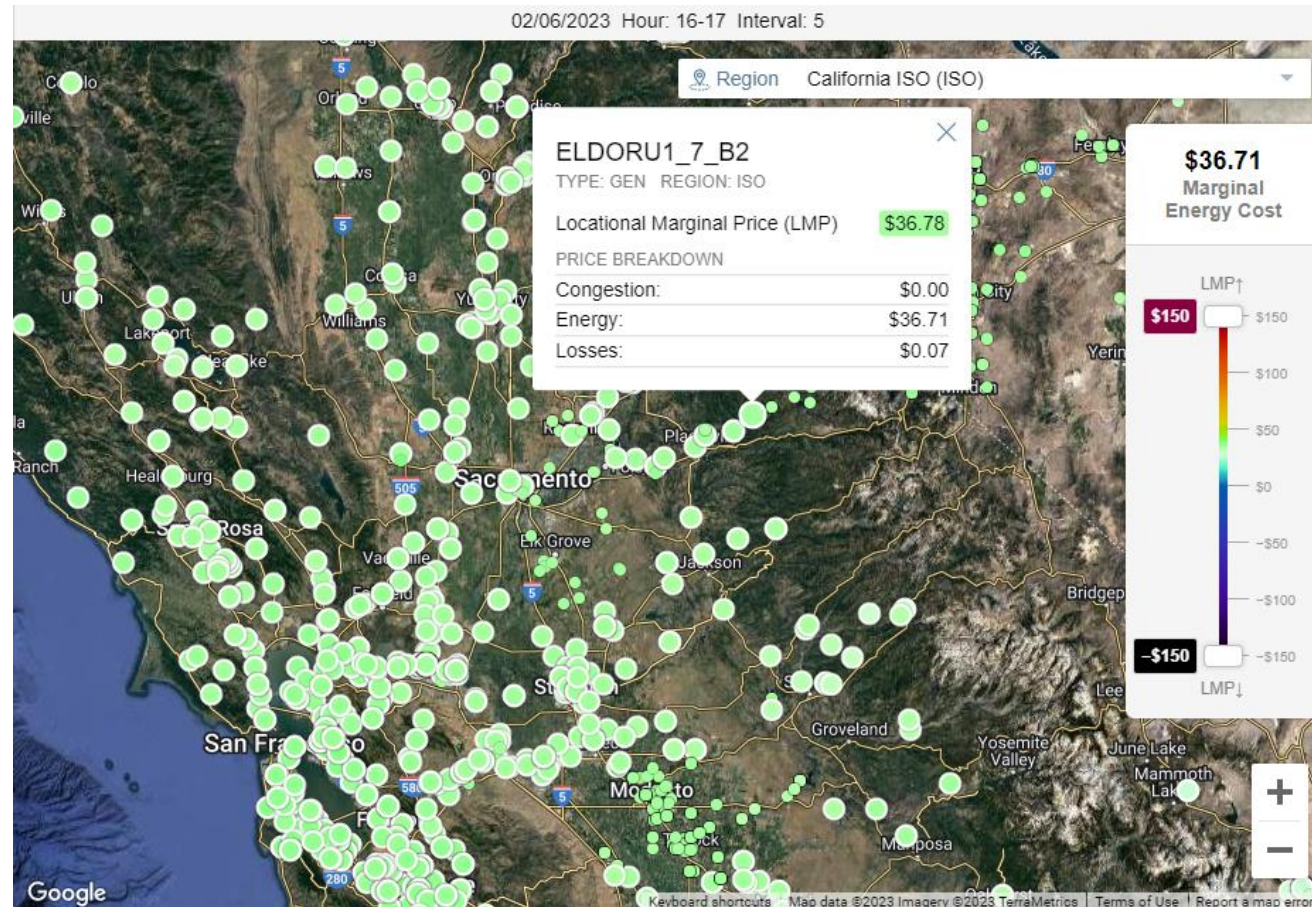
Load pays the weighted average price of all load nodes in the service territory

Imports and exports are paid, or pay, the price at the scheduling point



Components of the locational marginal price

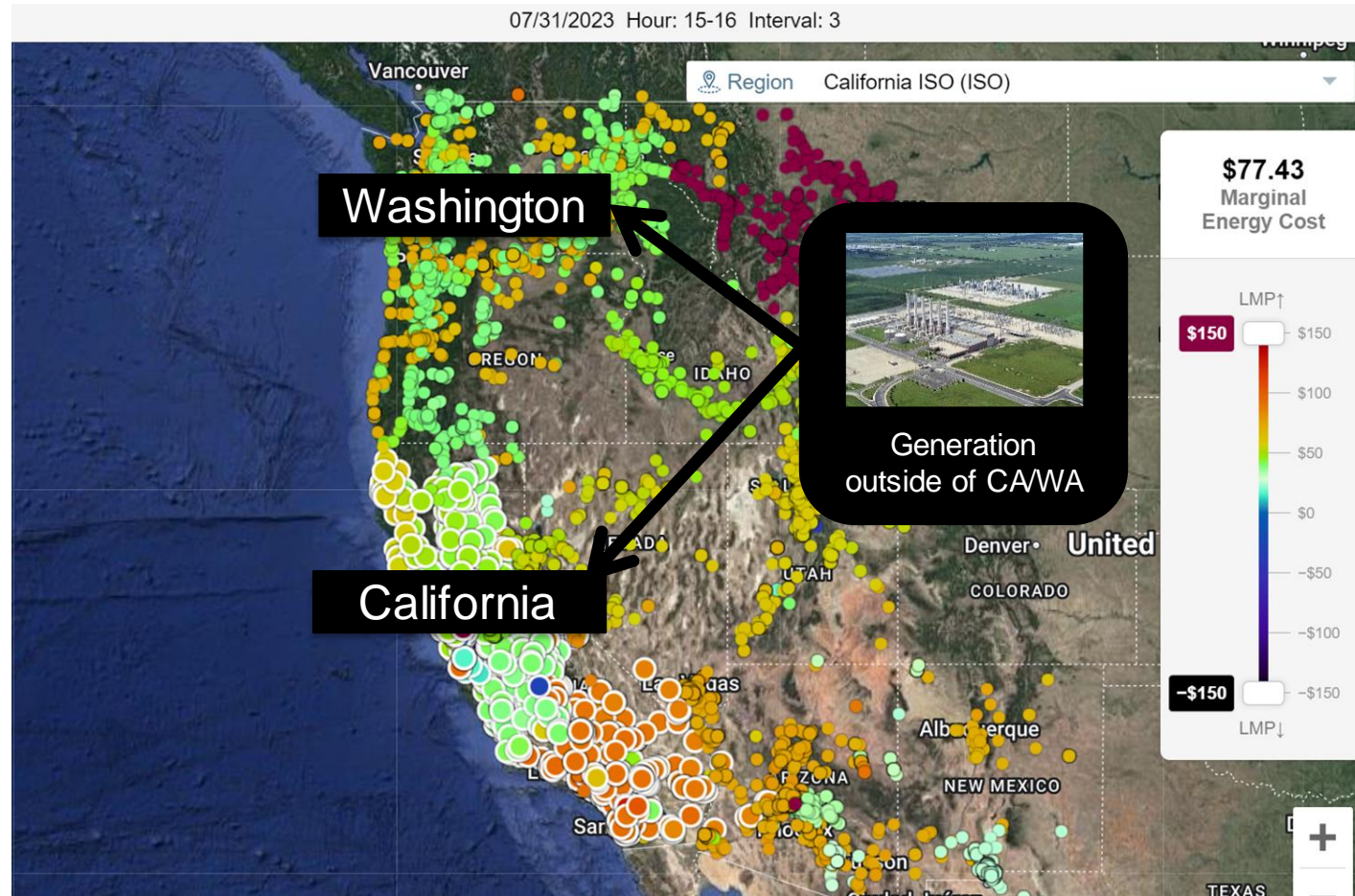
$$\frac{\text{Energy} + \text{Congestion} + \text{Losses}}{\text{LMP}}$$



LMP with Greenhouse Gas

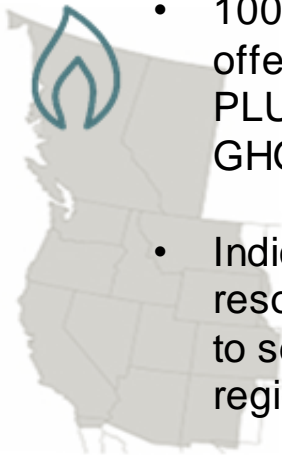
Energy
Congestion
Losses
+GHG

LMP



WEIM's approach for GHG emissions accounting is a voluntary, resource-specific framework

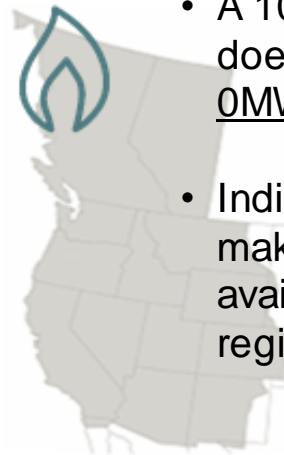
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- 100 MW gas unit offers a 50 MW bid PLUS \$15/MWh GHG bid adder
- Indicates half of its resource is available to serve to a GHG region

Example 1

Gas partial unit available w/GHG bid adder



- A 100 MW gas unit does not bid or bids 0MW
- Indicates they are not making that resource available to a GHG region

Example 2

Gas w/NO GHG bid adder



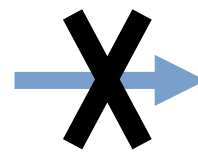
- A 100 MW wind resource bids 100 MW at \$0/MWh GHG bid adder
- Indicates they are making the whole resource available to a GHG region but do not face a GHG cost of compliance

Example 3

Clean resource with \$0 GHG bid adder

Scarcity pricing intends to reward available suppliers during tight system conditions

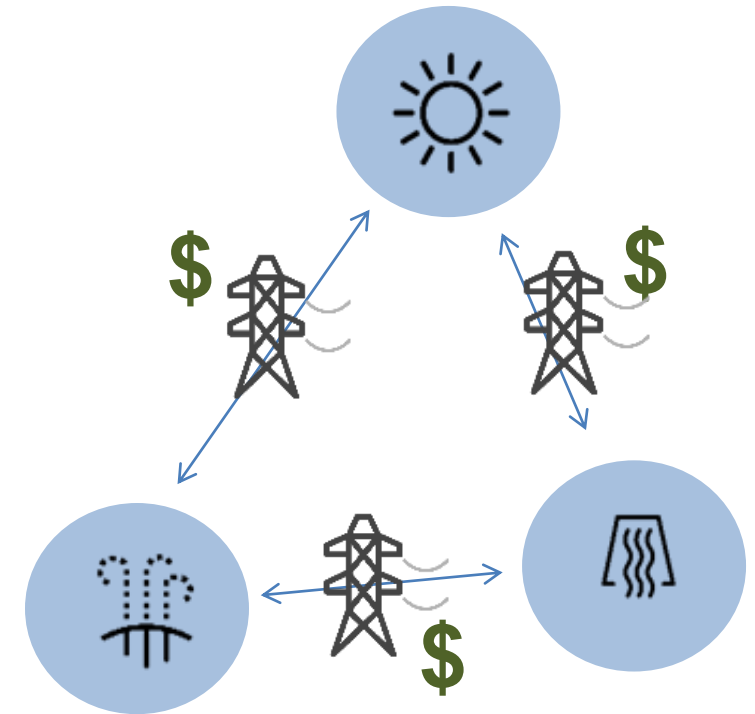
Occurs when the next available MW will not help relieve congested area



How transmission constraints effect pricing

Transmission Constraints

- Pricing mechanism to reduce congestion to avoid overloading a transmission line
 - What is the line rating?
 - What is the cost of the next MW?

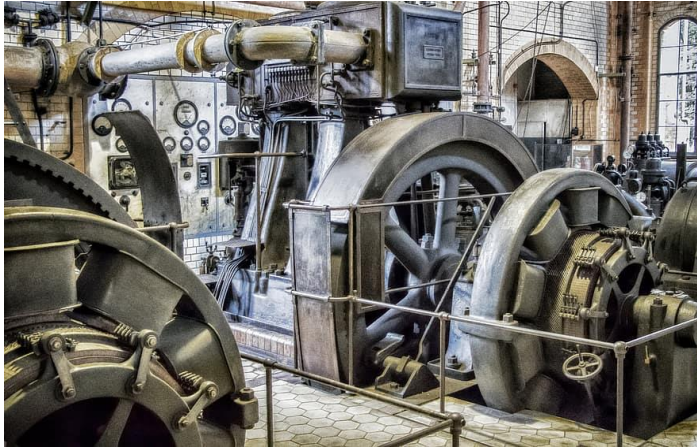




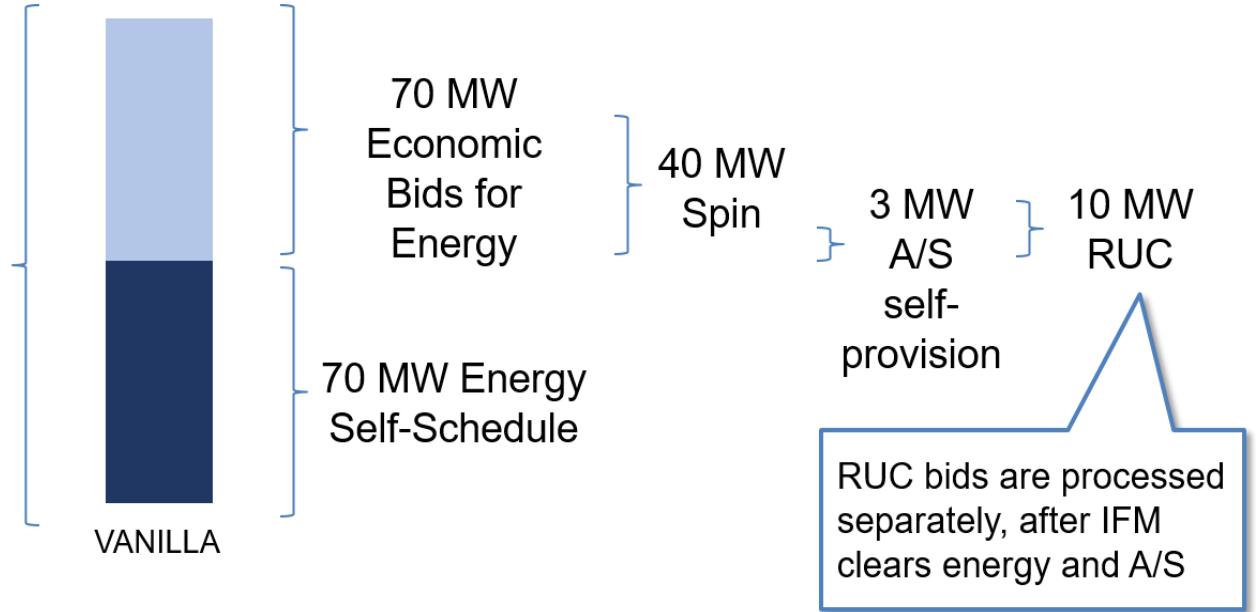
Bidding Examples

- **Conventional Resource**
- **Solar Resource**

Bidding Activity – Day-Ahead: Generator



PMAX = 140 MW
PMIN = 50 MW

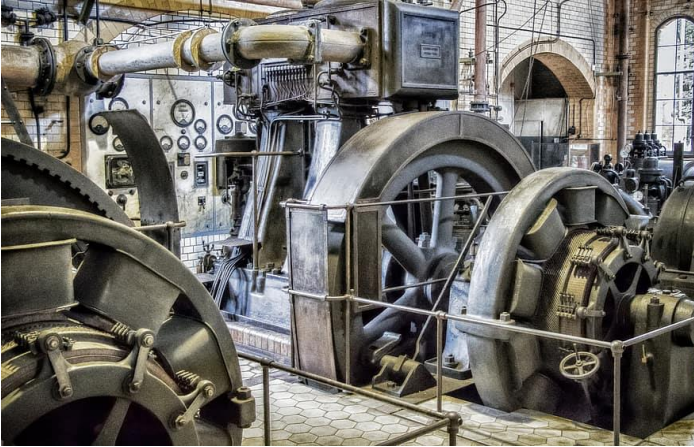


Submits day-ahead supply bids:

- The same MWs are being offered to the Market across a variety of products
- The Market co-optimizes the offers for **energy** and **ancillary services** along with those from all of the other resources to determine the optimal solution across the entire day

Bidding Activity – Real-Time: Generator Potential Market Outcome

S
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Submits supply bids:

- 80 MW self-schedule
- 53 MW Economic bids for energy

Trade Date	Resource	Product	Schedule type	HE11 [MW]
04/01/2023	VANILLA	A/S Spinning	Cleared	43.00
04/01/2023	VANILLA	A/S Spinning	Market	40.00
04/01/2023	VANILLA	A/S Spinning	Self	3.00
04/01/2023	VANILLA	Energy	Cleared	80.00
04/01/2023	VANILLA	Energy	Market	10.00
04/01/2023	VANILLA	Energy	Self	70.00
04/01/2023	VANILLA	RUC Capacity	Market	10.00

Day-Ahead Awards

Submit Real-Time energy bid to cover these awards

By doing nothing, this becomes a self-schedule in Real-Time

Submit Real-Time energy bid for this award

Treatment of variable energy resource (VER) forecasts in Day-Ahead vs. Real-Time

Day-Ahead

- The forecast is advisory and the Market doesn't consider the forecast when awarding/ optimizing

Real-Time

- For **self-schedules**, the Market defaults to the forecast amount
- For **economic bids**, the Market will cap or extend the awarded MWs to the forecasted amount, or to the MW amount that respects the bid curve

The Market assumes the economic bid extends to the PMAX of the resource

Supplier: **Real-Time** bidding activity Variable Energy Resource

PMAX = 100 MW
PMIN = 0 MW

SUNNY

70 MW
Self-Schedule

90 MW Forecast

The Market award extends the
Self-Schedule quantity to
match the forecast amount



Upcoming Market Changes

Extended Day-Ahead Market (EDAM)
Day-Ahead Market Enhancements (DAME)

Implementation of an extended day-ahead market



- Day-ahead capabilities extended to WEIM participants
- Multi-month onboarding process for voluntary participation
- Requires completion of an initial agreement followed by an approximately 18 month long onboarding process

Extended Day-Ahead Market (EDAM)

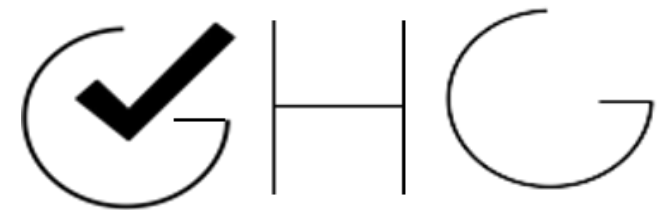
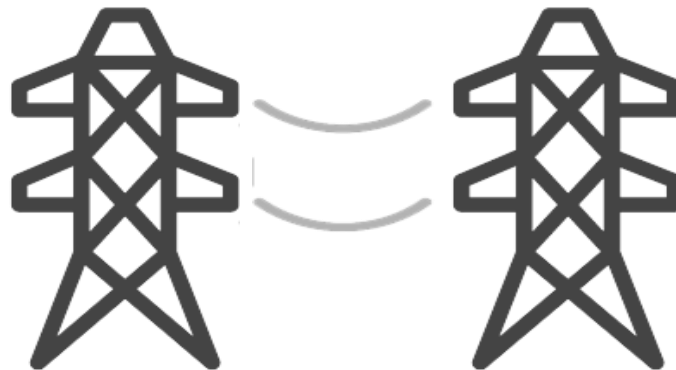
Extension of the ISO day-ahead market across the west



- Builds on WEIM to optimize commitment of generation a day in advance
- Allows for harnessing economic, grid reliability and environmental benefits of a day-ahead market throughout the West
- Participating BAs retain resource planning, transmission planning, and reliability functions

Elements of the EDAM program

- Daily resource sufficiency evaluation (RSE) across full 24-hour time horizon
 - RSE is universal adaptor that connects entities with varying resource adequacy programs to efficiently commit/dispatch resources
- Transmission capability on internal system and interties with other EDAM BAs made available to optimize transfers between participating areas
- Bidding and attribution to multiple state greenhouse gas regulation areas as well as accommodation for non-priced GHG programs





Day-Ahead Market Enhancements

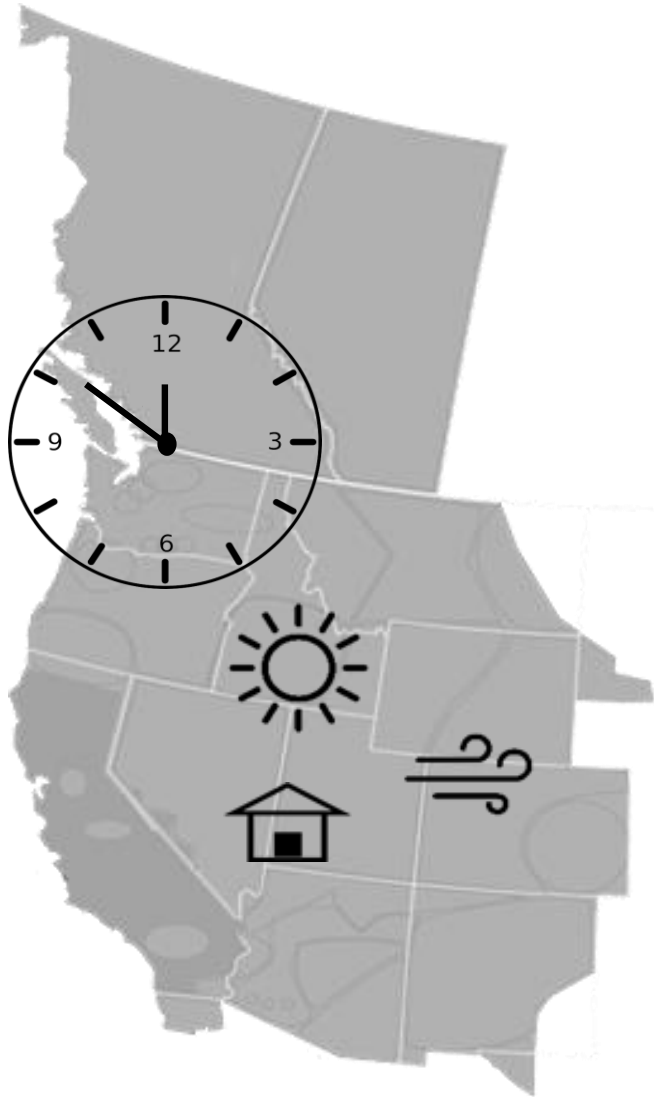
Parallel effort: Day-ahead market enhancements (DAME)

DAME
enhancements
automatically
included in
EDAM
participation

- ISO day-ahead market will undergo a series of enhancements as part of the DAME initiative
- DAME establishes two new market products:
 - Imbalance Reserves
 - Reliability Capacity

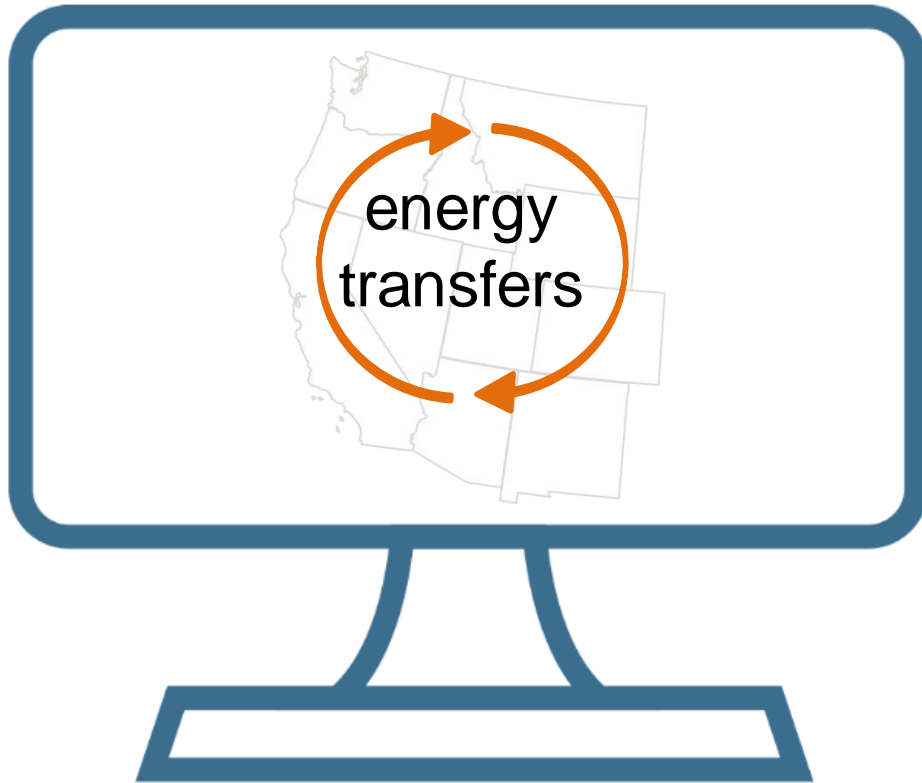
Day-Ahead Market Enhancements (DAME)

New IFM imbalance reserve products



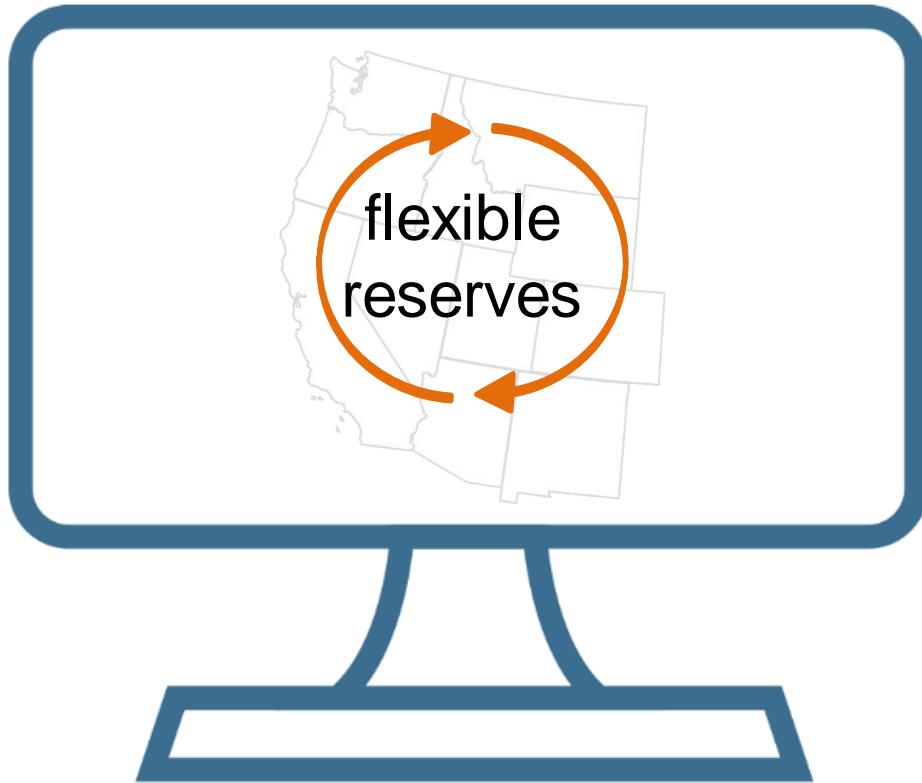
- Hourly procurement of imbalance reserve products (up and down) for each BAA
- Requirements based on tomorrow's forecast as well as historical uncertainty in the day-ahead
- Bids for imbalance reserves will come from participants throughout the market footprint

IFM co-optimization of energy schedules and transfers



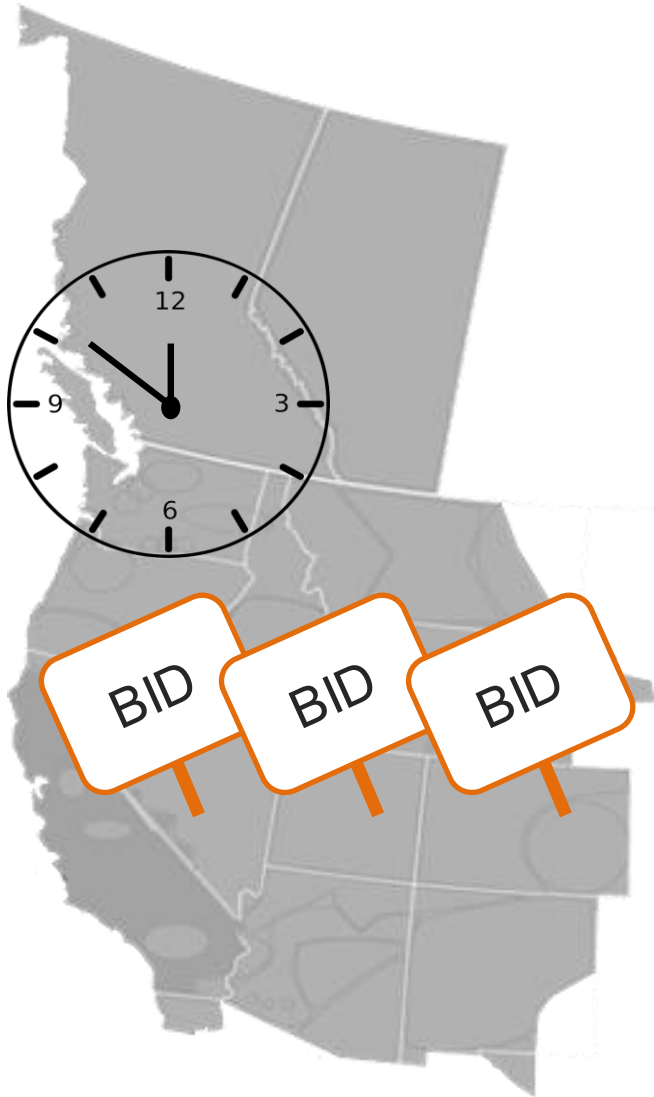
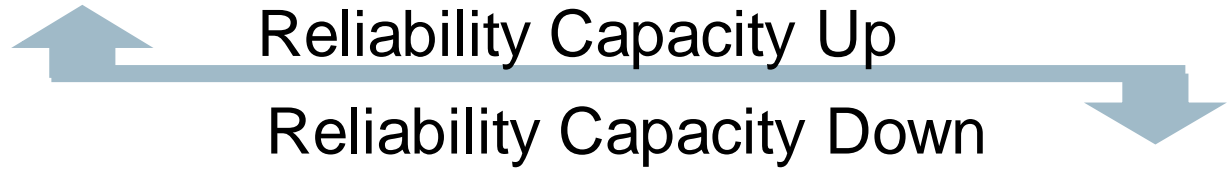
- IFM will manage energy schedules and optimize efficient transfers of energy between BAs
- Imbalance reserves included in co-optimization
 - Reserve resources' flexible ramping capability for real-time dispatch
 - Commit resources needed to provide ramping capability

Imbalance reserves optimize scheduling of flexible reserves across market footprint



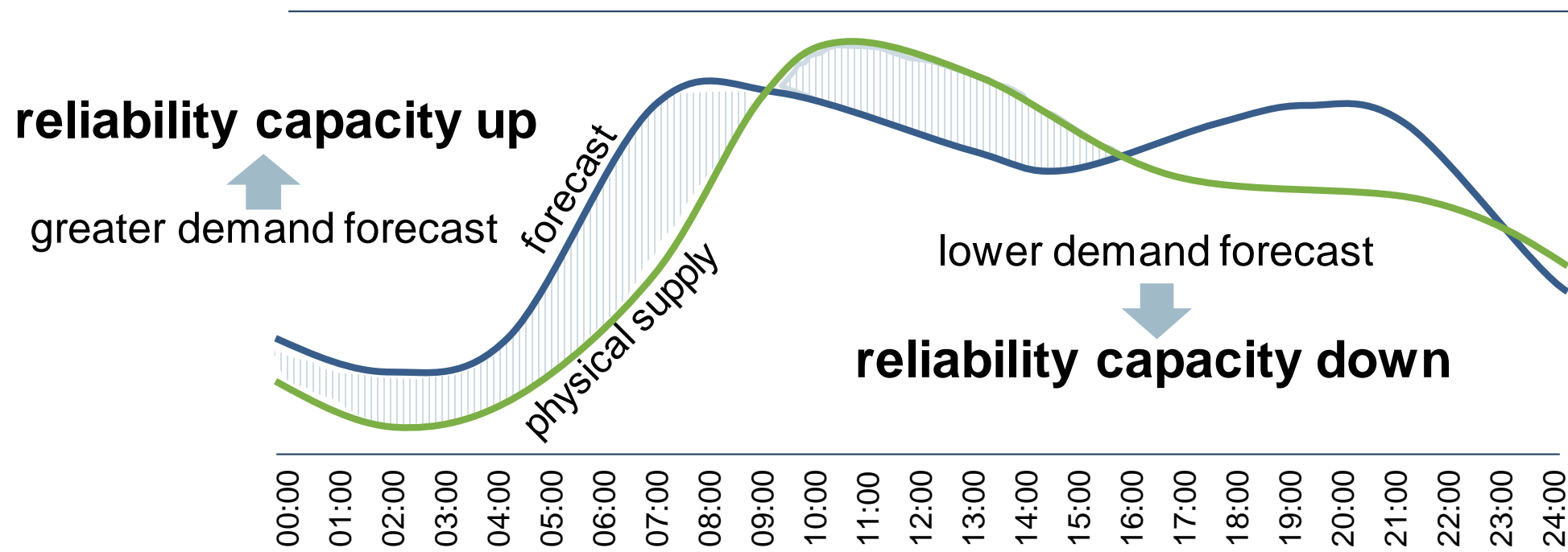
- Meets each participant's net load uncertainty and real-time ramping needs
- Maximizes diversity benefit of large market footprint

New RUC reliability capacity products



- Existing RUC process procures additional capacity to meet forecasted demand
- Reliability capacity provides both upward and downward dispatch capability
- Hourly requirement at the BAA level, awarded at the resource level
- Reliability capacity bids from across the market footprint

RUC compares demand forecast to physical supply that clears IFM



What are some other changes with EDAM?

Changes

- All loads and resources in EDAM area submit offers (economic or self-schedule)
- No more “non-participating” resources
- Settlement of Day-Ahead Market Transactions

Stays the Same

- EDAM entities continue to retain their resource planning, transmission planning and reliability functions

EDAM
Footprint



Day-Ahead &
Real-Time Market

What are some of the ways EDAM and DAME will provide benefit to participants?



- Economic benefits through commitment of least-cost generation
- Improved situational awareness across BAs
- Enhanced reliability
- Lower greenhouse gas emissions

changes targeted for spring
2026





Wrap Up

Summary, Q&A



Thank you for your participation!

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

Or send an email to: CustomerReadiness@aiso.com