



# California ISO Market Overview

Body of State Regulators – Training Session  
December 11, 2024

Today's Trainer:  
Radha Madrigal, Lead Customer Education Trainer

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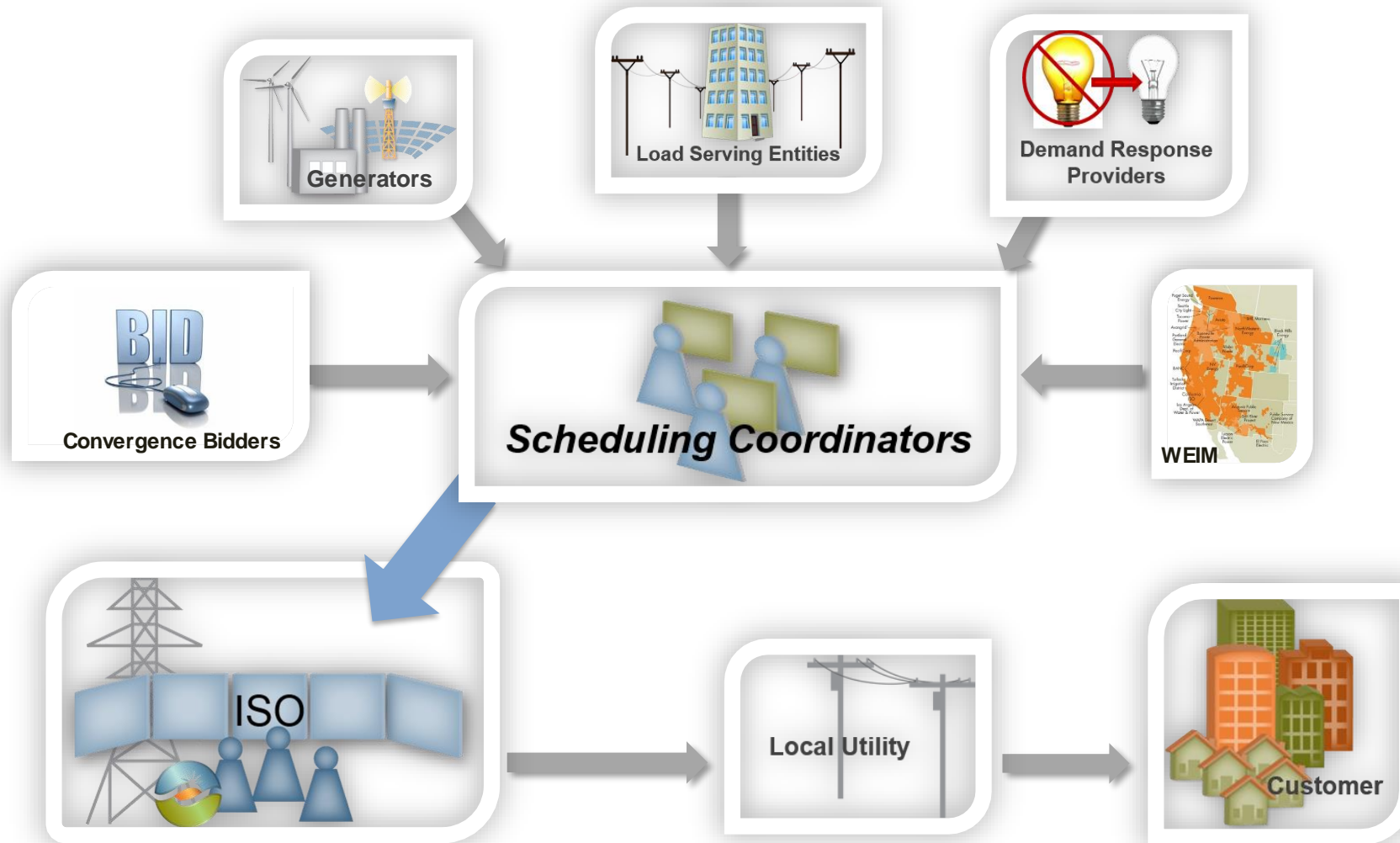
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Rev. 11/26/24

# What will I be learning about in today's market overview session?



- Day-Ahead and Real-Time Markets
- Market Pricing
- Review of EDAM and DAME projects
- Market Settlements

# Participation with the ISO depends on the service to be provided

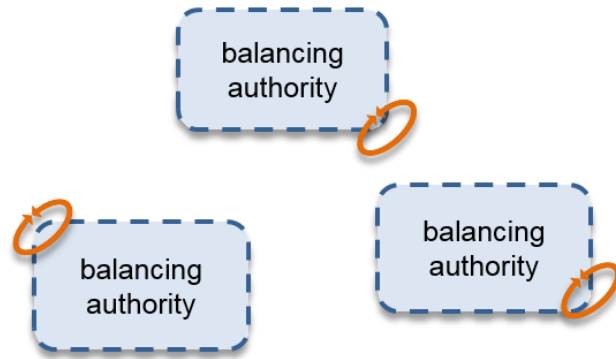


# How is the ISO Market evolving?

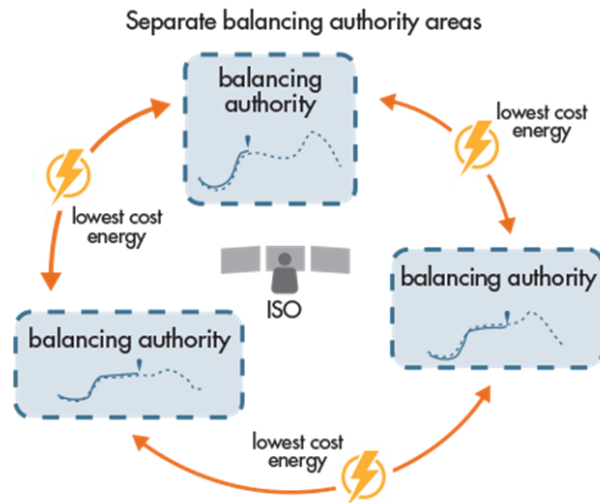
First, let's look at how  
things work today...



# BA of today outside of a market vs. market participation



- Focused on balanced schedules
- LSEs within BA identify their supplies
- BA ensures sum of LSEs demand equals the sum of supplies
- BA ensures each LSE is sufficient
- Some drawbacks of this construct are:
  - LSEs lose economic benefits of regional supply
  - Supply may have limited number of LSEs to serve



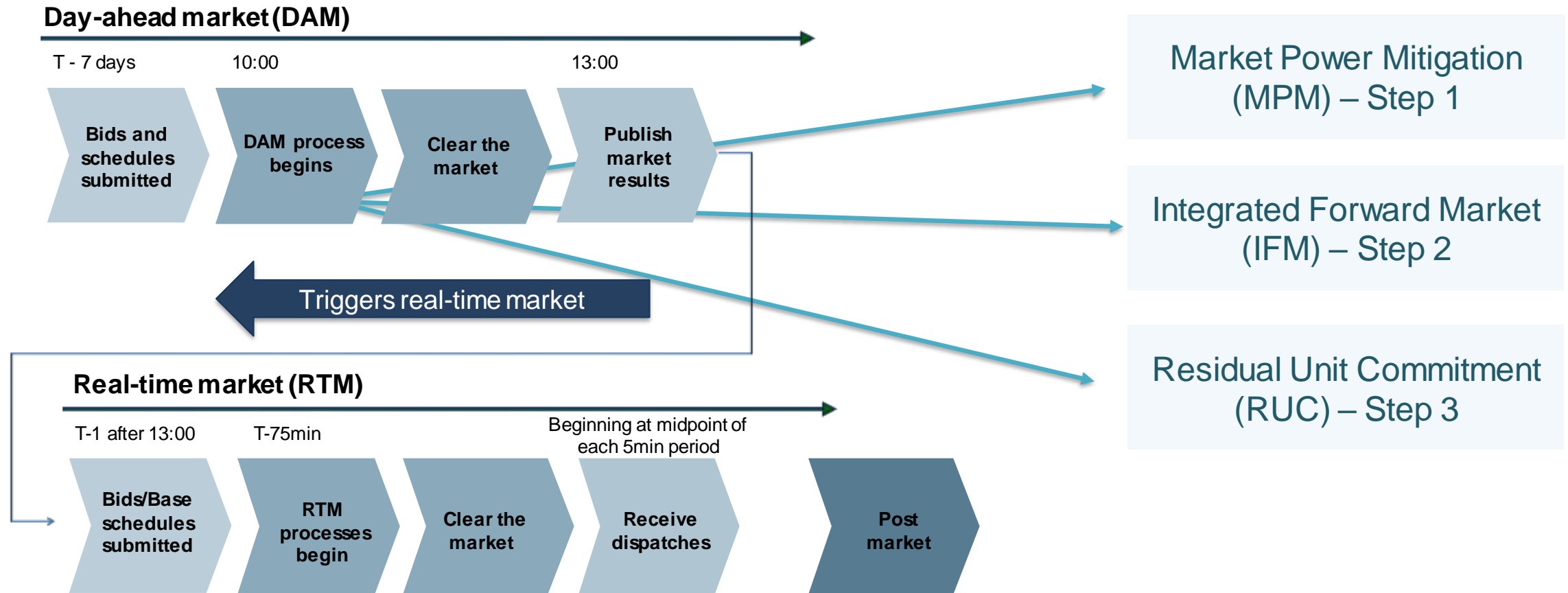
- Market changes concept of LSE coming in with balanced schedule
- Instead, LSEs independently bid in demand and resources independently bid in supply
- Gives LSEs access to larger supply footprint and resources access to larger pool of demand customers
- Market finds the most economic supply to meet demand at least cost while respecting transmission constraints



# ISO Market Operation

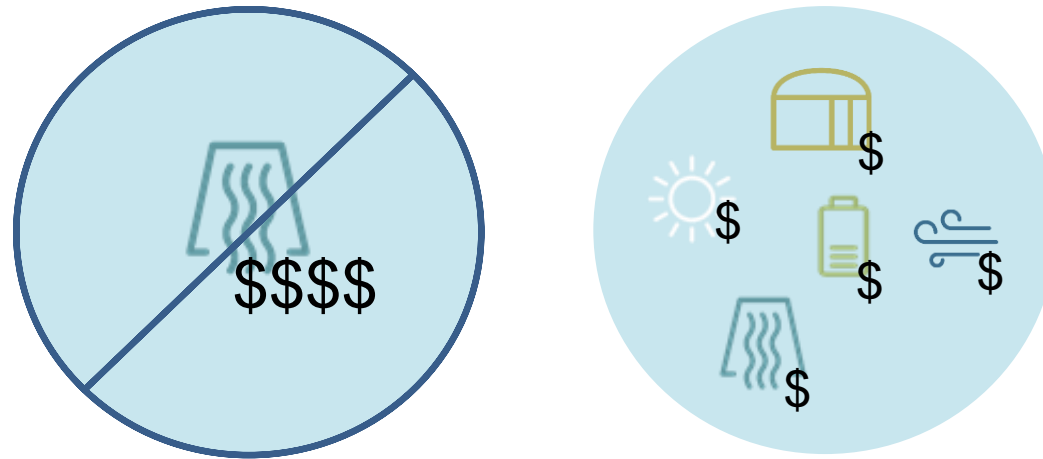
## Day-Ahead Market Processes

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



## 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

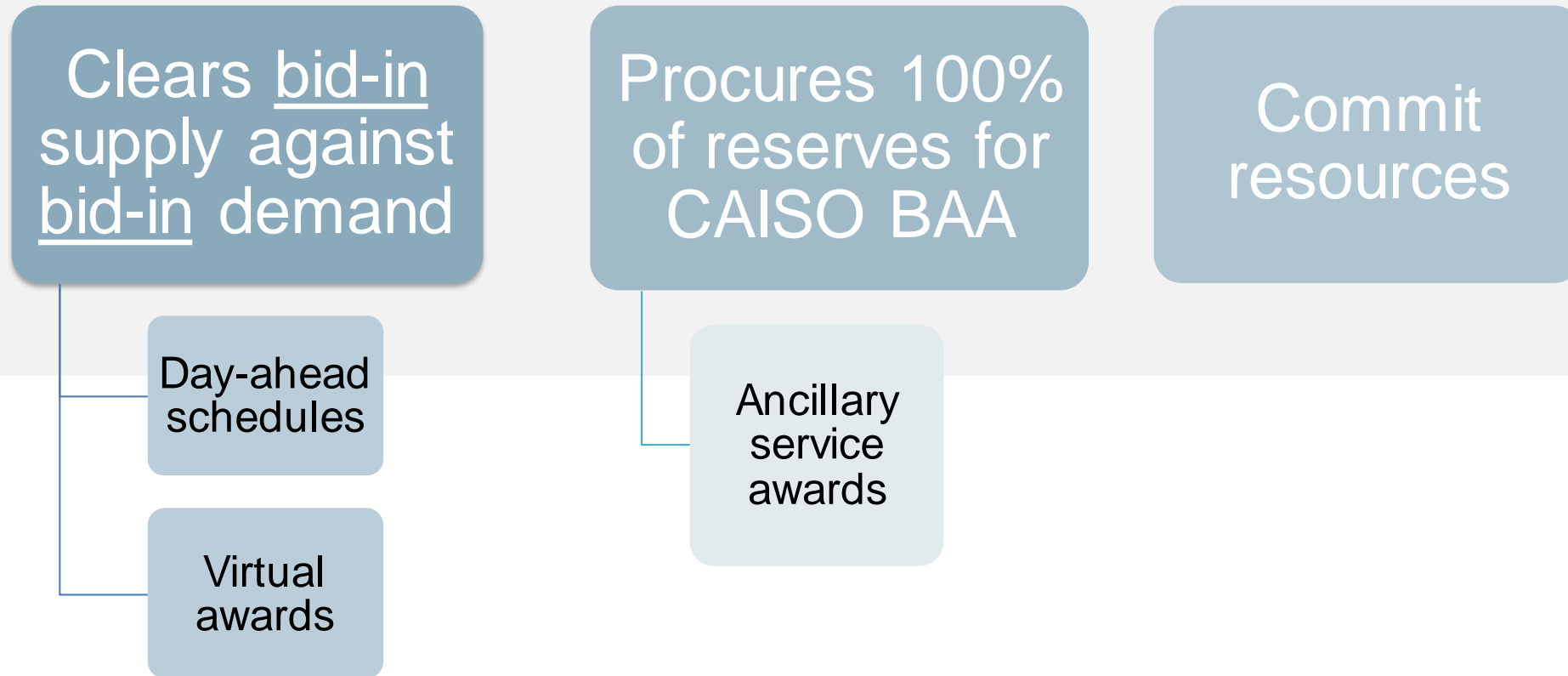
- As a result, sufficient capacity may not be committed to meet forecast demand
- More on this during Step 3 (RUC)

Day-ahead  
schedules

Virtual  
awards

DAM Processes Step 2

# Integrated forward market (IFM)



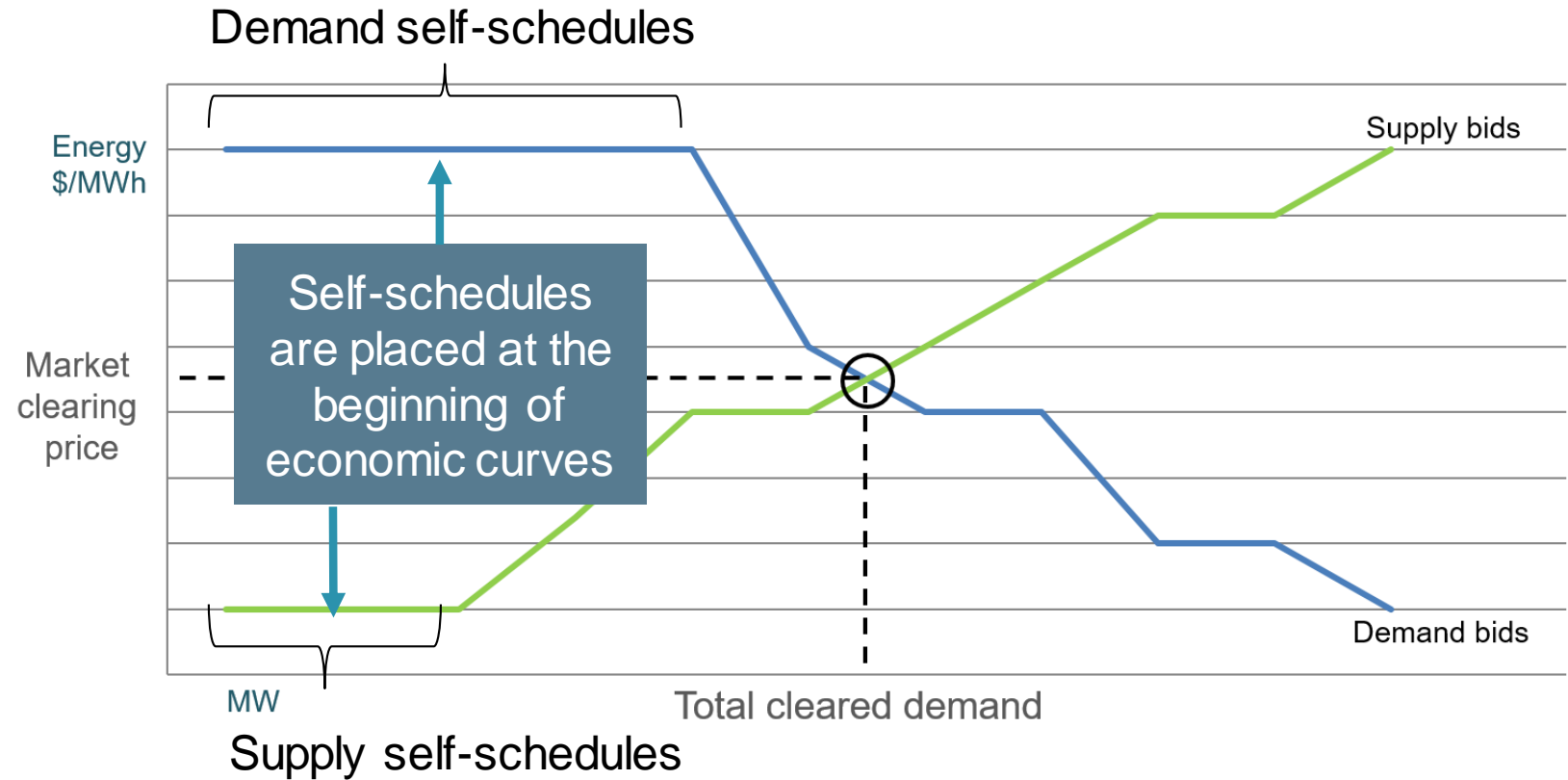
DAM Processes Step 2



# 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

# 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**

## 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

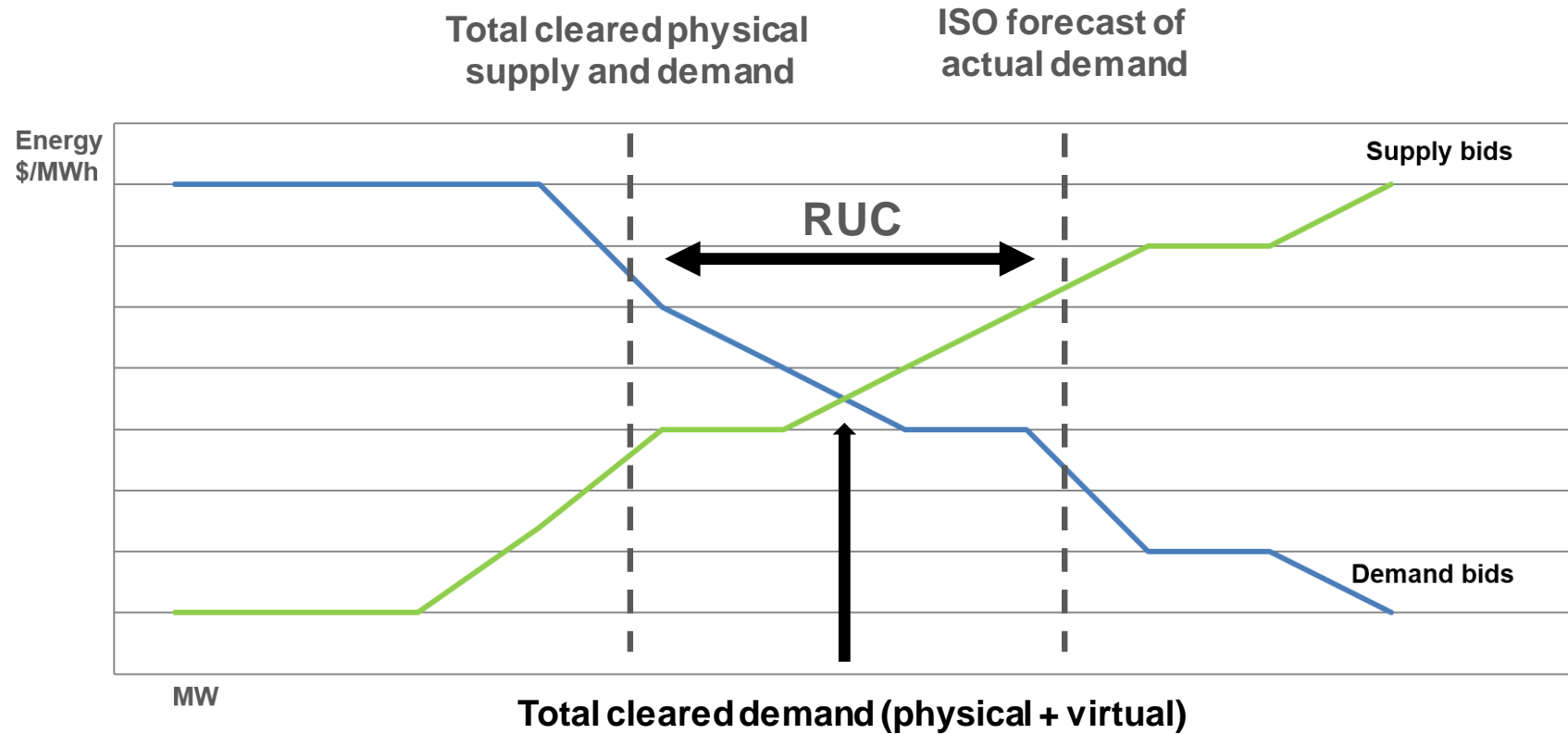
DAM Processes Step 3

## 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 includes 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

Real-Time  
Market

Real-time  
dispatches

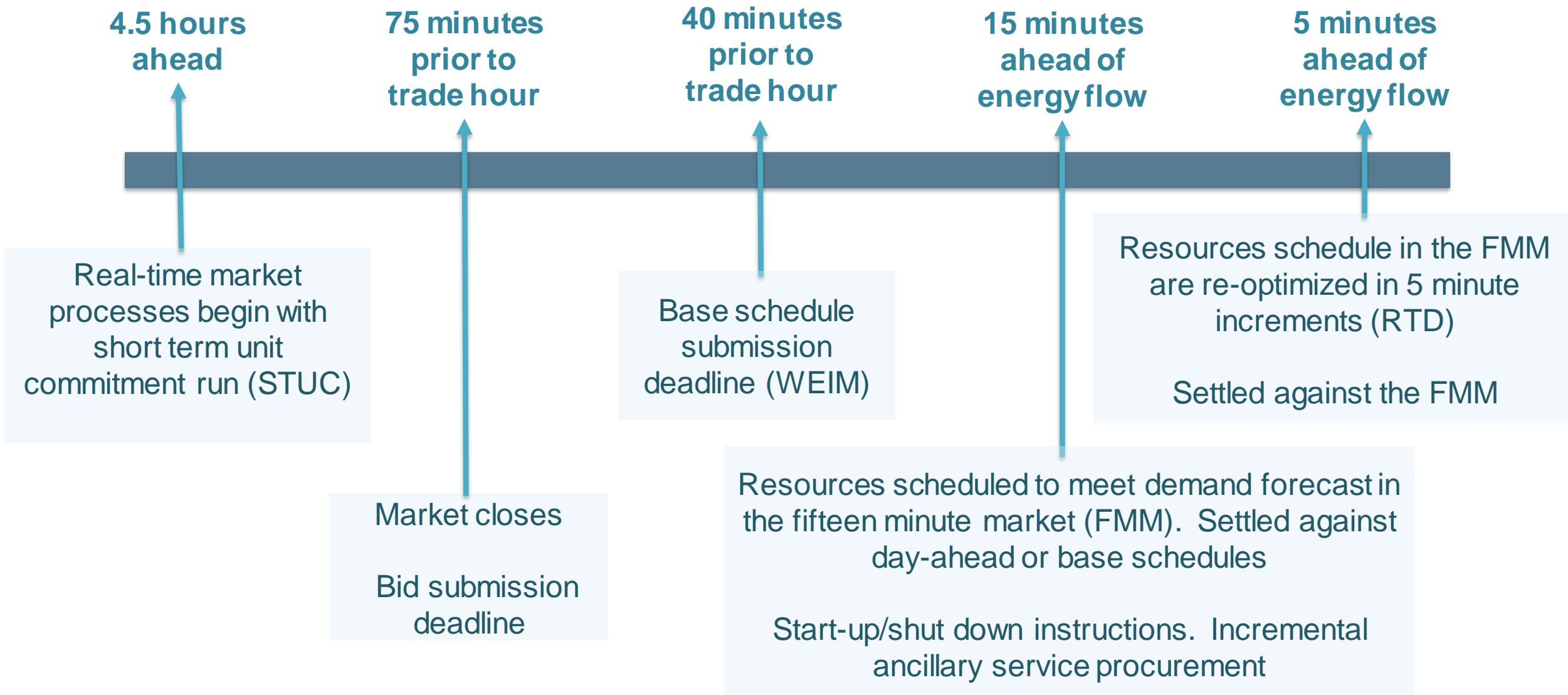
Reserves  
awards

Start-ups/  
shut downs

Multi-stage  
generator  
transitions

Settlements

# Real-time milestones



# Market process timelines: Real-Time

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



# 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

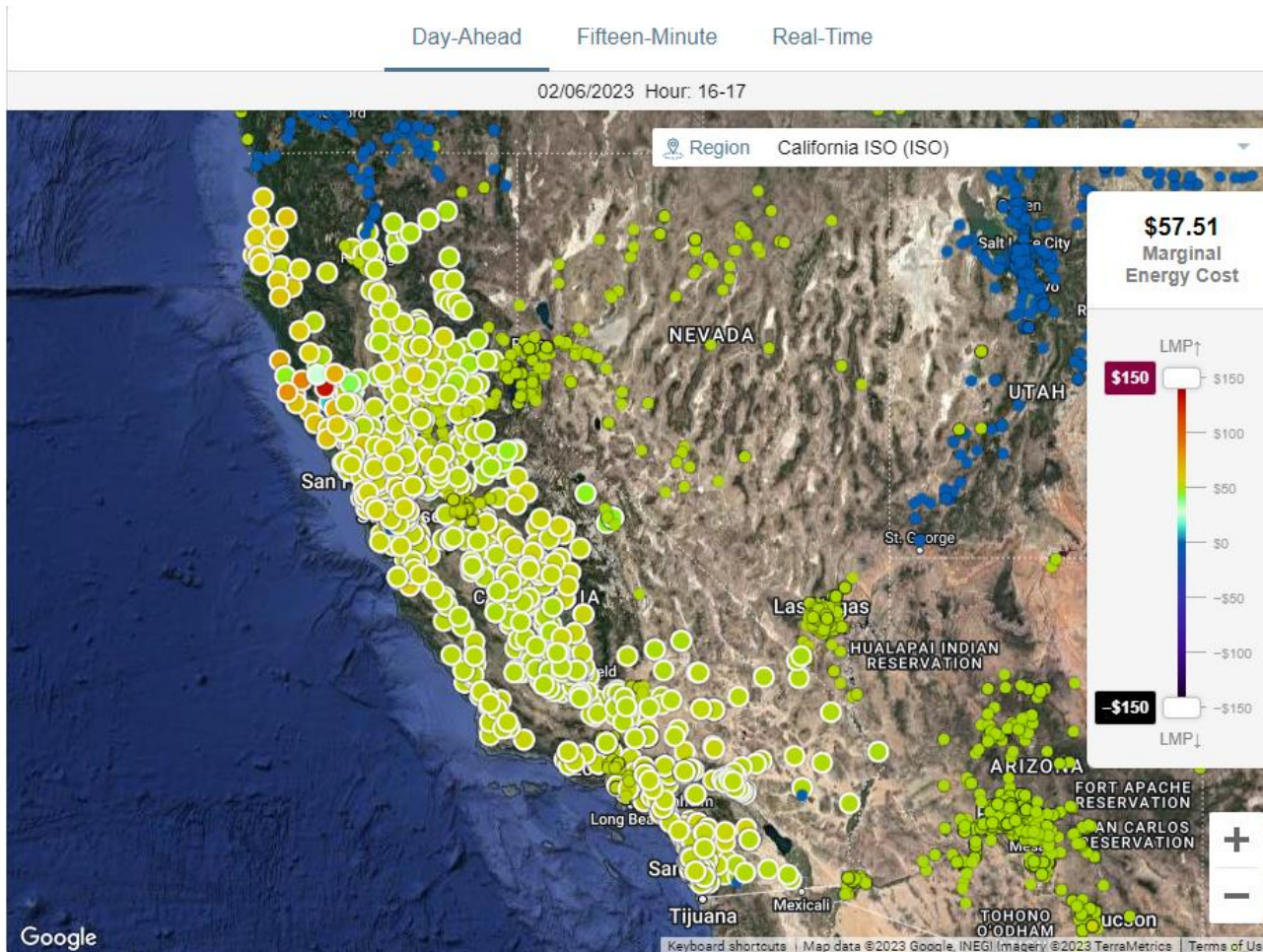
### **Locational Marginal Price (LMP)**

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

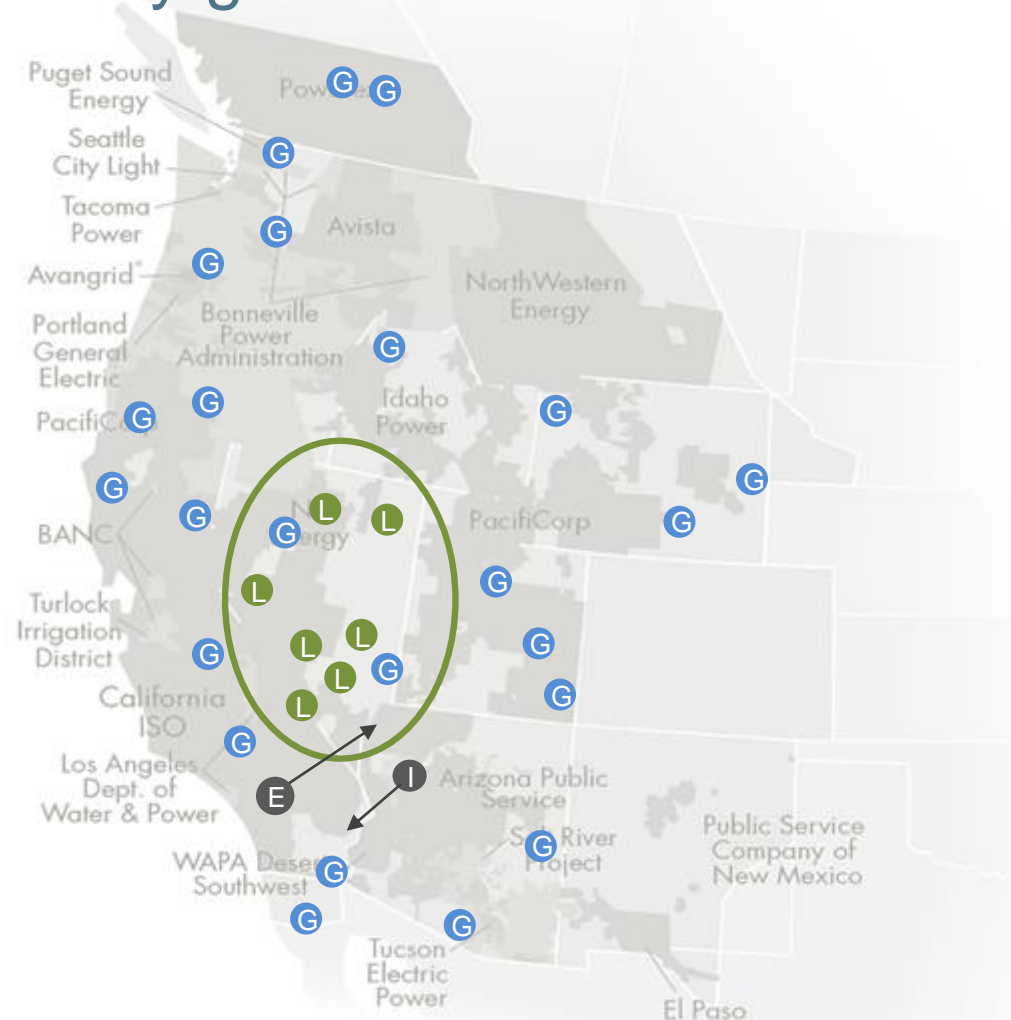


Nodal pricing is the price paid for electricity generated or consumed at a specific location

Resources are paid the nodal price

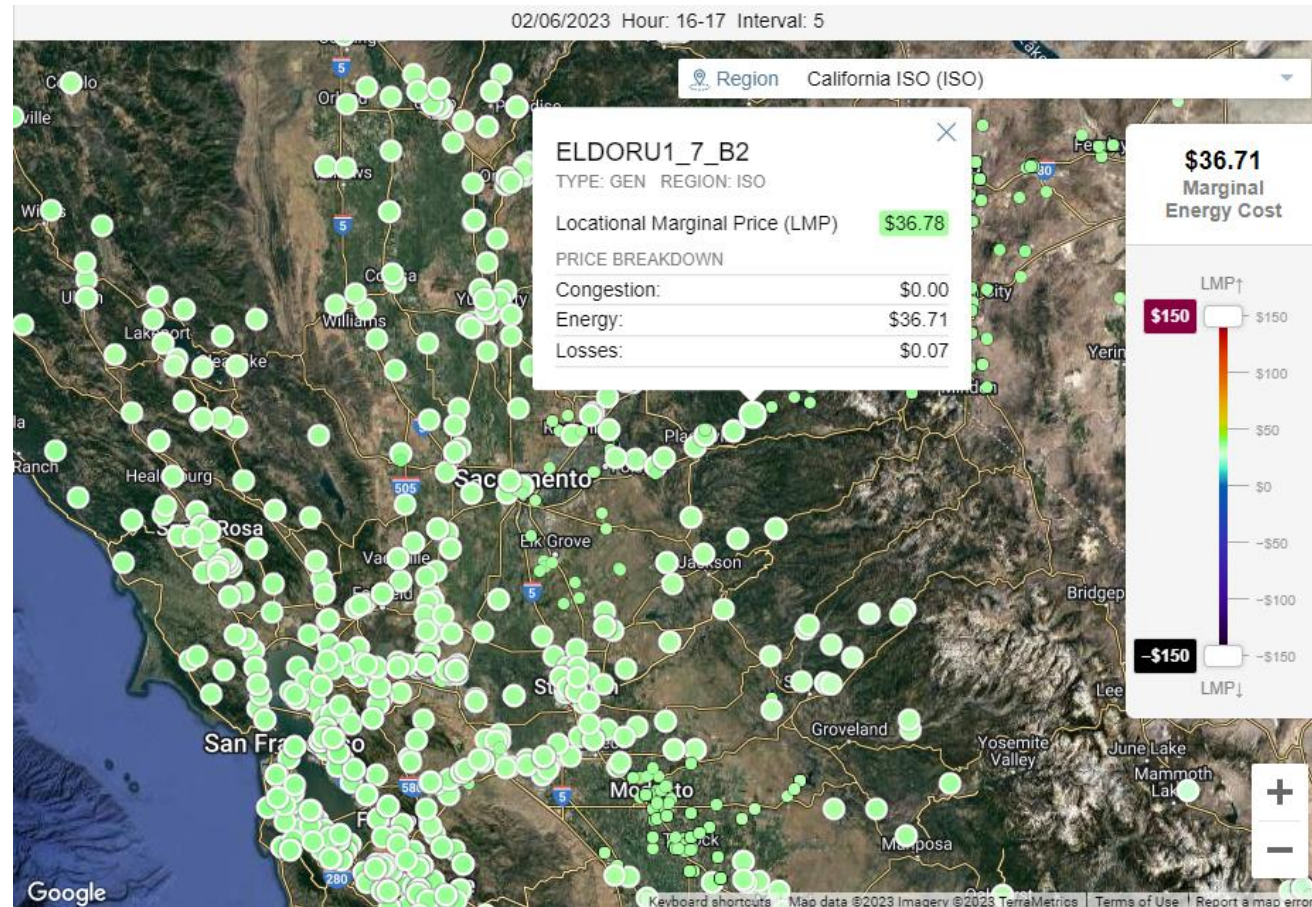
Load pays the weighted average price of all load nodes in the service territory

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



# Components of the locational marginal price

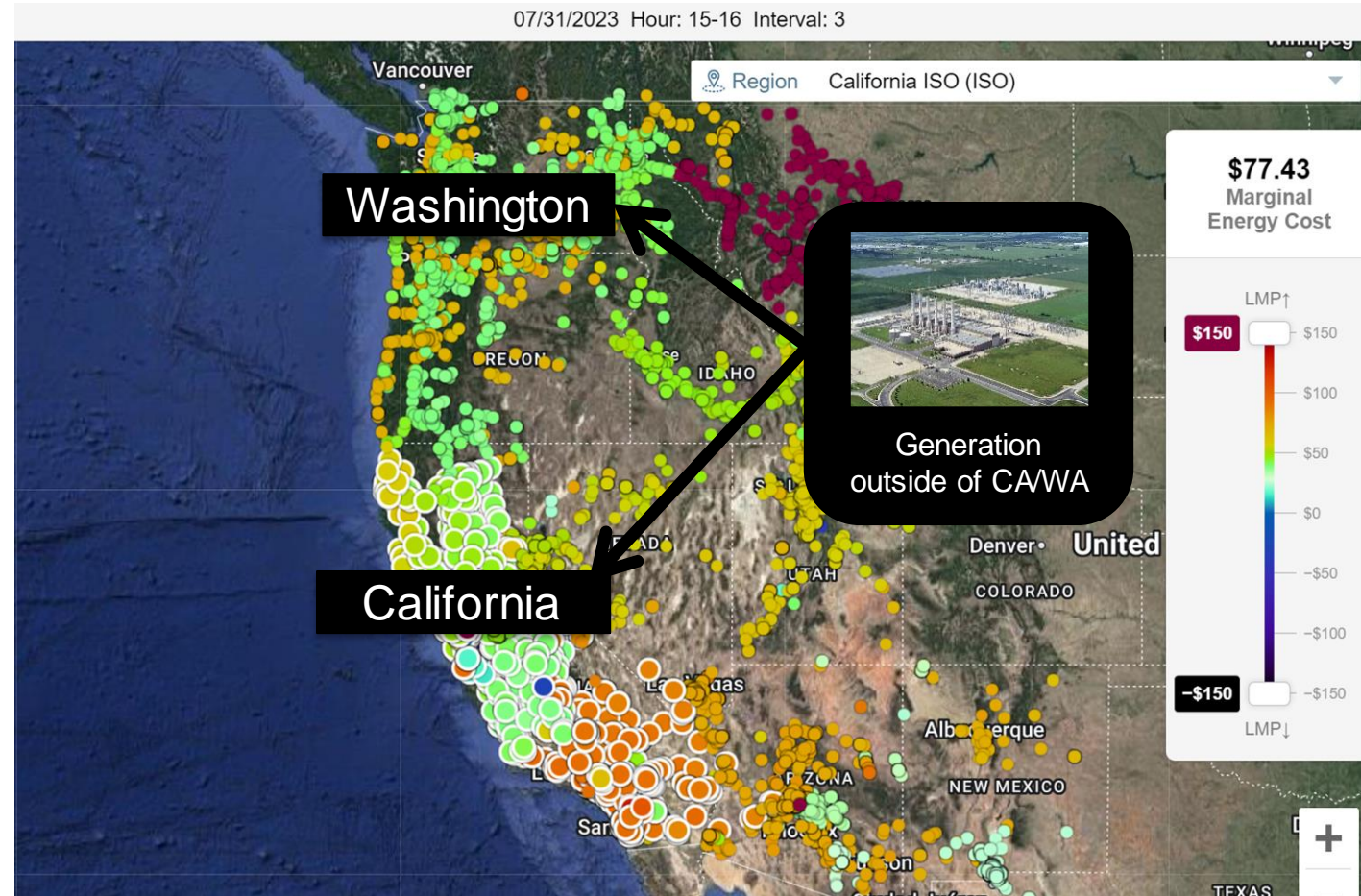
$$\frac{\text{Energy} + \text{Congestion} + \text{Losses}}{\text{LMP}}$$





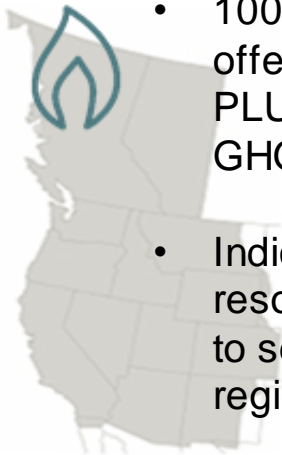
# LMP with greenhouse gas component

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



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

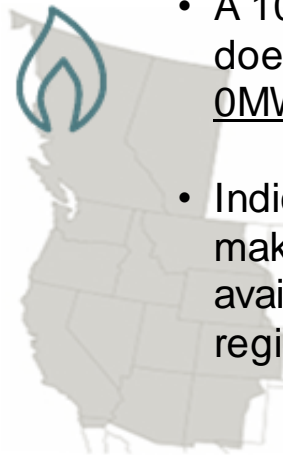
GHG



- 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



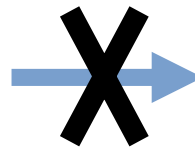
- A 100 MW wind resource bids 100 MW at \$0/MWh GHG bid adder
- Indicates they are making the whole resource available to a GHG region but do not face a GHG cost of compliance

## Example 3

Clean resource with \$0 GHG bid adder

# Scarcity pricing intends to reward available suppliers during tight system conditions

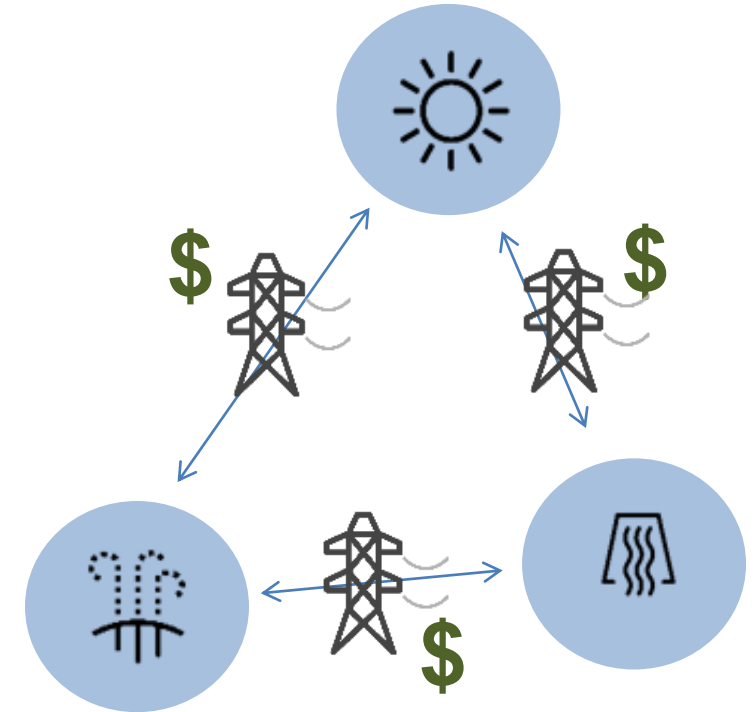
Occurs when the next available MW will not help relieve congested area



# 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?



Now, let's look at how things  
are changing...





## 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 who voluntarily opt in, providing additional benefits
- ISO market will manage energy schedules and optimize efficient transfers of energy between balancing areas
- Expands access to full complement of wholesale energy market services and builds upon WEIM to optimize commitment of generation a day in advance

Extended Day-Ahead Market (EDAM)

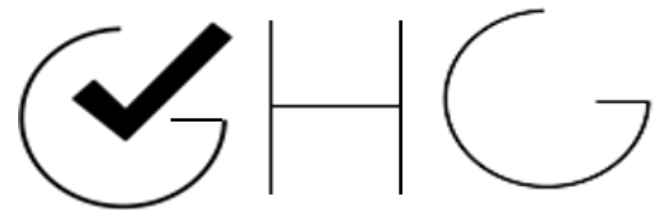
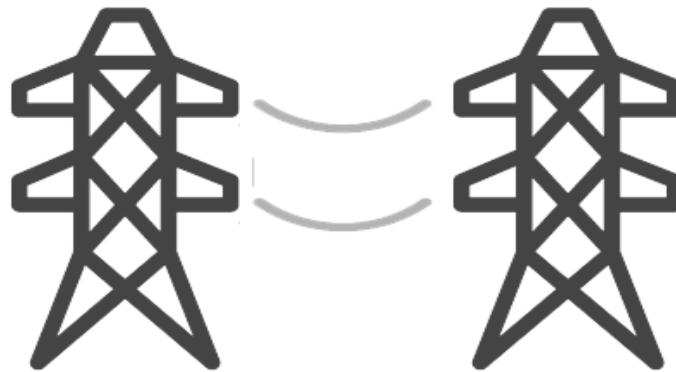
# Extension of the ISO day-ahead market across the west



- Enhances, supports, and complements bilateral trading activity that takes place today
- Increases reliability due to greater situational awareness
- Allows participants to share surplus renewable energy across a broad footprint
- 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

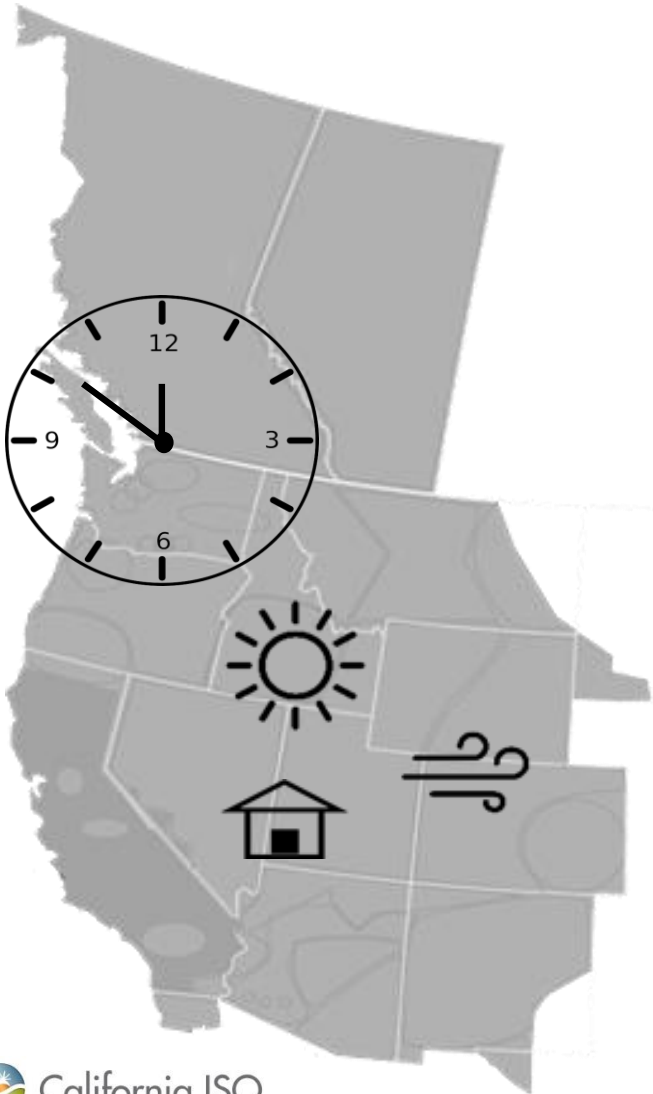
## Parallel effort: Day-ahead market enhancements (DAME)

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)

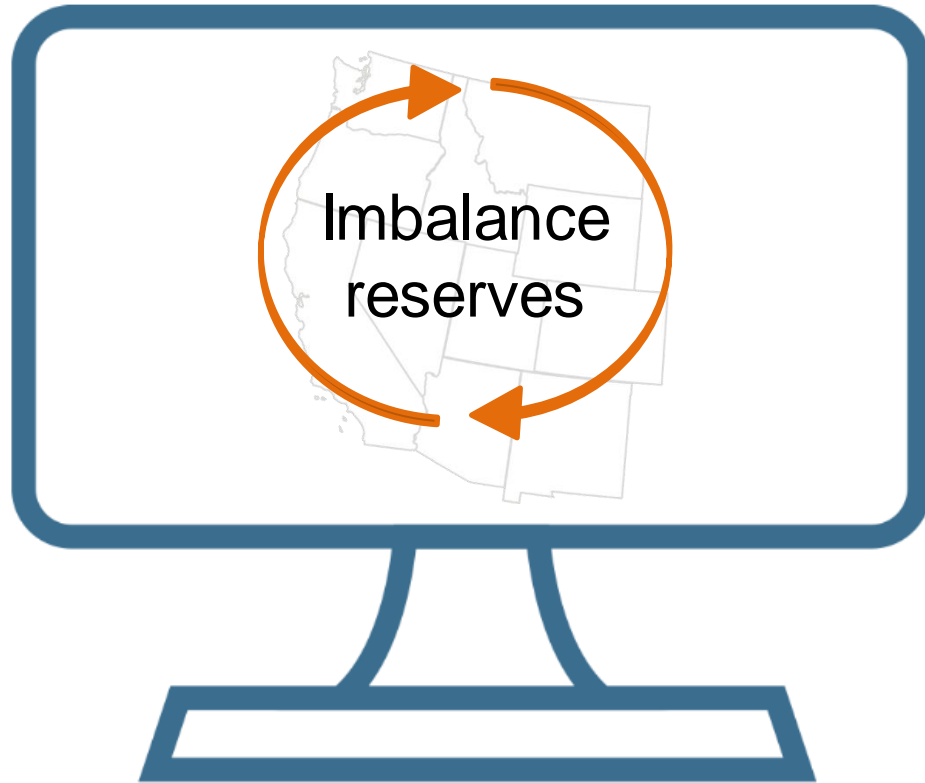
# New IFM imbalance reserve products provide consistent method for evaluating & addressing uncertainty needs in each BA



- Reserves procured on an hourly basis for each area
- 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 which maximizes diversity benefit

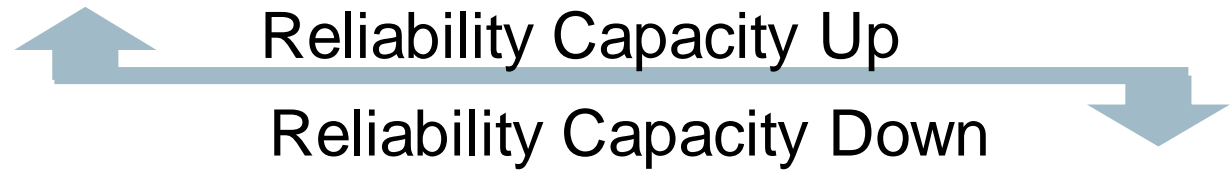


Imbalance reserves address expected range of load/supply uncertainties between day-ahead and real-time markets



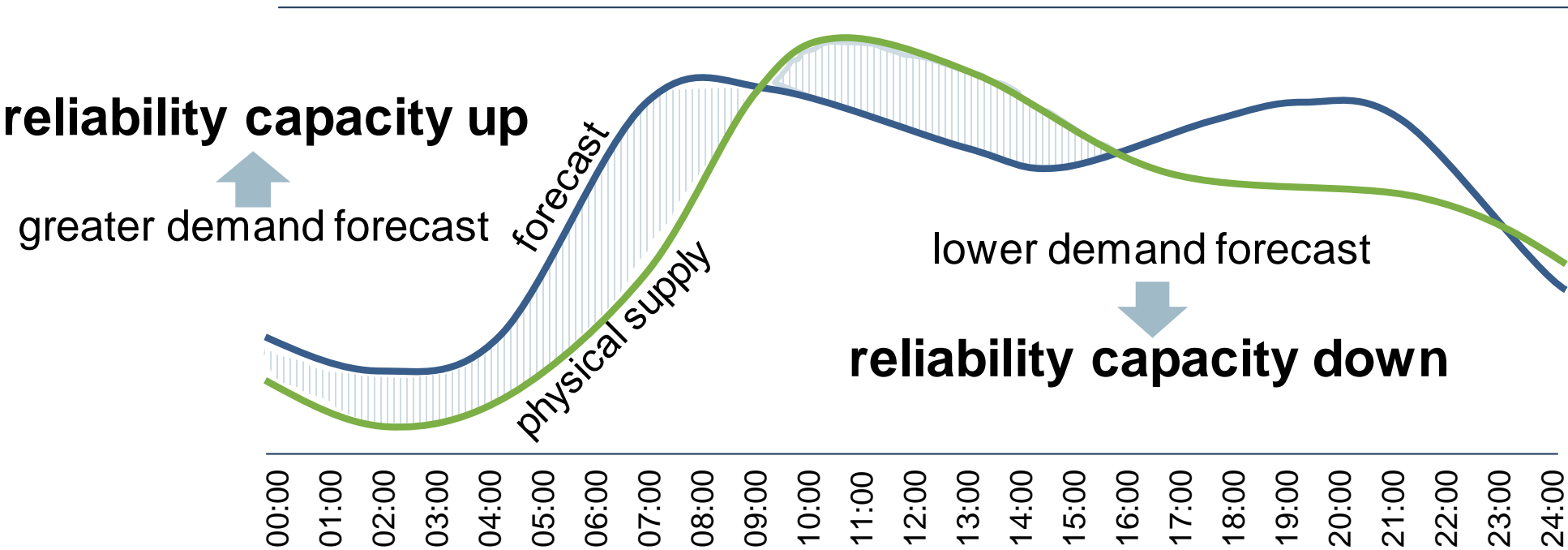
- Hourly analysis compares advanced energy purchases to real-time energy needs
- Differences determine reserve types needed for each area
- Reserve types can vary from hour-to-hour across the day

# New RUC reliability capacity products ensure sufficient physical supply scheduled in day-ahead



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

# RUC compares demand forecast to physical supply that clears the 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

# What should I keep in mind when preparing for EDAM?

## What changes?

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

## What stays the same?

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





# Market Settlements



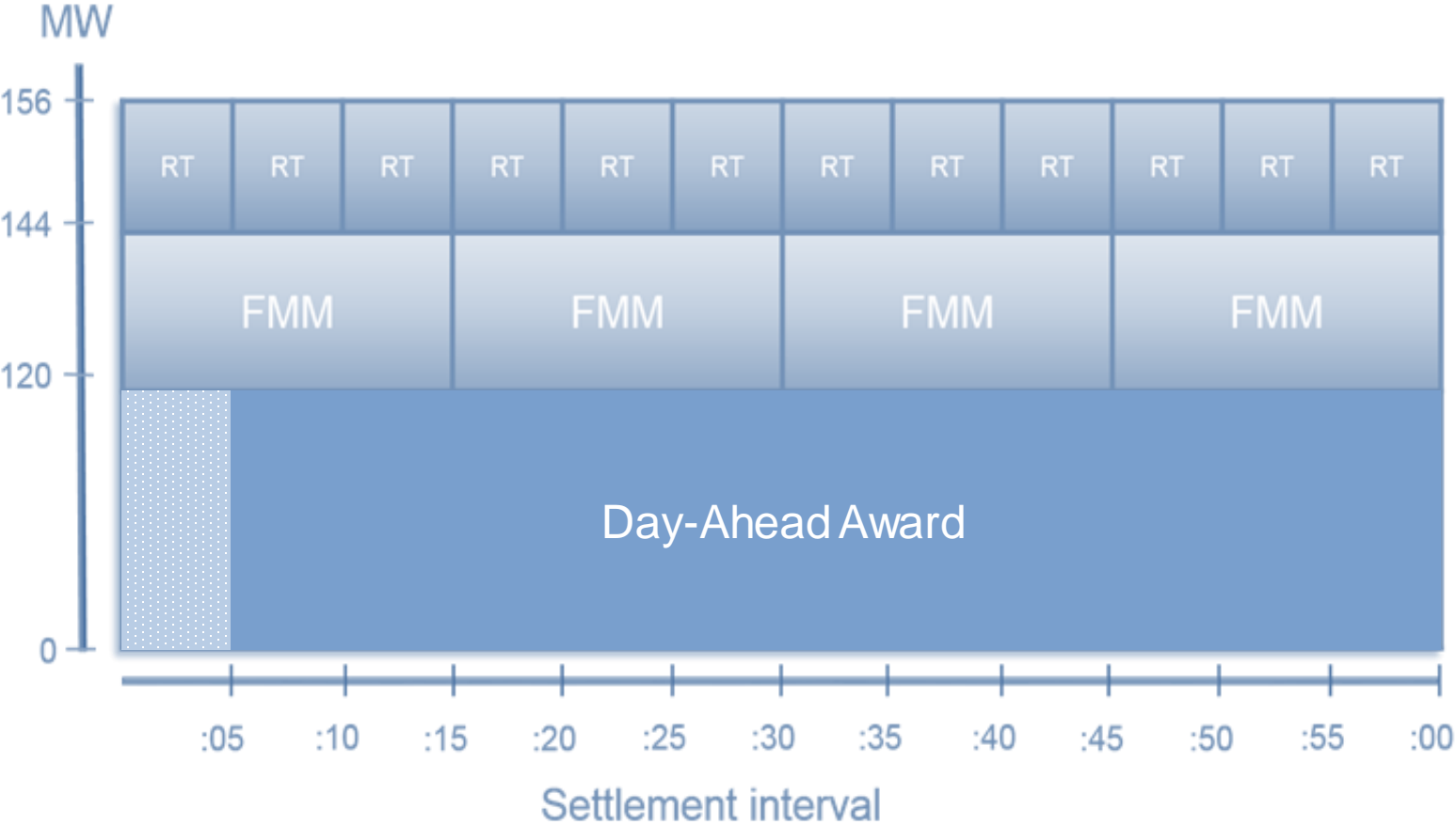
# Market Settlements

Market transactions are settled directly with SCs who represent market participants

- Settlements are conducted directly between the ISO and the respective SC for loads/resources that bid into and are awarded by the market
- Other aspects of settlements occur directly with the EDAM entity SC (entity may need to allocate these settlements within its balancing area)
- Information on the allocation of ISO settlements can be found in the EDAM entity's tariff

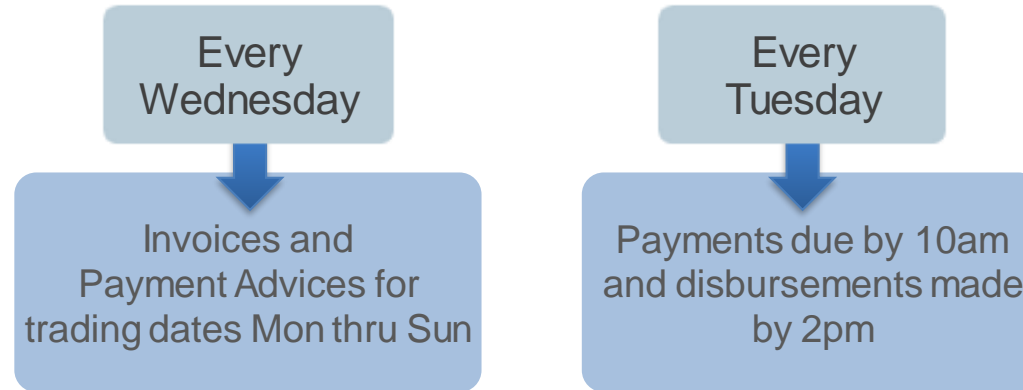
# Energy settlements occur in day-ahead, the fifteen-minute and real-time markets

Energy settlements are calculated in 5 minute intervals

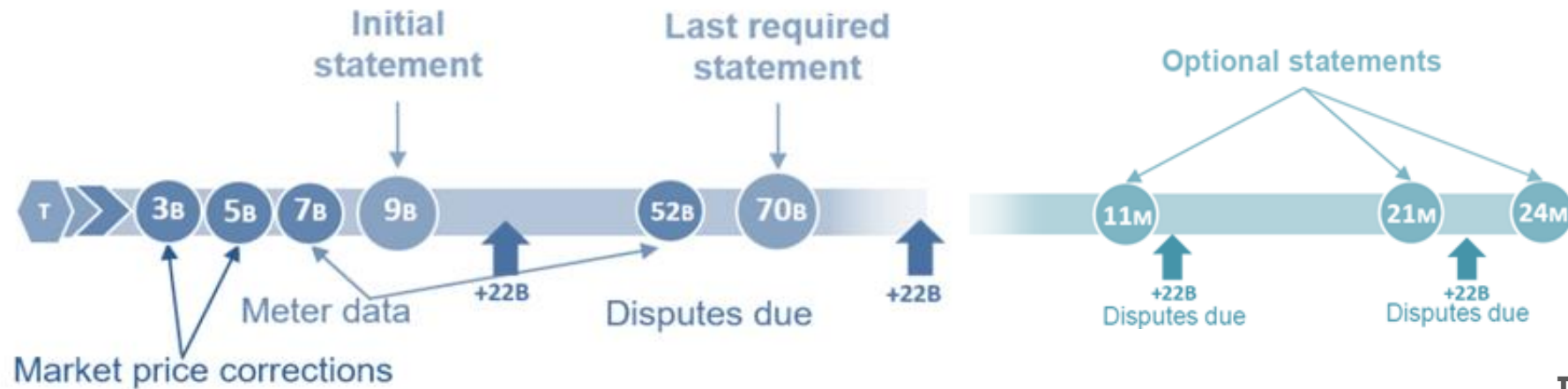


# Key Settlement Dates

Invoices & payment advices



Settlement Timeline



**T = Trade Date**  
**B = Business Days**  
**M = Months**

EDAM/DAME implementation in spring  
2026



Policy  
Initiatives



Daily  
Briefing



Stakeholder  
Meetings





# Thank you for your participation!

For more detailed information on anything presented, please visit our website at: [www.caiso.com](http://www.caiso.com) or send an email to: [CustomerReadiness@caiso.com](mailto:CustomerReadiness@caiso.com).



# WESTERN ENERGY IMBALANCE MARKET

## Role of the Independent Market Monitor

Body of State Regulators – Training Session  
December 11, 2024

Eric Hildebrandt, Executive Director  
Department of Market Monitoring



# Mission of independent market monitors

*"Each independent system operator ... must include a mission statement ... that identifies the Market Monitoring Unit's goals, including the protection of consumers and market participants by the identification and reporting of market design flaws and market power abuses."*

FERC Order 719

*To provide independent oversight and analysis of the CAISO Markets for the protection of consumers and Market Participants by the identification and reporting of market design flaws, potential market rule violations, and market power abuses.*

Department of Market Monitoring Mission Statement  
CAISO Tariff, Appendix P

# Core functions of independent market monitors (FERC Order 719)

1. Review and report on the performance of wholesale markets, including quarterly and annual reports.
2. Evaluate existing and proposed market rules, and provide recommendations.
3. Notify FERC when a market participant or the ISO has engaged in conduct that may require investigation.
4. Market monitors may also perform functions related to inputs for market power mitigation.
  - Cost-based bids used in mitigation

# ISO's Department of Market Monitoring (DMM)

- Internal business unit of the ISO
  - 17 staff (economics, data analysis, engineering)
  - Access to all ISO/WEIM market and operational data
  - Collaborate with ISO staff on market design and monitoring
- Work and communicate frequently with FERC staff on market monitoring, design issues, and referrals
- Stakeholder interactions
  - Participate actively and submit written comments in stakeholder process
  - Outreach and discussions with individual market participants
  - Frequently invited to present at BOSR, WIEB and RIF meetings
  - Outreach to individual WEIM participants and state regulators

# DMM independence and oversight

- DMM is independent from ISO management, as required by FERC Order 719
- DMM Oversight Committee
  - Sub-committee of Board of Governors (2 members)
  - WEM Governing Body representative (non-decisional member)
  - Approves DMM budget, compensation & other administrative issues
- DMM provides independent recommendations to ISO Board of Governors and WEIM Governing Body
  - Written stakeholder comments and Board memos
  - Meet in executive sessions with BOG and Governing Body
  - Verbal comments at BOG and Governing Body meetings

## Key western electricity market issues we are closely involved with .....

- Western Energy Imbalance Market
  - Performance, resource sufficiency evaluation, regional transfers between balancing areas
- Transmission scheduling priorities (exports/imports, wheeling, firm/non-firm)
- Extended day-ahead market
- Battery and renewable energy market issues
- Greenhouse gas issues (incorporating in market dispatch and pricing, GHG accounting)
- Resource adequacy programs (California, WRAP)
- Market power mitigation (bid caps)



# WEIM market power mitigation...

- System-wide market power
  - \$1,000/MWh cap (up to \$2,000/MWh)
  - CAISO/WEIM rules cannot mitigate regional market power throughout West
- Bid caps on start-up and minimum load bids
  - 125% of cost
- Energy bids only subject to mitigation when congestion occurs on uncompetitive transmission constraints within CAISO/WEIM
  - Bids capped at higher of cost-based bid or competitive market price
  - Competitive price can be set by imports or bilateral prices at trading hubs
  - Import bids not subject to bid mitigation

# DMM webpage on CAISO website .....



## Market and operations

*Procedures, reports and reference information pertinent to grid and market operations.*

[Market reports](#)  
[Dynamic transfers](#)

Today's Outlook

Outages

Products and services

Settlements

Network and resource modeling

Interchange scheduling

Scheduling coordinator

**Market monitoring**

## California ISO 2024 Year in Review

2024 saw more shared progress on critical strategic objectives for grid reliability

[Read the blog](#)



The October 2024 Key Statistics are now available.



**Join the Winter Readiness Training for Scheduling Coordinators**

Dec. 12 from 1:00 p.m. - 2:00 p.m.

## Market monitoring

The ISO Department of Market Monitoring (DMM) keeps a close watch on the efficiency and the effectiveness of the California ISO markets and the Western Energy Imbalance Market (WEIM). Our reports and presentations provide transparency to the market participants, regulators, policy makers, and other stakeholders. We provide recommendations for market design and operational changes, and monitor for potential detrimental market behavior.

### On this page

[Transparency and potential corrective actions](#)

[Market monitoring hotline](#)

[Contact](#)

[More about DMM](#)

## Reports, presentations, filings and comments

### Annual and quarterly reports

These reports include analysis and recommendations by the Department of Market Monitoring on market issues and performance of California's wholesale energy markets and the Western Energy Imbalance Market.

### Reports and presentations

- Special reports and presentations
- Board of Governors and Governing Body materials
- Western Energy Imbalance Market resource sufficiency evaluation reports
- Western Energy Imbalance Market transition reports
- Regulatory filings
- Comments on policy initiatives

## For more information .....

- Department of Market Monitoring webpage
  - <http://www.caiso.com/market/Pages/MarketMonitoring/Default.aspx>
- ISO Tariff, Appendix P
  - [http://www.caiso.com/Documents/AppendixP\\_CAISODepartmentOfMarketMonitoring\\_asof\\_Apr1\\_2017.pdf](http://www.caiso.com/Documents/AppendixP_CAISODepartmentOfMarketMonitoring_asof_Apr1_2017.pdf)
- Eric Hildebrandt, Executive Director
  - [ehildebrandt@caiso.com](mailto:ehildebrandt@caiso.com)
- Ryan Kurlinski, Senior Manager, Monitoring & Reporting
- Adam Swadley, Manager, Market & Policy Analysis







# California ISO Reference Material

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Western Electricity Markets  
Training

December 11, 2024





General ISO and Market Knowledge	
For those who would like to learn more about the ISO market in general, the below modules provide a high-level overview of the ISO itself, the Day-Ahead Market, and the Real-Time Market.	
Module	Title
 <b>CBT</b>	Welcome to the ISO (45 minutes)  <a href="https://www.caiso.com/content/cbt/welcome-to-the-iso/story.html">https://www.caiso.com/content/cbt/welcome-to-the-iso/story.html</a>
 <b>CBT</b>	Day-Ahead Overview (25 minutes)  <a href="https://www.caiso.com/content/cbt/day-ahead-overview/story.html">https://www.caiso.com/content/cbt/day-ahead-overview/story.html</a>
 <b>CBT</b>	Real-Time Overview: (25 minutes)  <a href="https://www.caiso.com/content/cbt/real-time-overview/real-timeoverview.html">https://www.caiso.com/content/cbt/real-time-overview/real-timeoverview.html</a>
 <b>Website</b>	ISO Glossary of terms and acronyms:  <a href="https://www.caiso.com/glossary">https://www.caiso.com/glossary</a>
 <b>Website</b>	Department of Market Monitoring Annual and Quarterly Reports provide information on market activity and pricing along with analysis of trends.  <a href="https://www.caiso.com/market-operations/market-monitoring/market-issues-and-performance-reports">https://www.caiso.com/market-operations/market-monitoring/market-issues-and-performance-reports</a>
 <b>Website</b>	Market Performance Reports provide granular reports on a daily/monthly basis on selected metrics such as energy prices, wind and solar forecast data compared to actuals, etc.  <a href="http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=BA9489A9-1B4A-4D56-8AB2-DBE56269893D">http://www.caiso.com/Pages/documentsbygroup.aspx?GroupID=BA9489A9-1B4A-4D56-8AB2-DBE56269893D</a>







## Bidding in the ISO Markets



These modules provide information on the nuances of bidding in the ISO markets and how market prices are constructed.


Module	Title
 CBT	Economic Bids and Self-Schedules (45 minutes) <a href="https://www.caiso.com/content/cbt/economic-bids-and-self-schedules/story.html">https://www.caiso.com/content/cbt/economic-bids-and-self-schedules/story.html</a>
 CBT	Market Pricing (35 minutes) <a href="https://www.caiso.com/content/cbt/market-pricing/story.html">https://www.caiso.com/content/cbt/market-pricing/story.html</a>

## EDAM/DAME Reference Material

Here is a collection of links to additional information about the Extended Day-Ahead Market (EDAM) and the Day-Ahead Market Enhancements (DAME) initiative.

Module	Title
 Website	<p>Extended Day-Ahead Market – Webpages</p> <p>EDAM Overview:  <a href="https://www.westerneim.com/Pages/ExtendedDayAheadMarket.aspx">https://www.westerneim.com/Pages/ExtendedDayAheadMarket.aspx</a></p> <p>EDAM Overview Video:  <a href="https://youtu.be/wNzT-nXceVs">https://youtu.be/wNzT-nXceVs</a></p> <p>Join EDAM:  <a href="https://www.westerneim.com/Pages/ExtendedDayAheadMarketImplementation.aspx">https://www.westerneim.com/Pages/ExtendedDayAheadMarketImplementation.aspx</a></p> <p>EDAM FAQ:  <a href="https://www.caiso.com/documents/extended-day-ahead-market-edam-faq.pdf">https://www.caiso.com/documents/extended-day-ahead-market-edam-faq.pdf</a></p>
 Website	<p>Extended Day-Ahead Market – Policy Initiative Page  <a href="https://stakeholdercenter.caiso.com/StakeholderInitiatives/Extended-day-ahead-market">https://stakeholdercenter.caiso.com/StakeholderInitiatives/Extended-day-ahead-market</a></p>
 Website	<p>Day-Ahead Market Enhancements – Policy Initiatives Page  <a href="https://stakeholdercenter.caiso.com/StakeholderInitiatives/Day-ahead-market-enhancements">https://stakeholdercenter.caiso.com/StakeholderInitiatives/Day-ahead-market-enhancements</a></p>
 Website	<p>GHG Accounting – Energy Matters Blog  <a href="https://www.caiso.com/about/news/ghg-accounting-aligning-markets-with-state-greenhouse-gas-reduction-policies">https://www.caiso.com/about/news/ghg-accounting-aligning-markets-with-state-greenhouse-gas-reduction-policies</a></p> <p>Greenhouse Gas Coordination Working Group  <a href="https://stakeholdercenter.caiso.com/StakeholderInitiatives/Greenhouse-gas-coordination-working-group">https://stakeholdercenter.caiso.com/StakeholderInitiatives/Greenhouse-gas-coordination-working-group</a></p>

Energy Emergency Alert (EEA) Modules	
These modules provide insight into the ISO's Energy Emergency Alert (EEA) process.	
Module	Title
 CBT	Emergency Response and Abnormal Operations (15 minute) <a href="https://www.caiso.com/content/cbt/emergency-response-and-abnormal-operations/story.html">https://www.caiso.com/content/cbt/emergency-response-and-abnormal-operations/story.html</a>
 Video	This Summer Readiness training video from 2023 outlines the EEA process (1 hour) <a href="https://www.youtube.com/watch?v=x9-oR-OJ9bk">https://www.youtube.com/watch?v=x9-oR-OJ9bk</a> <a href="https://www.caiso.com/documents/presentation-summer-readiness-2023-training-may25-2023.pdf">https://www.caiso.com/documents/presentation-summer-readiness-2023-training-may25-2023.pdf</a> (Presentation)

Library of Computer-Based Training Modules	
We have identified some key modules in the sections listed above. The full suite of learning modules is available in the CBT library in the ISO's Training Center, organized into specific learning tracks. Here is a link to the complete CBT library.	
Module	Title
 CBT	ISO CBT Library <a href="https://www.caiso.com/stakeholder/training/computer-based-training">https://www.caiso.com/stakeholder/training/computer-based-training</a>