



California ISO: Overview of Market Processes

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Customer Readiness

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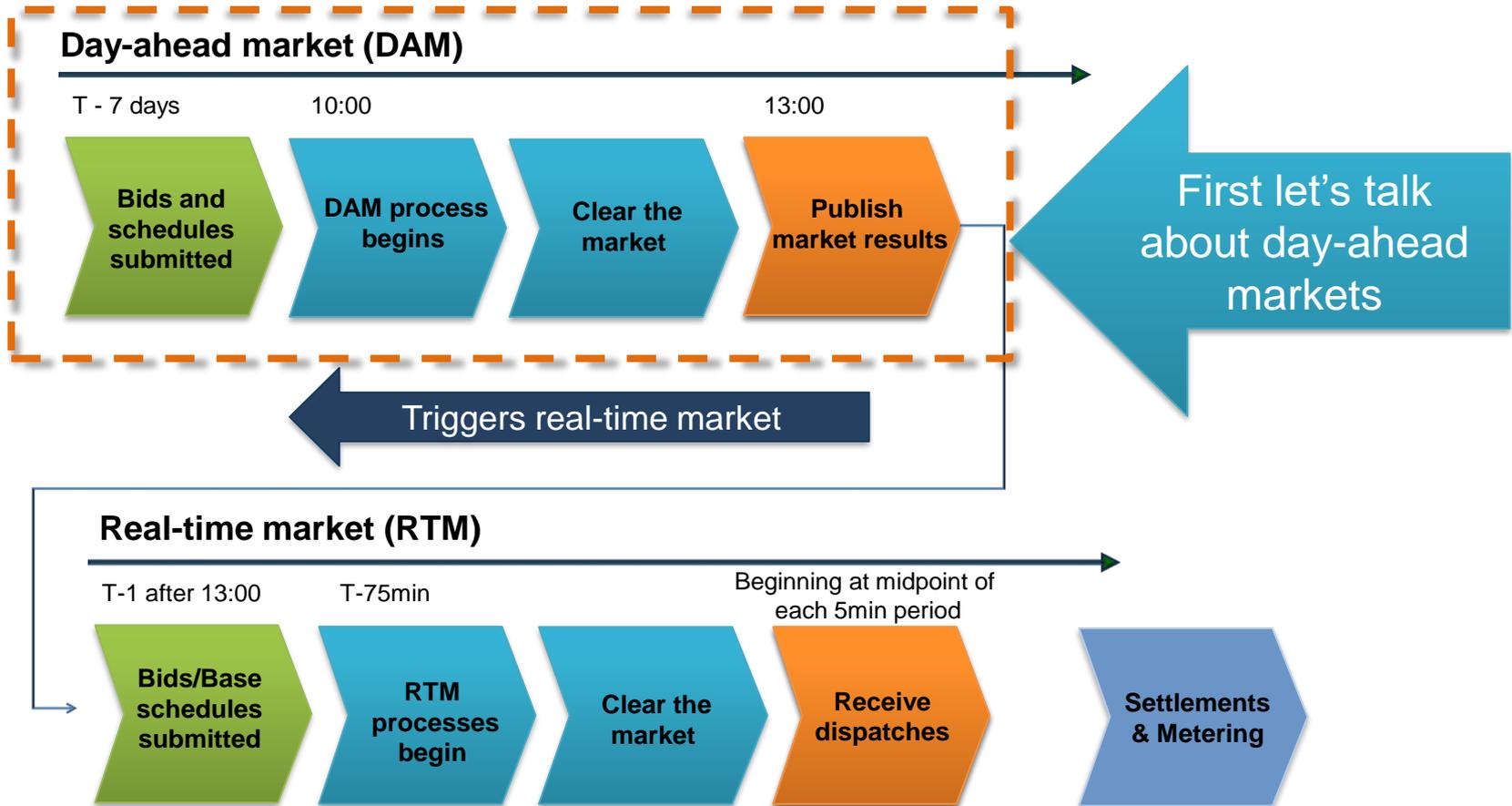
Agenda

- This training will cover the following topics:
- Day-ahead market processes
- Real-time market processes



DAY-AHEAD MARKET

Market process timelines: day-ahead



Day-ahead markets procure resources to meet reliability needs

Assurance, a day in advance, that there are adequate resources available and deliverable in real-time

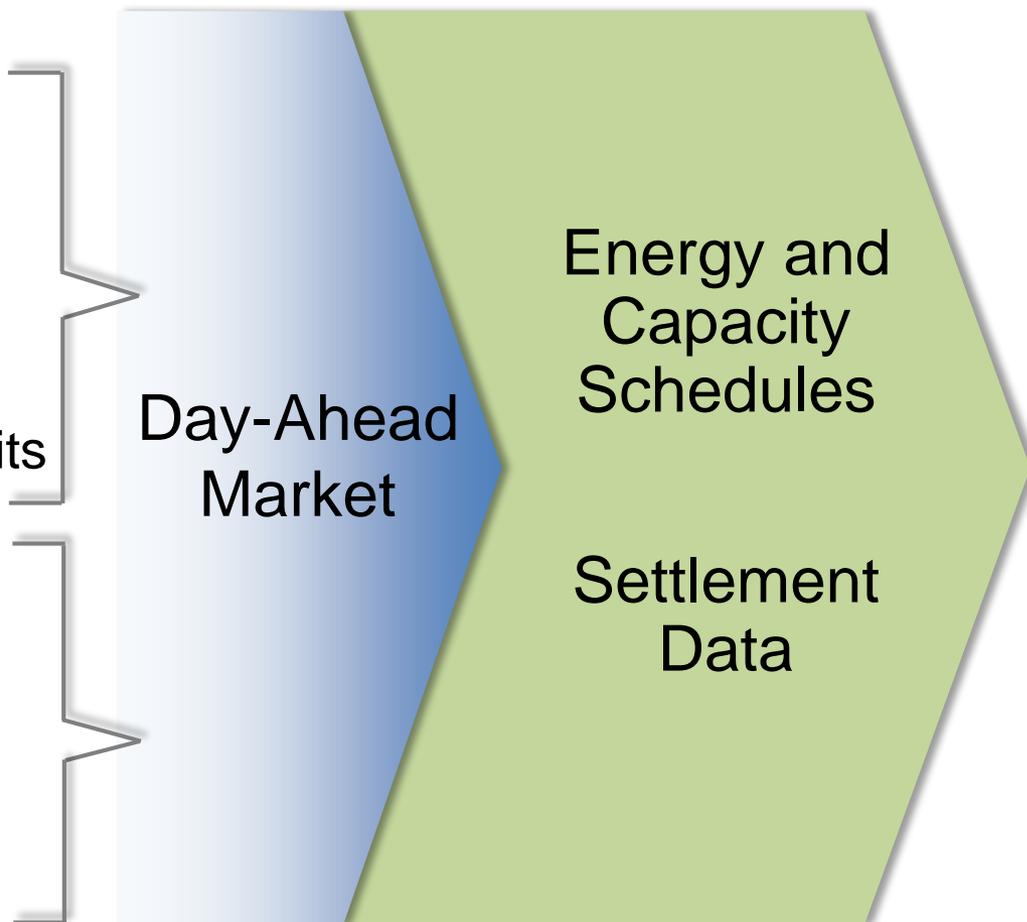
Inputs and output of the **day-ahead** market

Data:

- System parameters
- Resource parameters
- Outage information
- Bid information
- ISO forecast of demand
- Transmission interface limits

Requirements:

- Reserves
- Residual unit commitment
- Energy to serve demand



Day-ahead market process

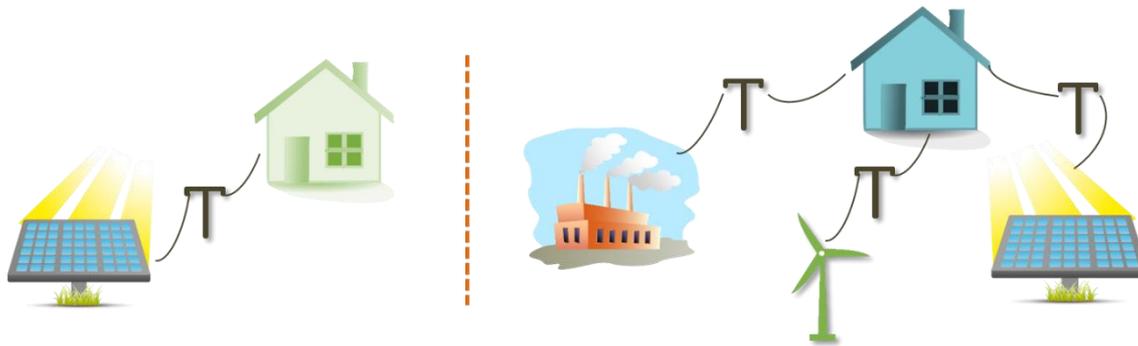
Market opens 7 days before the trade date



* Pacific Prevailing Time

Step 1: Market power mitigation (MPM)

- Ensure 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



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

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

(ISO Tariff section 39.7.1)

Step 2: Integrated forward market (IFM)

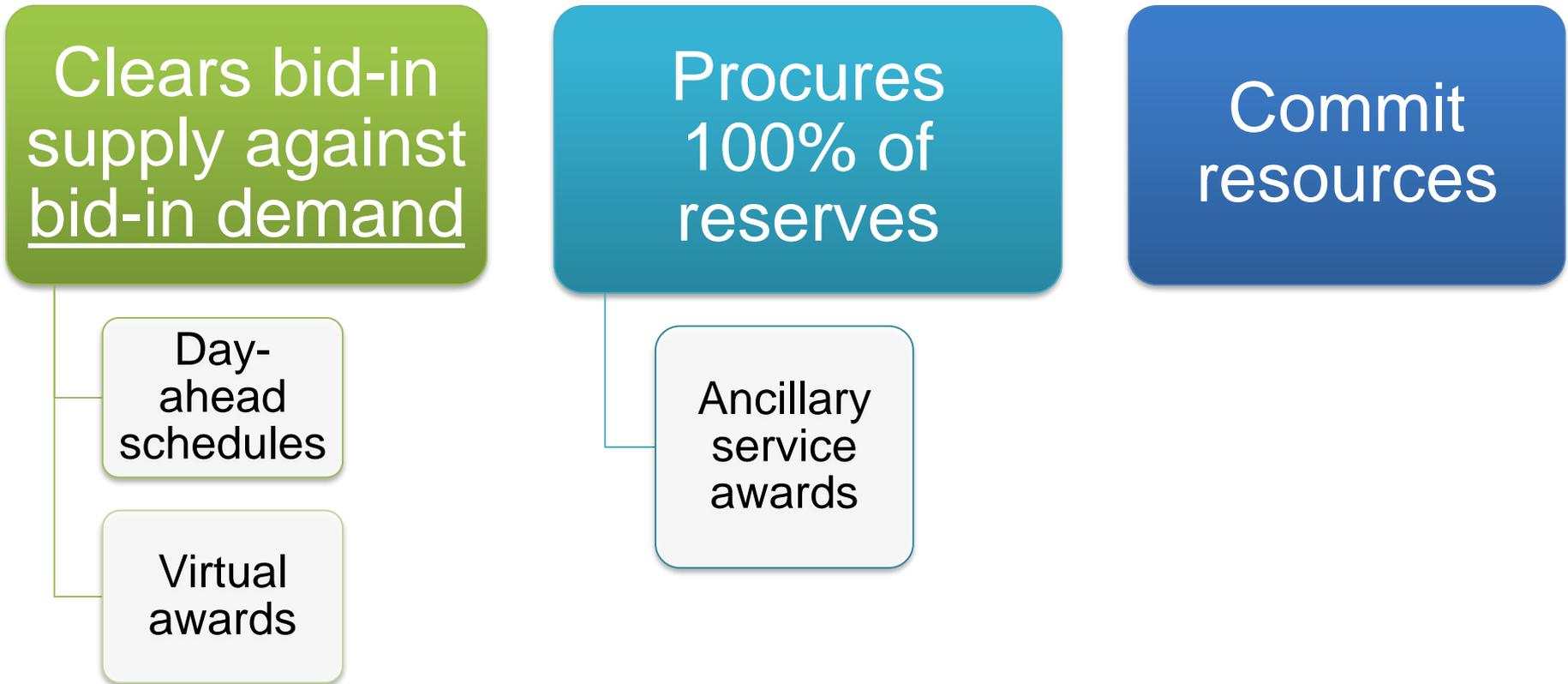
Clears bid-in supply against bid-in demand

Day-ahead schedules

Virtual awards

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

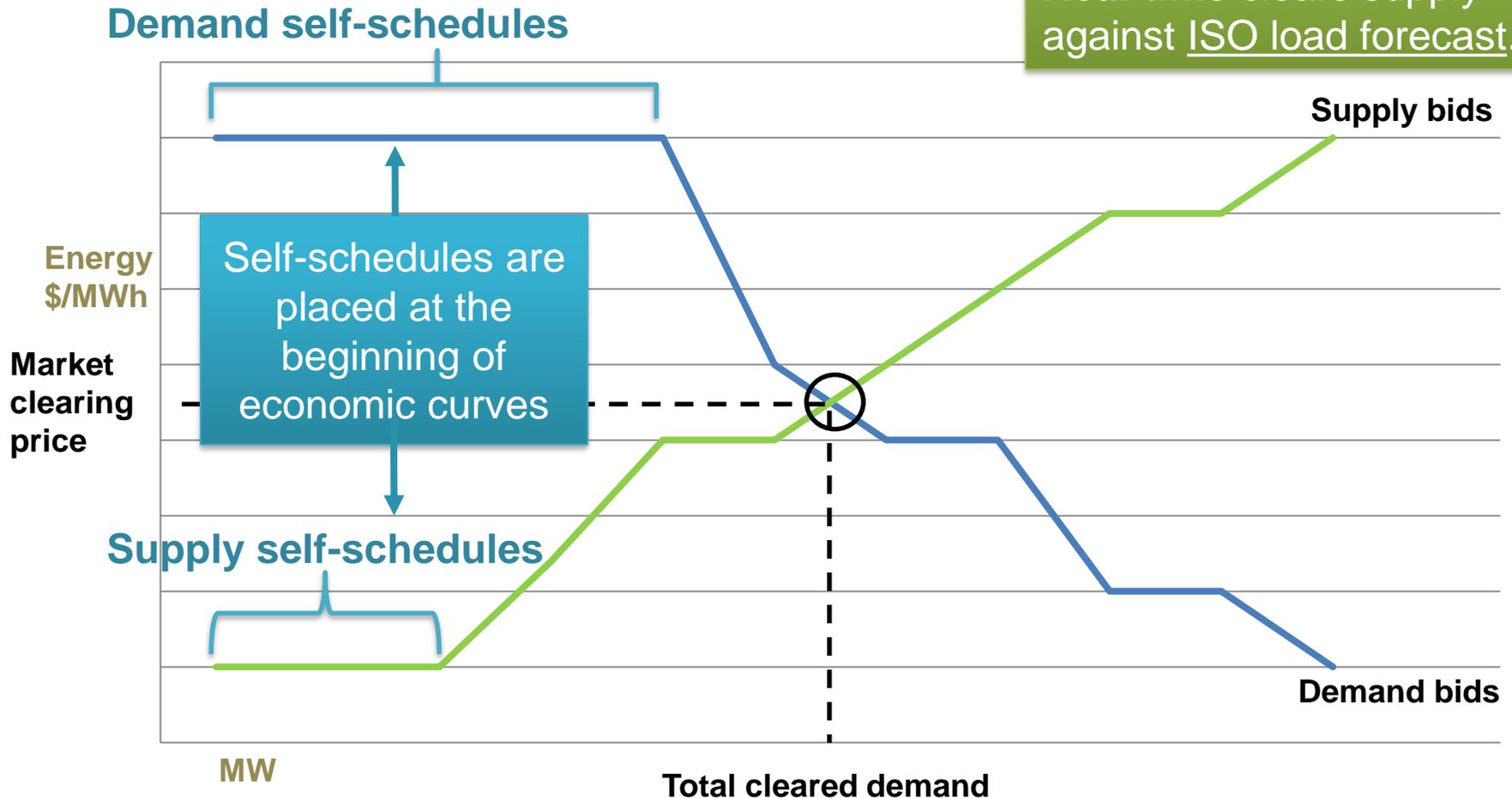
Step 2: Integrated forward market (IFM)



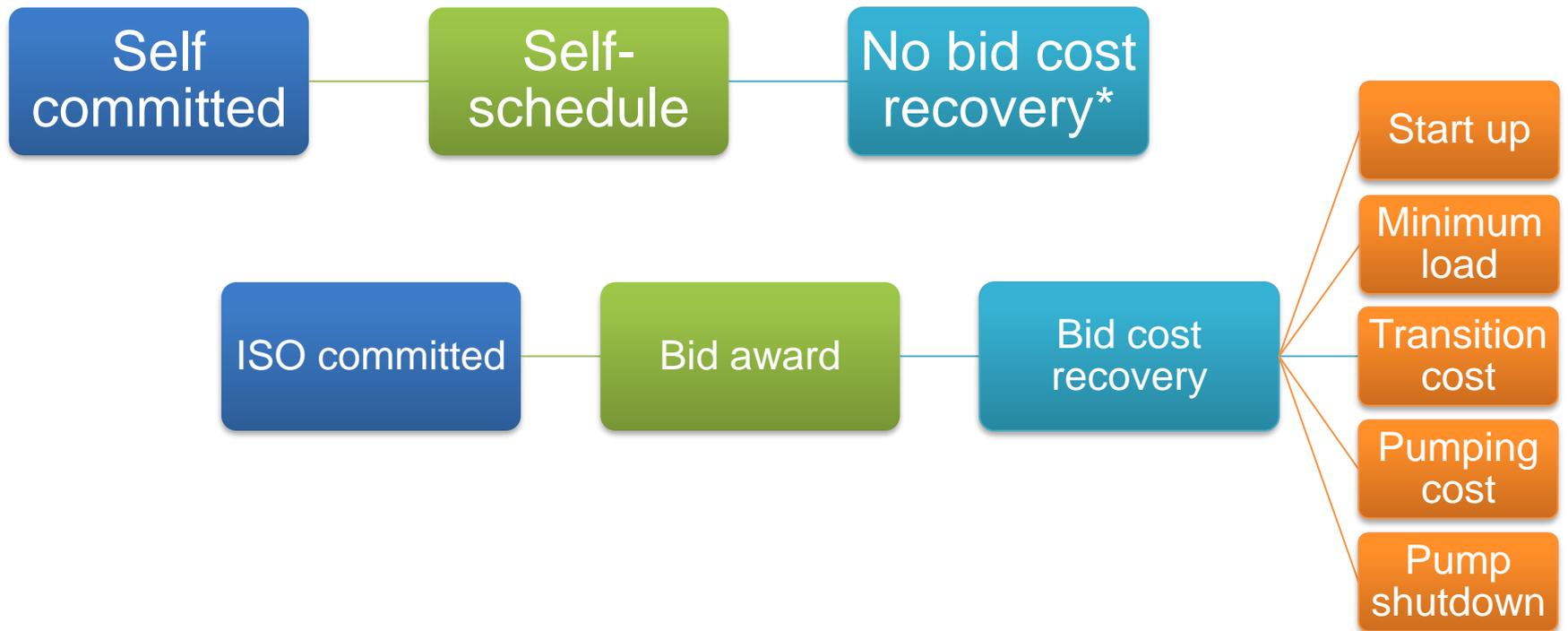
Step 2: What clears in the IFM?

Day-ahead clears supply bids against demand bids;

Real-time clears supply against ISO load forecast.

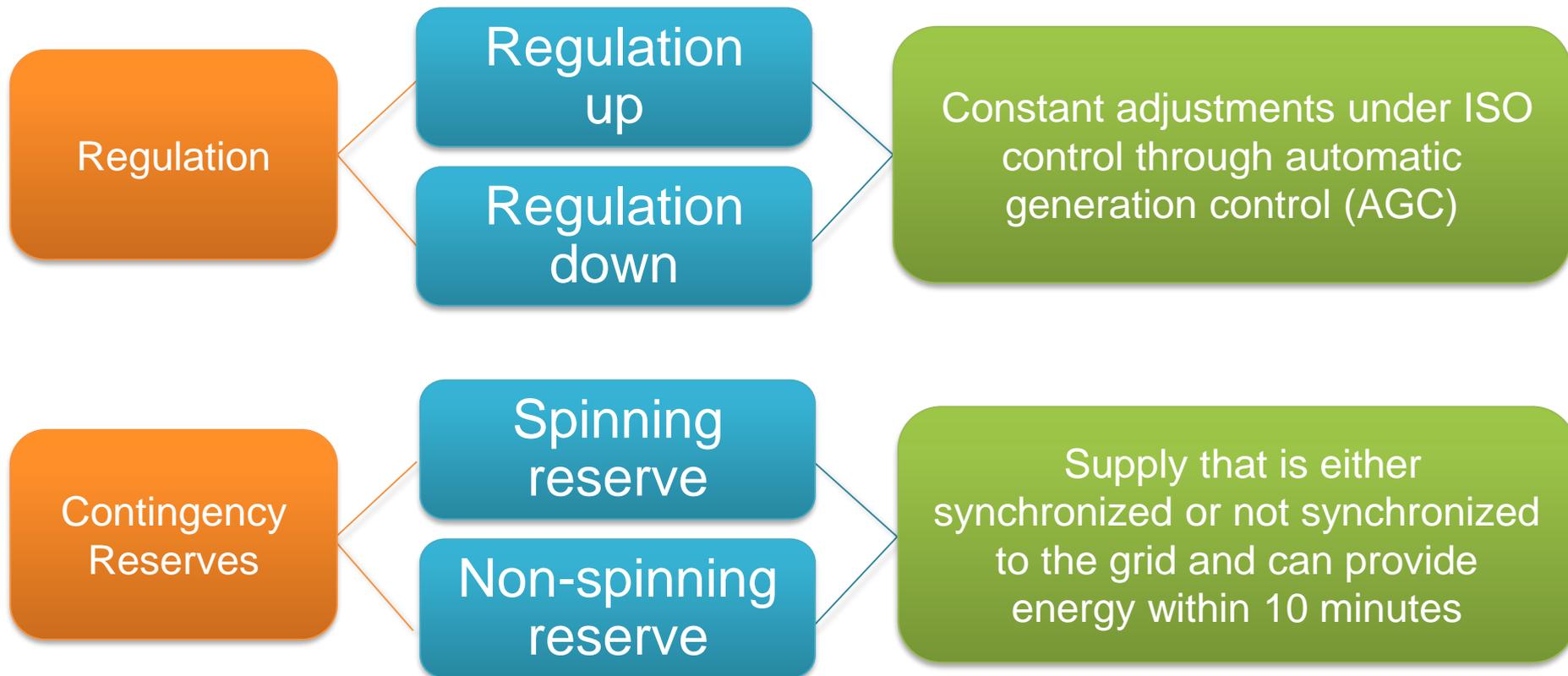


How the bid is submitted affects the resource commitment status



* If resource bids above self-schedule they could be eligible to recover energy bid amount, not start up and minimum load

Step 2: Ancillary services ensure reliability as electricity is moved from generating sources to customers



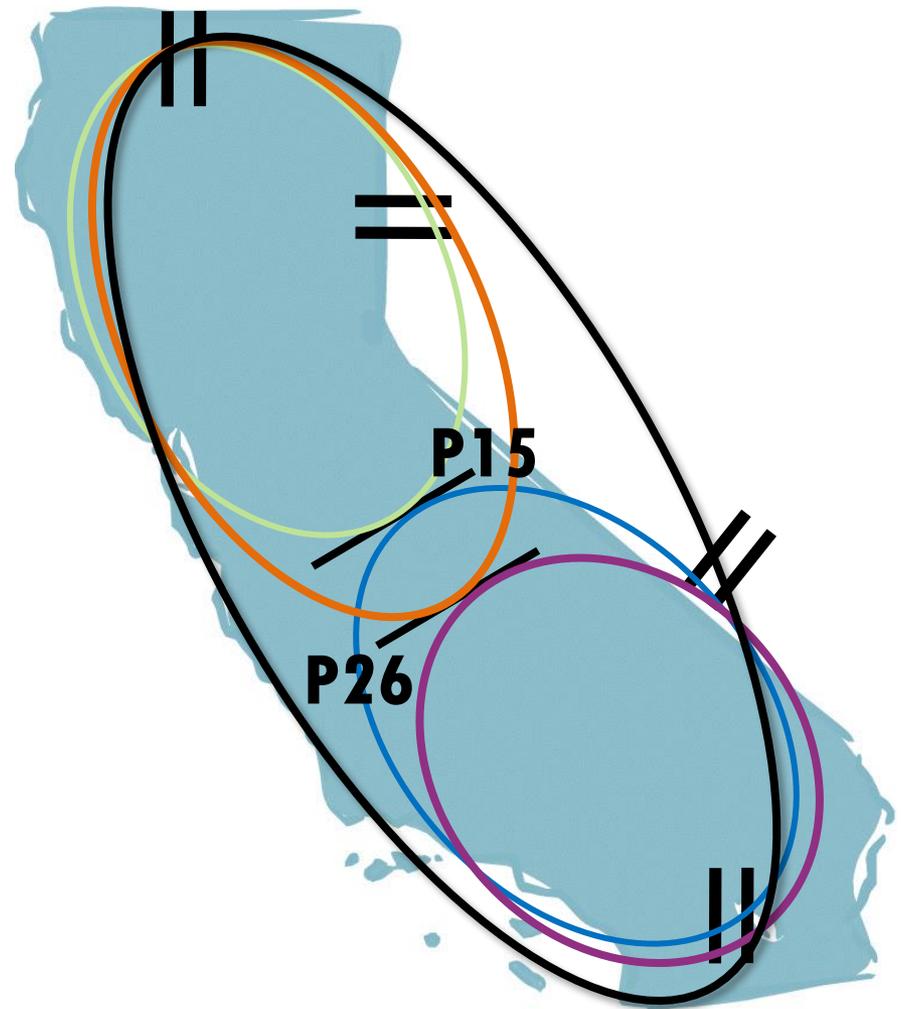
Step 2: Ancillary service procurement is regional

Two overlapping system regions to ensure reliability

- ISO system region
- ISO expanded system region

Eight sub regions

- North of Path 15 & 26 + expanded northern region
- South of Path 15 & 26 + expanded southern region



The ISO procures ancillary services and additional capacity in day-ahead to meet reliability requirements

Regulating reserves

- based on procurement targets set by ISO to meet WECC standards

Contingency reserves

- based on procurement targets set by WECC

Residual Unit Commitment

- to meet the ISO system-wide and regional forecasts

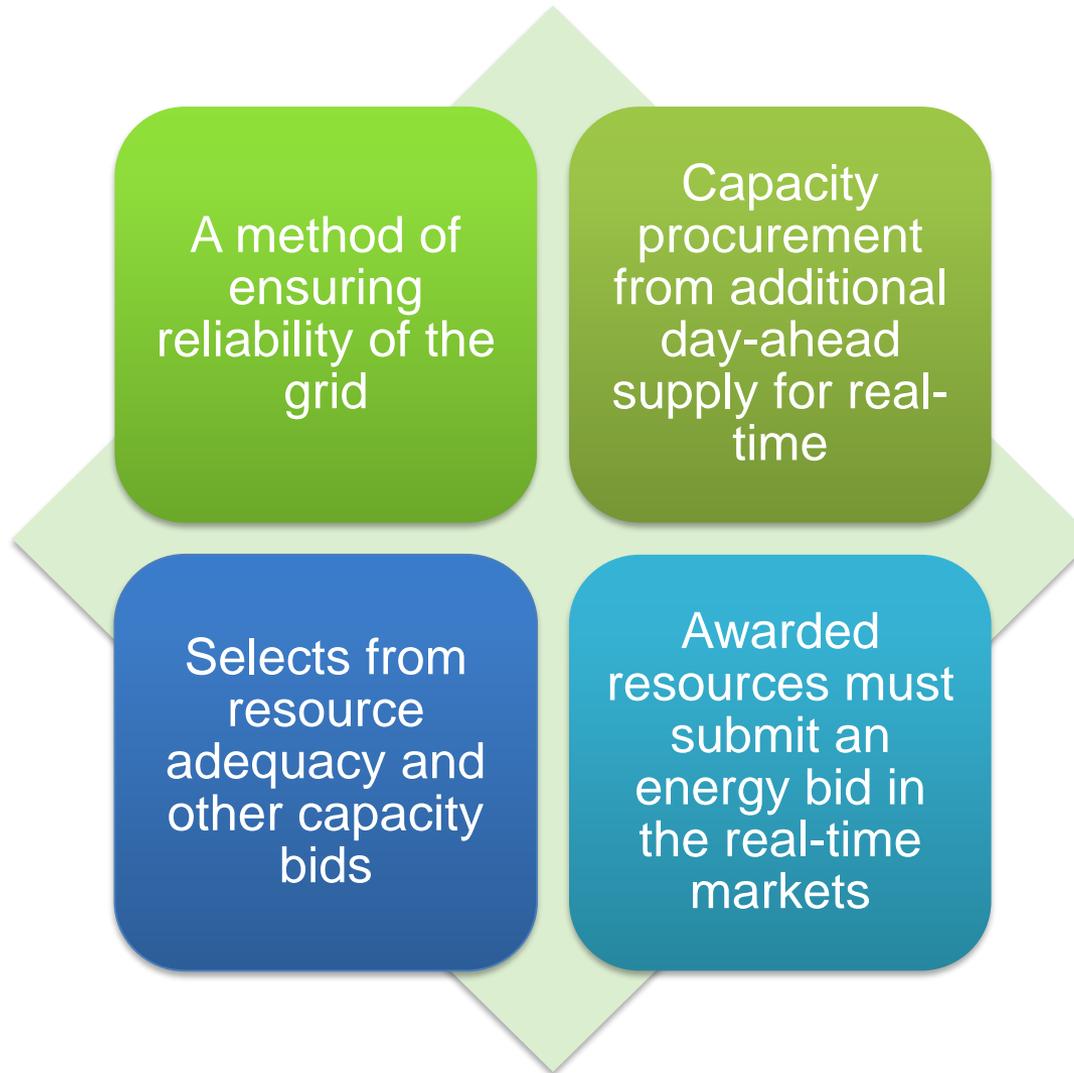
Security Constrained Unit Commitment (SCUC)

The ISO uses SCUC to run the processes associated with the commitment of resources

The objective is to minimize start-up and minimum load costs, bid in energy costs, and ancillary services costs, subject to network and resource-related constraints over the entire time horizon

The SCUC methodology maximizes economic efficiency, relieves network congestion, and considers physical constraints to achieve least-cost resource commitment and scheduling

Step 3: Residual unit commitment (RUC)



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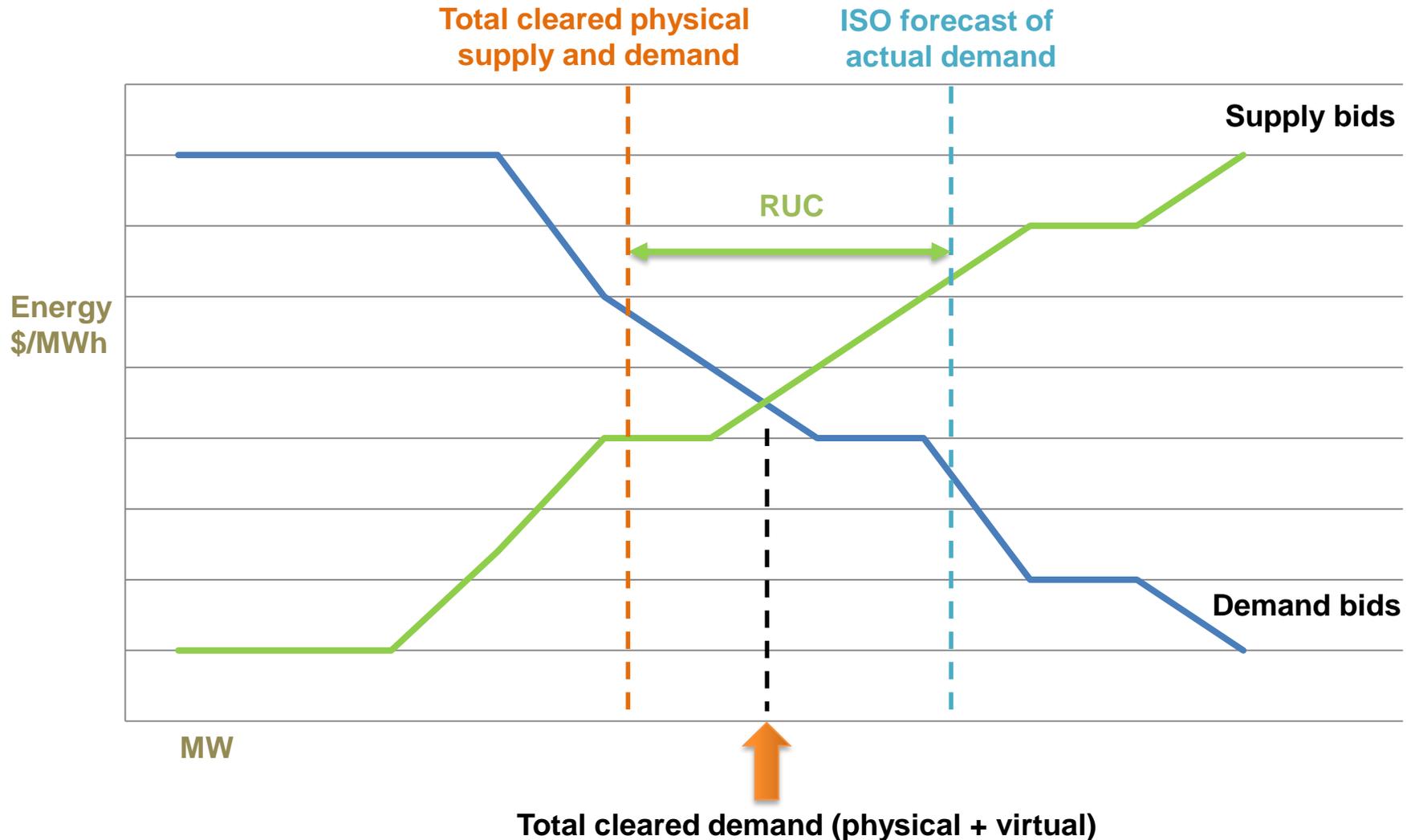
Uses the same SCUC optimization as IFM

Set up to meet high confidence demand forecast

Removes virtual supply & demand bids from calculation

Introduces ISO forecast for variable energy resources

Step 3: RUC ensures sufficient capacity is available to meet forecast demand that was not committed in IFM



RUC procured in zones

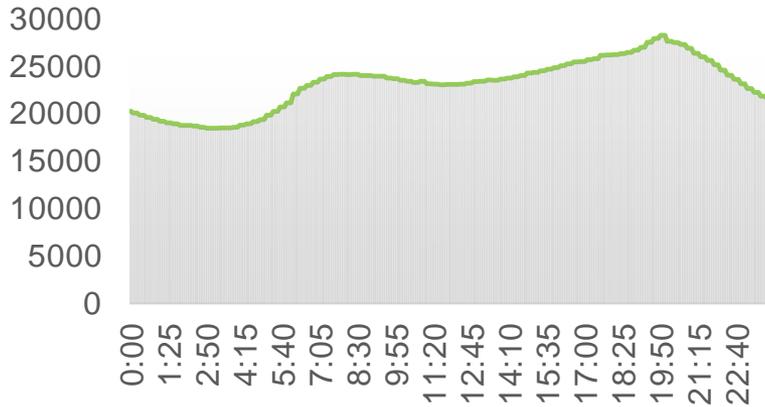
Regional requirements align with the following service territories:

- PG&E
- SCE
- SDG&E
- VEA

PTOs provide Demand Response spreadsheets that the ISO uses to lower RUC obligations



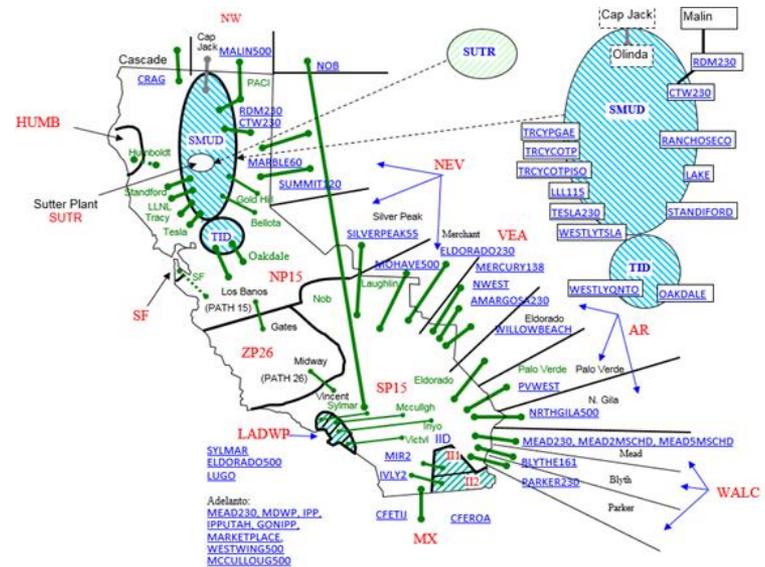
Meeting the RUC target



— Forecast

- RUC bids are a single quantity and price
- RUC bids must be \$0 for all MWs that have been designated resource adequacy (RA) capacity

- RUC distributes **demand forecast** data over the FNM's connectivity nodes using system load distribution factors



Full Network Model

To meet the RUC target, the market looks at:

RA resources that are short-start, with RA not awarded or not fully awarded in IFM as energy

- All MWs up to the RA obligation are taken at \$0
- If market can clear all RUC MWs from RA resources, RUC price will be \$0

Long-start resources that already have an IFM award

Then it looks at the RUC offers

- If offer is from long-start resource without IFM award, it also factors in the Minimum Load Cost & Start-Up Cost because RUC awards are binding for long-start resources

RUC awards

Resources with a RUC award must submit a Real-Time economic bid to cover the awarded MWs

RUC awards for short-start units are advisory

- Submit RT economic bids for energy to support RUC award

RUC awards for long-start units are binding

- In Real-Time the resource must be on at PMIN with Real-Time economic bids for energy that support RUC award

Long-start = startup & min runtime > 4.5 hours

RUC looks out further than the next trade date

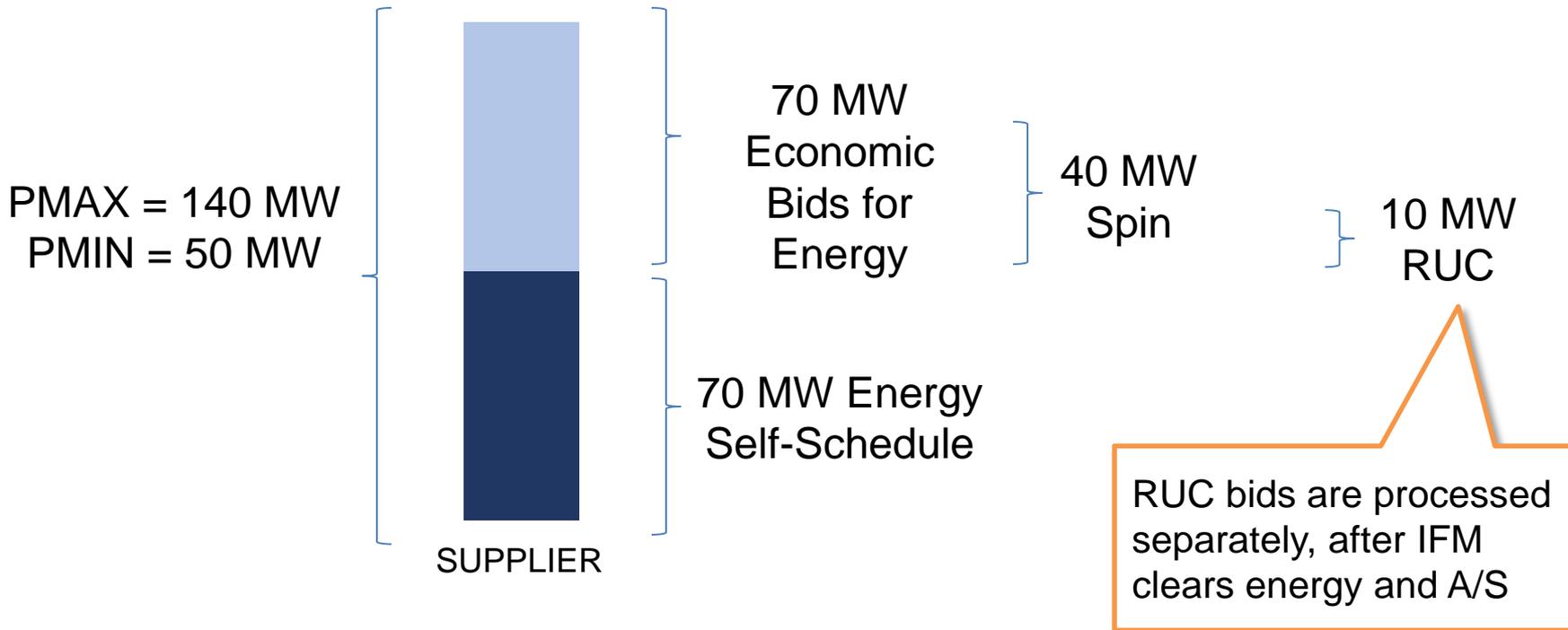
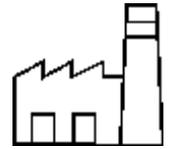
Extremely long-start commitment (ELC) process applies to:

- 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.



Example: Day-ahead bidding activity (supplier)

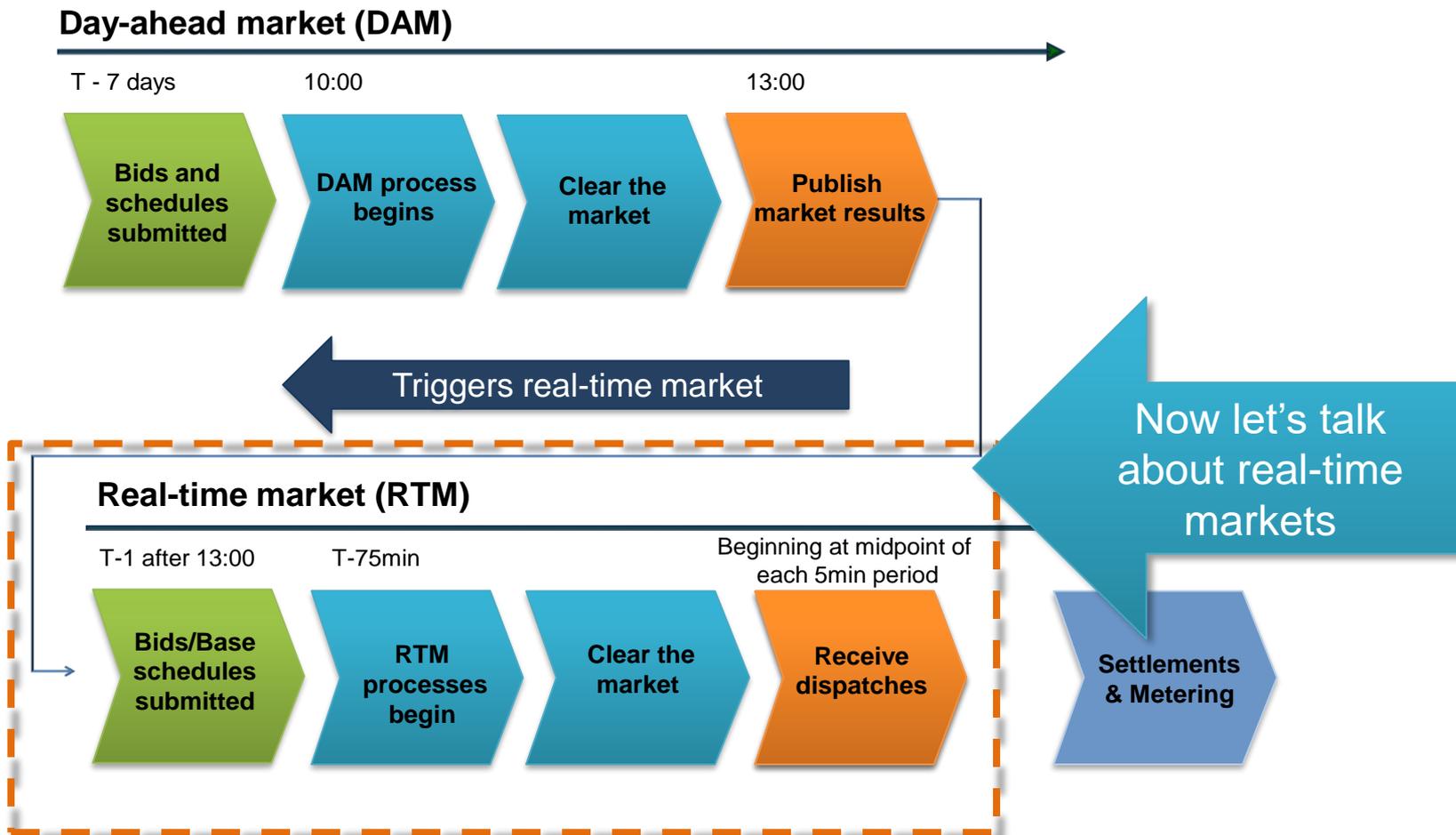


- The same MWs are being offered to the market across a variety of products
- The market co-optimizes the offers for **energy** and **ancillary services** along with those from all of the other resources to determine the optimal solution across the entire day

Questions

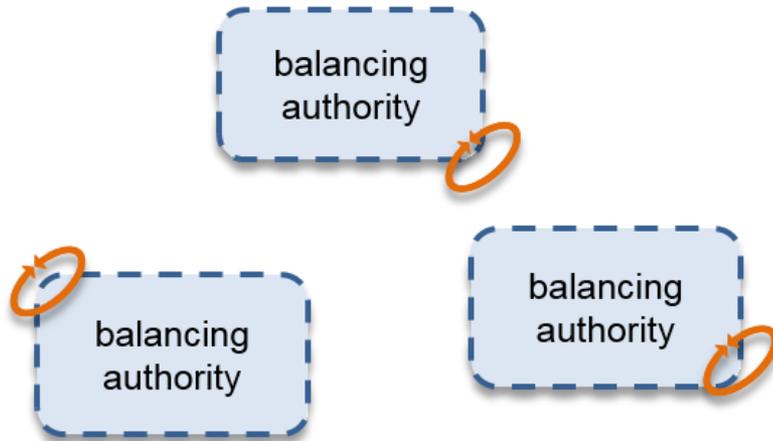
REAL-TIME MARKET

Day-ahead and real-time markets

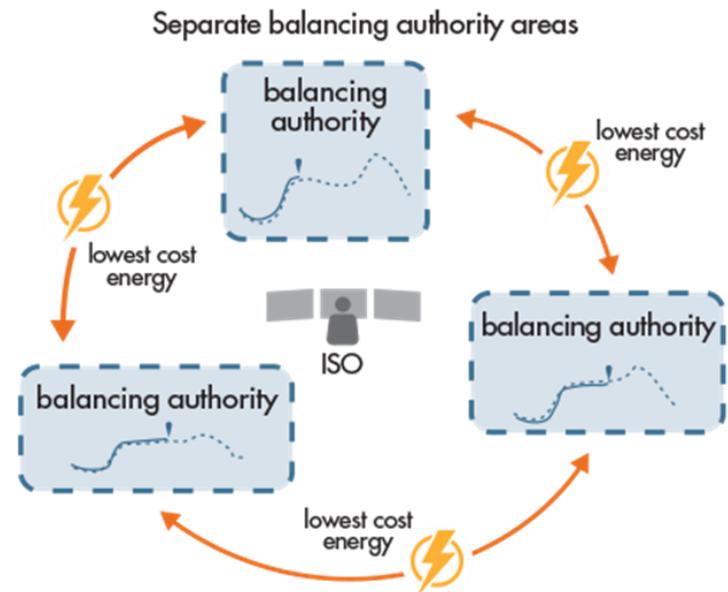


The real-time market includes Energy Imbalance Market participants

In a non-EIM environment:
Each BA balances loads and resources within its borders



In an EIM:
The market dispatches resources across BAs to balance energy



**Entities are still responsible for running their own
BAAs**

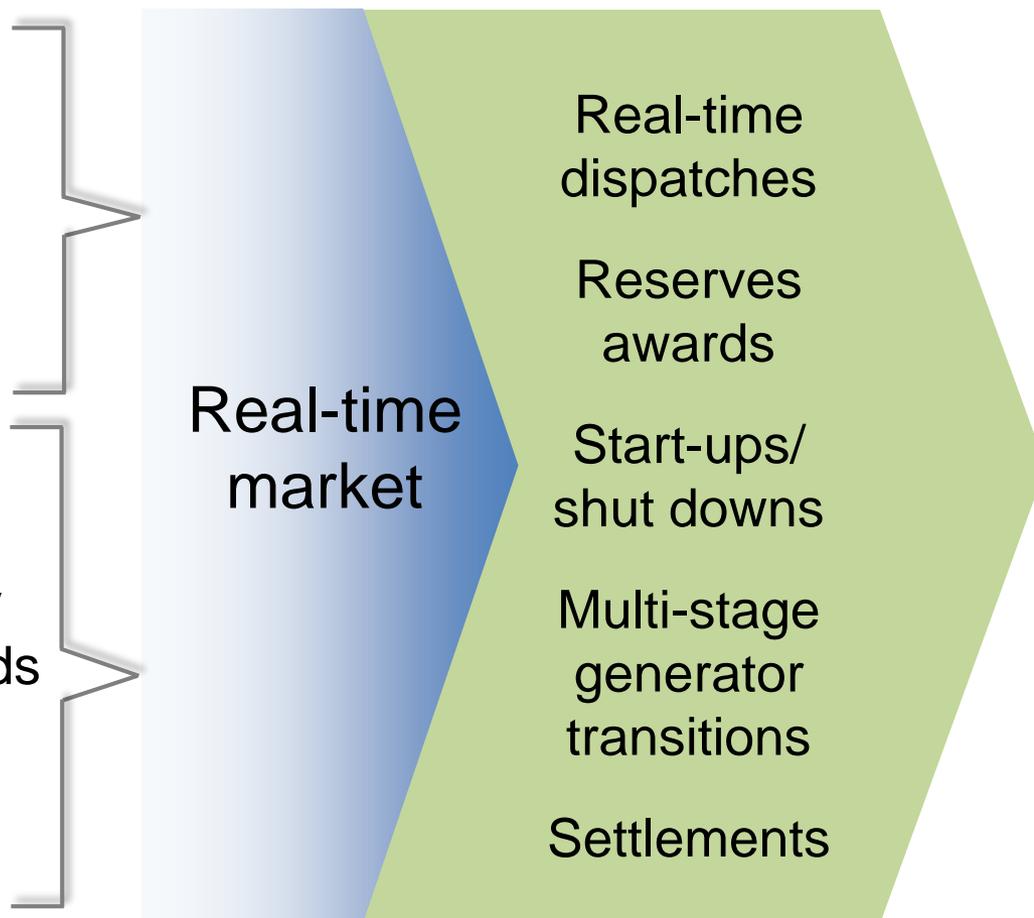
Inputs and outputs of the **real-time** market

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



There are different ways SCs can participate in the real-time market (RTM)

Energy bids are used to manage the instantaneous demand movement on the grid



Ancillary service bids are procured in RTM as contingency only products to maintain stability of the grid



Variable energy resources use forecasts to cap or extend schedules and bids



Intertie bidding options determine how FMM will optimize resources

Bids and base schedules are submitted for each hour of each day in real-time

Opens when the day-ahead market results are published in CMRI and OASIS

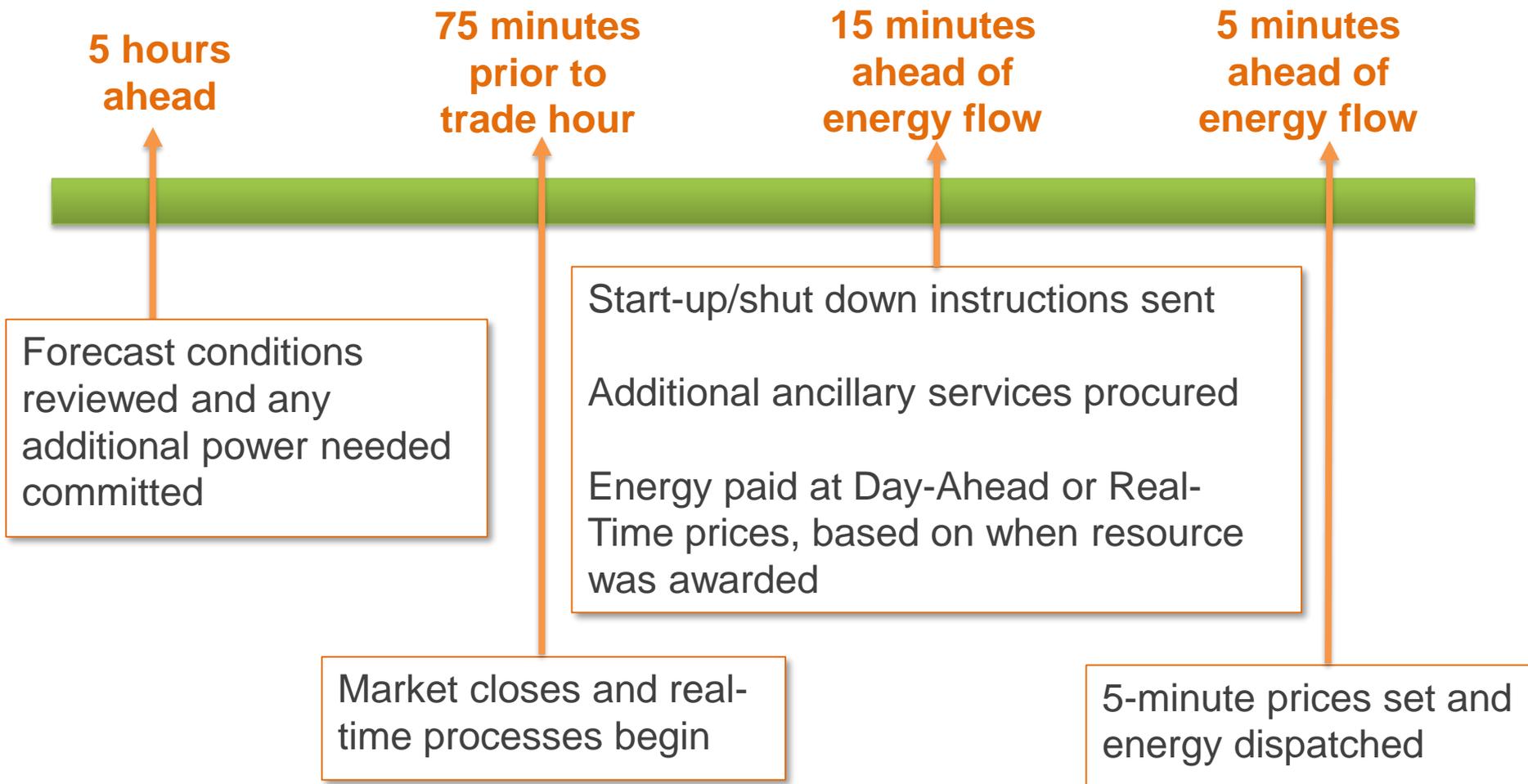


Submit bids & base schedules



Closes 75 minutes before the trade hour

Real-time milestones



Real-time market processes

Market power mitigation
(MPM)



Mitigates market power

Hour-ahead scheduling
process (HASP)



Produces HASP advisory
schedules and advisory AS
awards; Binding HASP intertie
schedules with hourly block bids

Short term unit
commitment (STUC)



Issues start-up instructions to
medium and short start units

Real-time unit
commitment (RTUC) /
15-minute market (FMM)



Issues start-up/shut down
instructions to short and fast start
units
Procures ancillary services as
needed

Real-time market processes

Real-time economic
dispatch (RTED)



5 minute dispatch to meet energy
imbalances

As needed

Real-Time Contingency
Dispatch (RTCD)



Dispatches of energy in real-time
to respond to a grid disturbance or
a system emergency

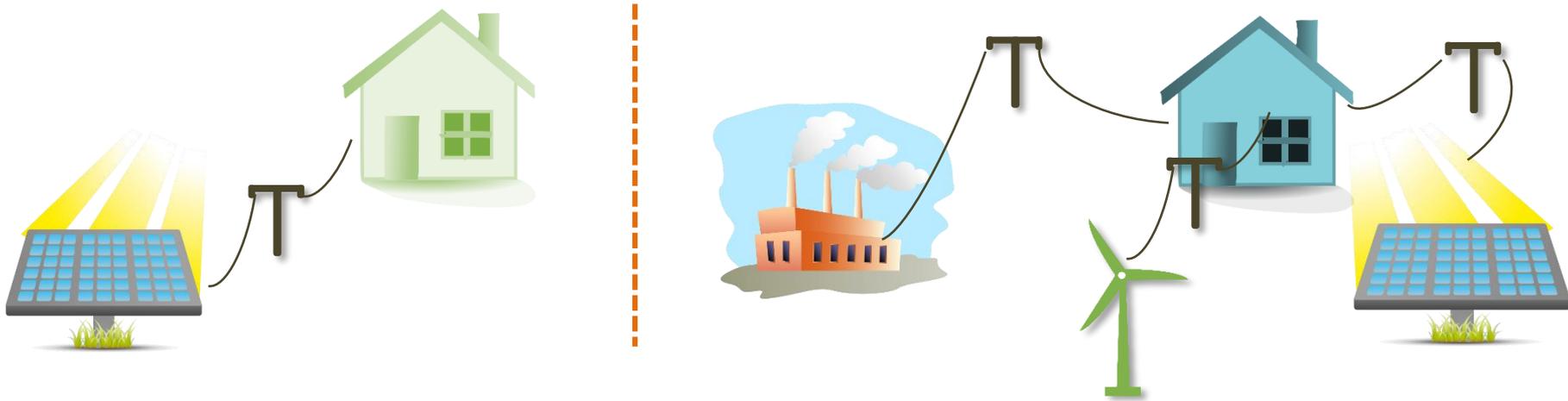
Exceptional Dispatch
(ED)



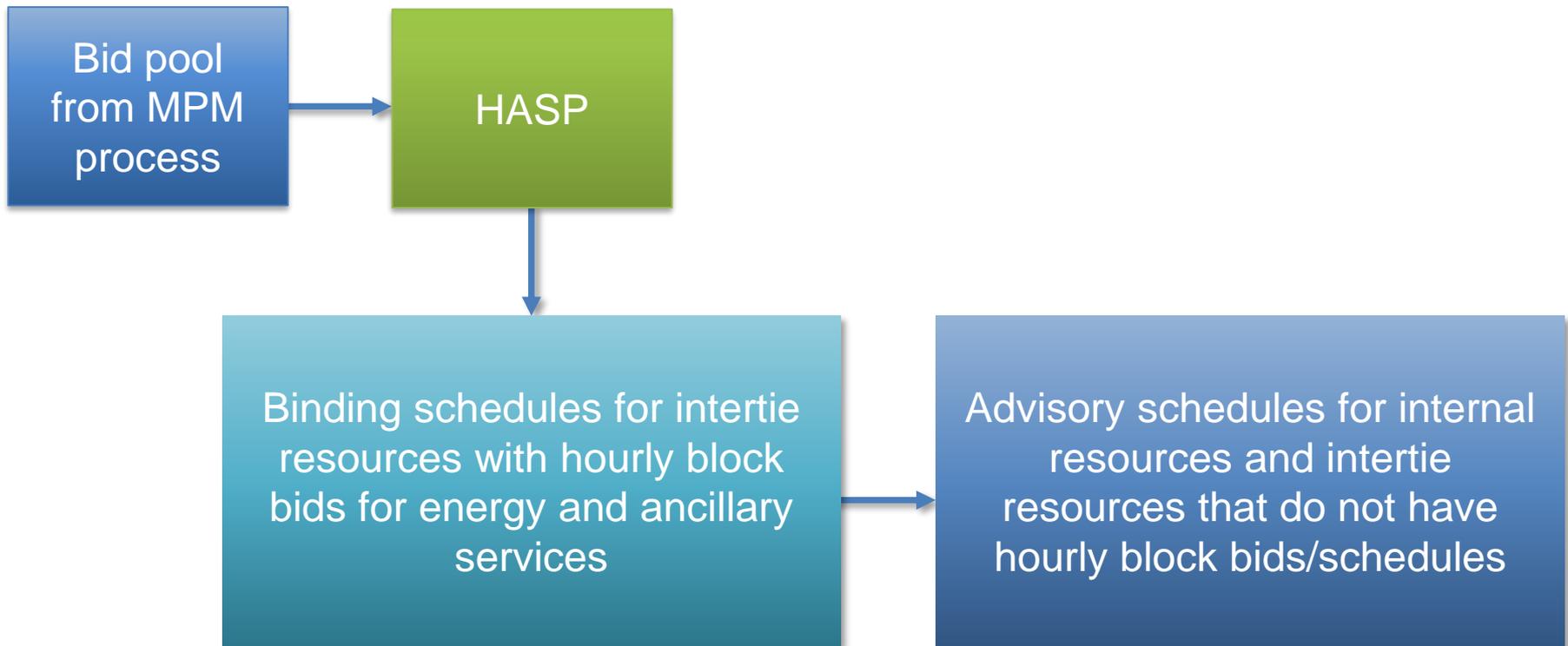
To prevent an imminent system
emergency or a situation that
threatens system reliability

Market power mitigation (MPM) is the same process as performed in the day-ahead market

- Performed separately for HASP, RTUC, and RTD
- Produces a bid pool for use in the fifteen-minute market and real-time dispatch



Hour-ahead scheduling process (HASP)



- *Compensated at FMM prices for each interval*
- *Some opportunity to be made whole in case of emergency situations*
- *All energy moving through the scheduling point between the ISO control area and the neighboring control area must be tagged before it can flow*

Short-term unit commitment (STUC)

STUC occurs once per trade hour

Examines the potential demand requirements for the next 4 ½ trade hours and issues start up and shut down instructions to medium and short start resources in order to meet the anticipated demand

Real-time unit commitment (RTUC) & fifteen-minute market (FMM)

Runs every 15 min.
& looks ahead in
15 min. intervals
spanning the
current & next
trading hour

Produces
binding and
advisory FMM
awards

Start-up /
Shut down
instructions to
fast start and
short start
resources

Transition
decisions for
multi-stage
generating
resources

Real-time unit commitment (RTUC) & fifteen-minute market (FMM)

Determine financially binding FMM schedules and corresponding LMPs (including LAP LMPs for settling demand)

Processes forecasts and limits for variable energy resources

Uses energy and AS bids to optimize schedules and awards

- Procure additional AS and re-calc ASMP prices used for the next FMM interval

Real-time economic dispatch (RTED)

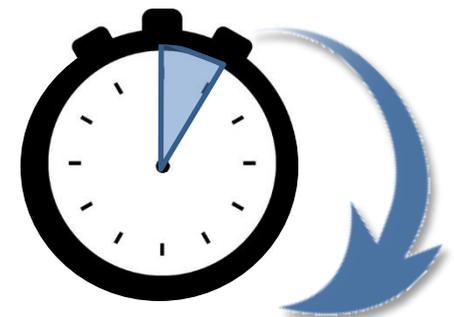
RTED is a process that runs every five minutes that produces the most efficient solution to:

- manage transmission constraints
- meet the short-term load forecast

Produces dispatch instructions for energy for the next interval and advisory instructions for as many as 12 future intervals

Security Constrained Economic Dispatch (SCED)

- Centralized economic dispatch optimizes use of all resources
 - reduces cost of serving demand
- Resolve transmission constraints economically
- Transparency on constraints and costs
- System is re-dispatched every five minutes to meet current system conditions



Outputs: resource instructions in Automated Dispatch System (ADS)

- For each **fifteen minute interval** we are:
 - Starting-up or shutting down resources
 - Transitioning multi-stage generators
- For each **five minute interval** we are:
 - Issuing real-time dispatch instructions



Real-time contingency dispatch (RTCD)

- Run in response to a significant contingency event, such that waiting until the next normal economic (RTED) run is not adequate
- Produces a 10-minute dispatch
- Dispatches energy to respond to a grid disturbance or a system emergency
 - Dispatch instructions override previously issued instructions from RTED



Real-time contingency dispatch (RTCD)

- Ancillary service awards for spinning or non-spinning reserves designated as contingency only are made available to the market
- Energy produced as a result of RTCD settles at real-time LMP



Exceptional dispatch (ED)

Entered manually by ISO operator into the real-time market optimization software

Cannot set the LMP

May be utilized to issue an energy dispatch, forced shut-down, forced start-up, or forced multi-stage generator transition

Used to prevent a situation that impacts system reliability, or an imminent system emergency, that cannot be addressed through normal market operations

Called “Manual Dispatch” when performed by EIM Entity operator

Exceptional dispatch (ED)

Other reasons an exceptional dispatch may be issued:

- Perform ancillary services testing
- Perform pre-commercial operations testing for generating units
- Mitigate for over-generation
- Accommodate TOR or ETC self-schedule changes after the market close of the real-time market

Questions



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