Energy Storage Enhancements, Track 1 Refresher Training

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Rev 06/20/23

Scheduling Coordinators with Storage Resources

Market Optimization	Ancillary Services	Default Energy Bids

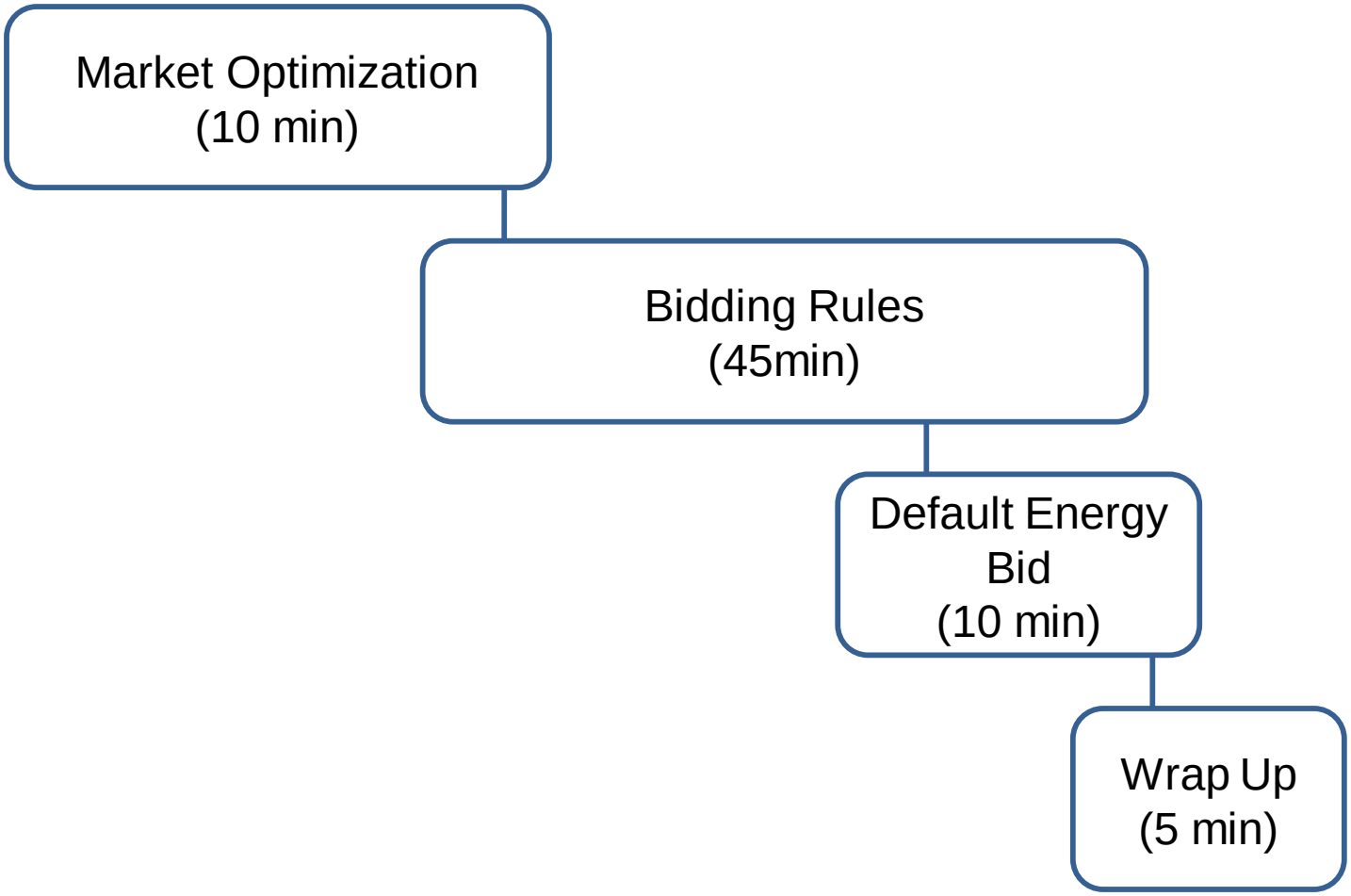
Housekeeping

Make sure to keep yourself muted unless you have a question

If you have a question, you may either ask over the phone or in the chat

If you want to ask a question, you can virtually “raise your hand” in WebEx

In today's session we'll cover:



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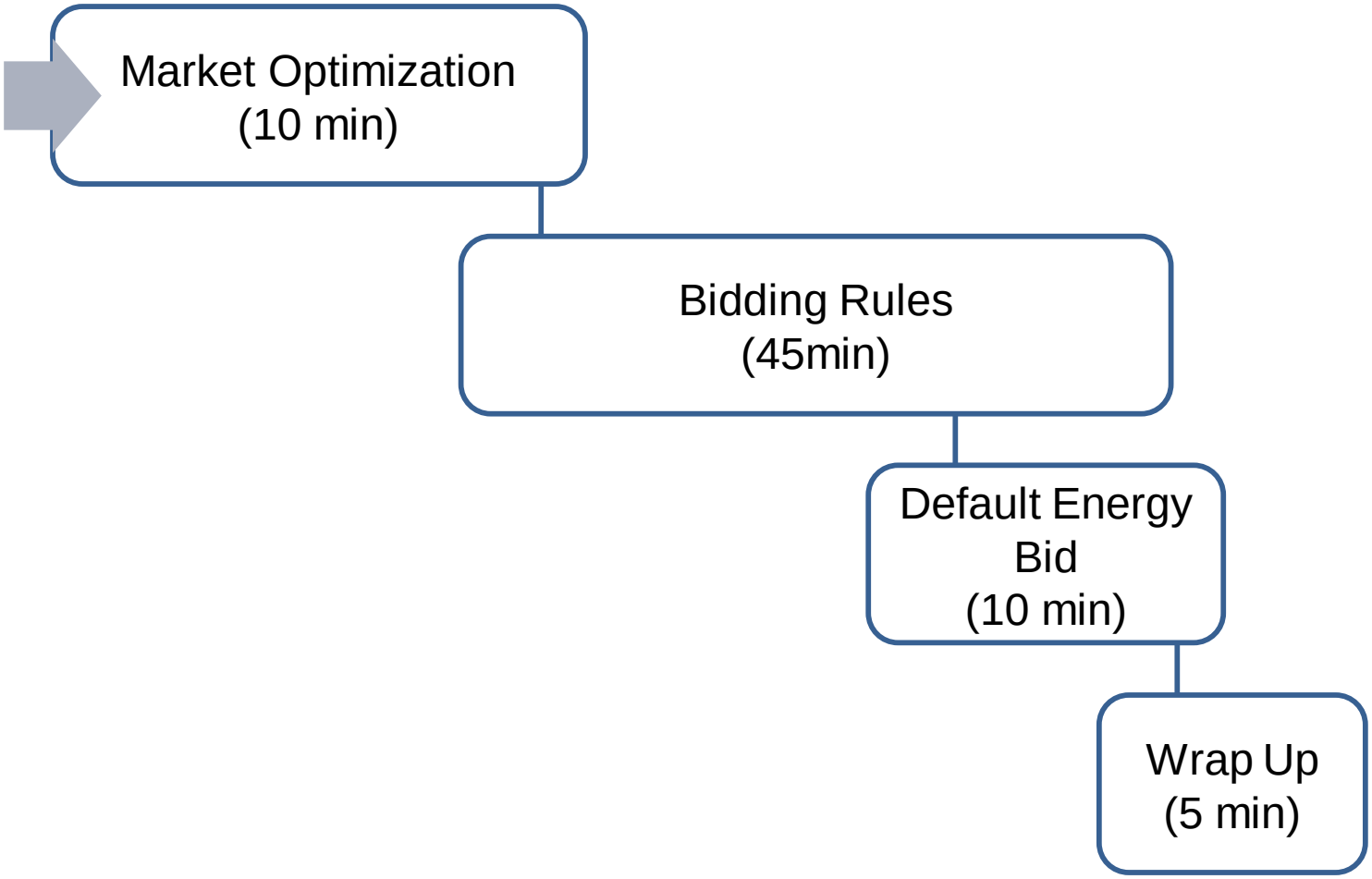
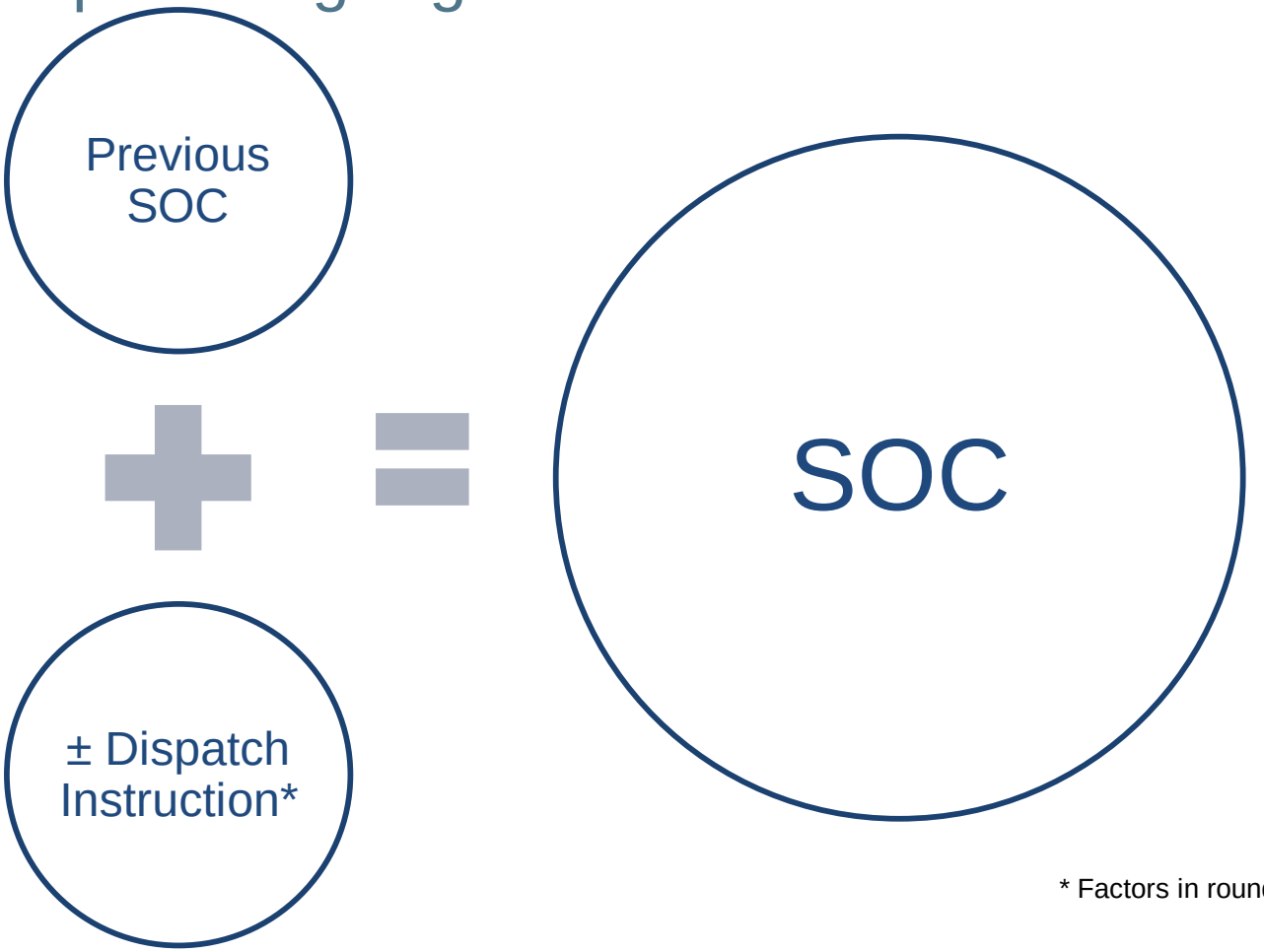


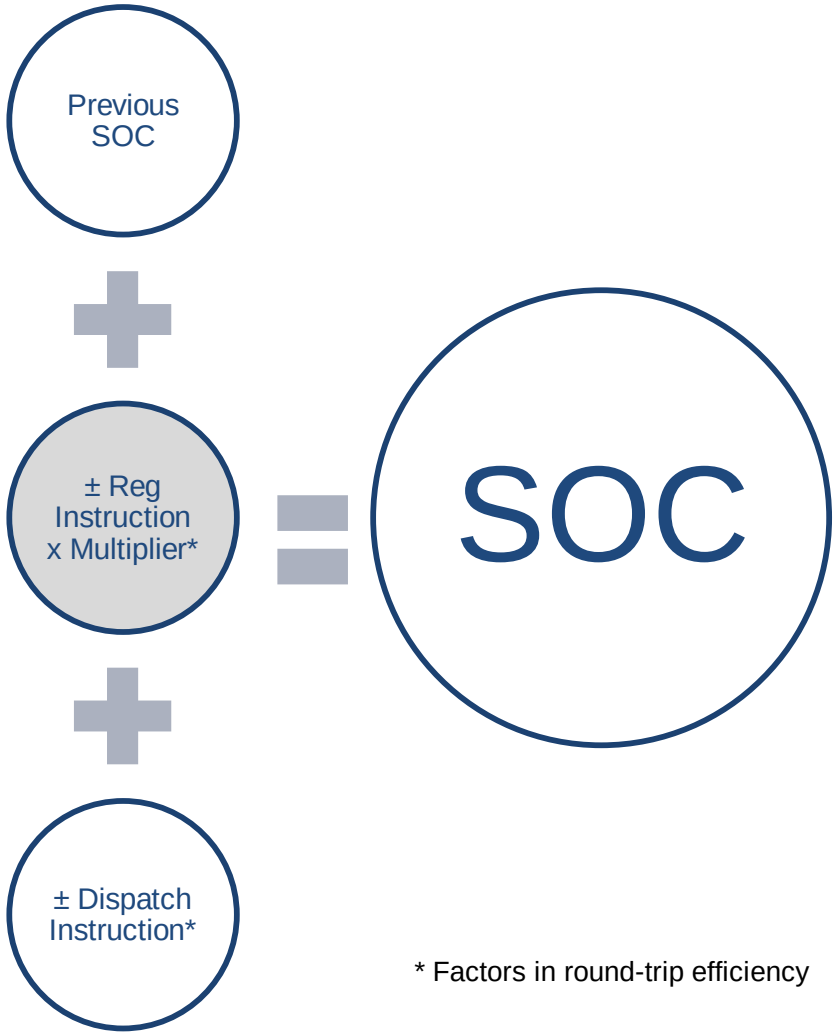
The issue: The state of charge (SOC) optimization does not anticipate the energy that will be gained or lost when providing regulation



* Factors in round-trip efficiency

The proposed solution: Consider regulation up and regulation down in the SOC optimization

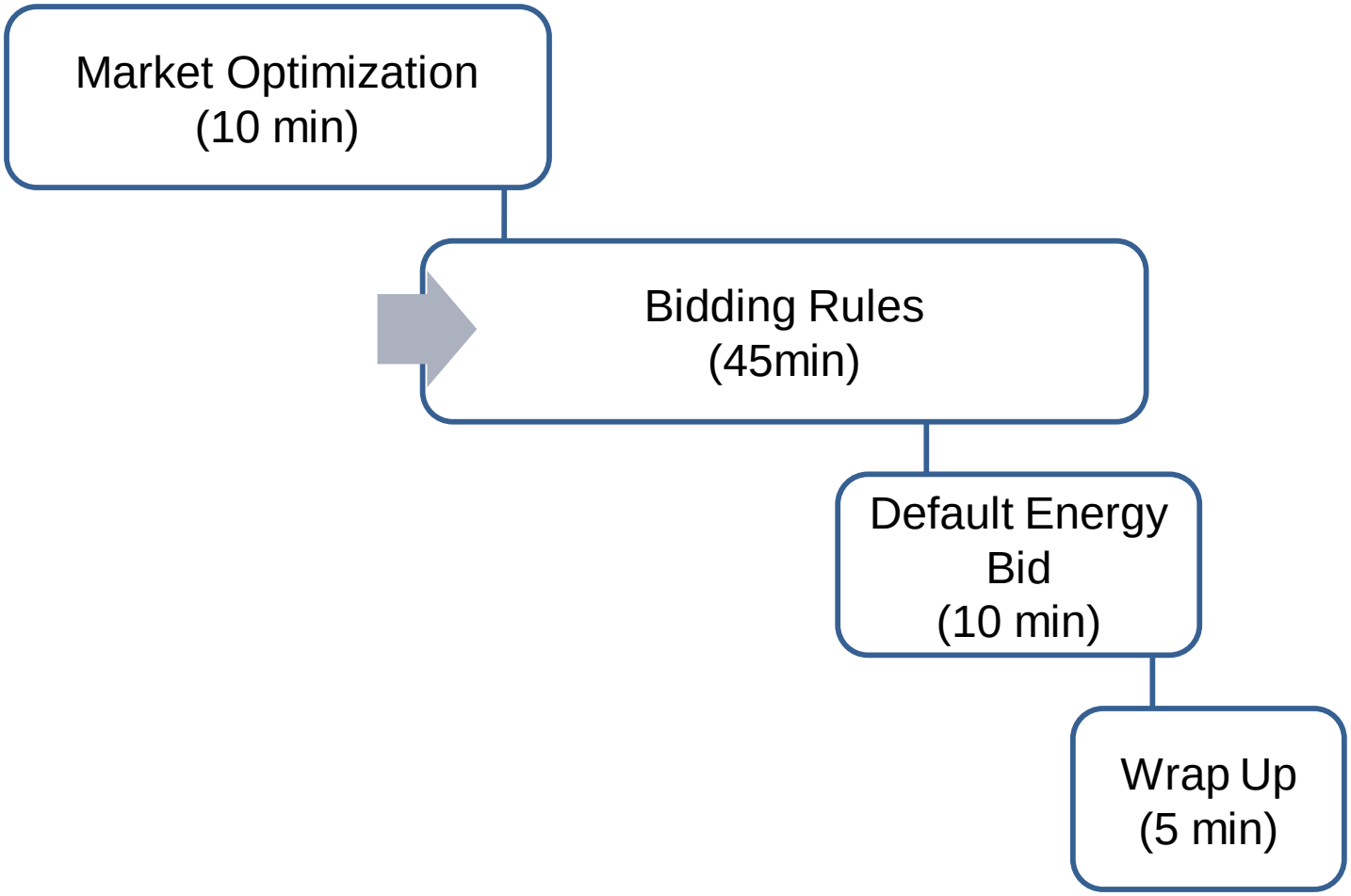
6/22 Update – This solution will not be implemented on 7/1. The ISO will continue work on this feature and in the meantime the "multiplier" or attenuation factor will be set to zero for all hours for regulation up and regulation down.



* Factors in round-trip efficiency

Q&A

In today's session we'll cover:



Storage resources that are awarded ancillary services in the day-ahead market have new bidding rules

In real-time an energy bid is required to cover at least 50% of the AS award, in the opposite direction.

If AS award is for regulation up, spinning reserve or non-spinning reserve

- Real-time energy bid must be for charging

If AS award is for regulation down

- Real-time energy bid must be for discharging

Examples: A storage 48MWh resource with a ±12 MW range.

Day-ahead	Real-time
12 MW regulation up award	Bid at least 6 MW of energy to charge (negative range)
12 MW regulation down award	Bid at least 6 MW of energy to discharge (positive range)

Examples: A storage 48MWh resource with a ±12 MW range.

Day-ahead	Real-time
8 MW regulation up and 8 MW regulation down awards	Bid the remaining 4 MW of discharging and charging range as energy

Link to Energy Storage Enhancements Final Proposal:
FinalProposal-EnergyStorageEnhancements.pdf (caiso.com)

Final Proposal (October 27th, 2022): Language

- Page 12:

This final proposal, relaxes the prior requirement to only require energy bids in the real-time market equal to 50% of the ancillary service award from the day-ahead market. The proposal also relaxes the requirement for energy bids in the day-ahead market. Returning to the prior example, a +/- 12 MW storage

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The proposed rules will not require bids in the day-ahead market from the storage resource, but ancillary services will not be awarded in the day-ahead market that cannot accommodate the required energy bids in the real-time market. Further, numerical examples are provided in the sub-section below.

Final Proposal (October 27th, 2022): Examples

- Page 12:

day-ahead market. Returning to the prior example, a +/- 12 MW storage resource with an ancillary service schedule of 12 MW of regulation up would be required to bid a 6 MW range of charging capability in the real-time market alongside the ancillary service award. This could be a bid from in the operating range of the resource from 0 MW to -6 MW. The same resource could be awarded up to 8 MW of regulation up and 8 MW of regulation down at the same time, as long as these awards were accompanied by bids of a 4 MW range to charge and a 4 MW range to discharge energy. However, this resource could not be awarded to provide 9 MW of regulation up and 9 MW of regulation down during the same hour. If this was awarded the resource could not provide the required energy bids in real-time. This requirement is less burdensome than the

- From the language and these examples, the concept is that the energy bid in the opposite direction along with the AS awards must fit between the upper and lower capacity range

Implementation:

$$IFM/RUC: \begin{cases} CF\left(RU_{i,t} + SR_{i,t} + NR_{i,t}\right) \le -LCL_{i,t} - RD_{i,t} & (1) \\ CF\ RD_{i,t} \le UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t} & (2) \end{cases}$$

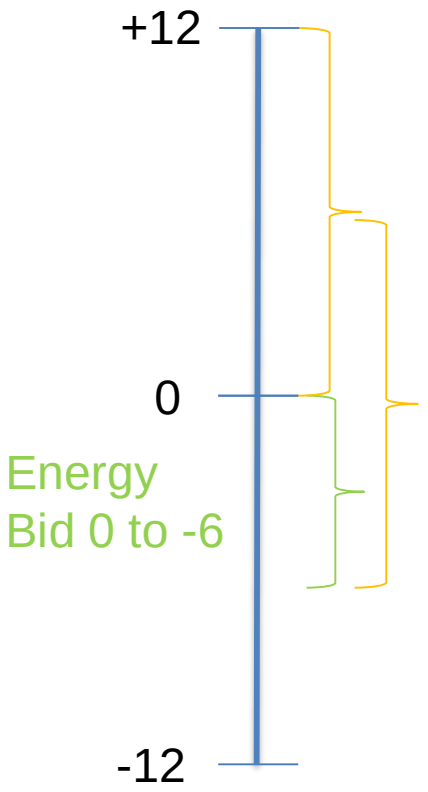
$$RTM: \begin{cases} CF\left(RU_{i,t} + SR_{i,t} + NR_{i,t}\right) \le -LCL_{i,t} - RD_{i,t} & (1) \\ CF\ RD_{i,t} \le UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t} & (2) \\ CF\left(RU_{i,t} + SR_{i,t} + NR_{i,t}\right) \le \max\left(0, -LEL_{i,t}\right) & (3) \\ CF\ RD_{i,t} \le \max\left(0, UEL_{i,t}\right) & (4) \end{cases}$$

$$, \forall i \in S_{LESR} \wedge t = 1,2, \dots, T$$

- Equations (1) and (2) are the capacity constraints
- Equations (3) and (4) are the energy bid constraint in the opposite direction of the AS awards.
- Our focus is on equations (1) and (2)

Acronyms
CF = Coverage Factor
LCL = Lower Capacity Limit
UCL - = Upper Capacity Limit

Example A : Reg Up=12, Reg Down=0, Energy Bid range is 0 to -6



$$CF\left(RU_{i,t}\right) \leq -LCL_{i,t} - RD_{i,t}$$

$$0.5\,(12) \leq 12 - 0 \rightarrow True$$

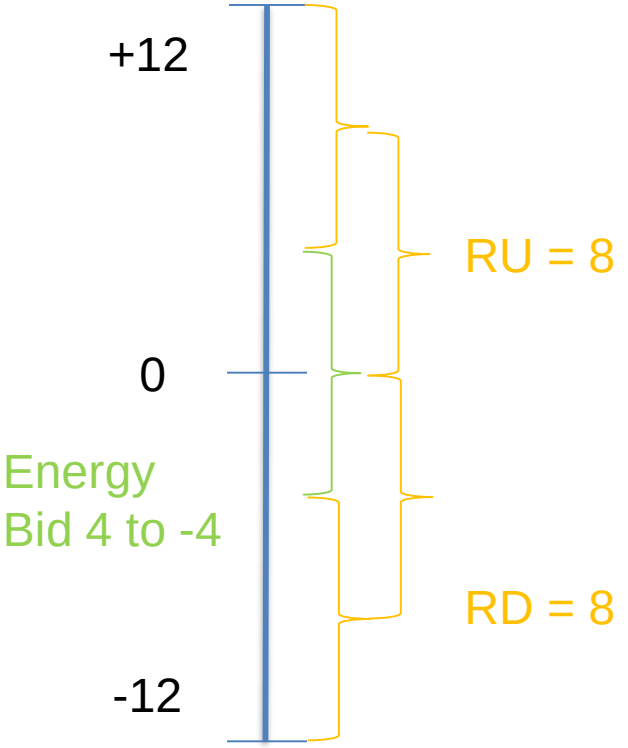
$$CF\ RD_{i,t} \leq UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t}$$

$$0.5 * 0 \leq 12 - 12 \rightarrow True$$

Model can award RU=12, RD=0

- Implementation results are in alignment with the approved Final Policy

Example B : Reg Up=8, Reg Down=8, Energy Bid range is 4 to -4

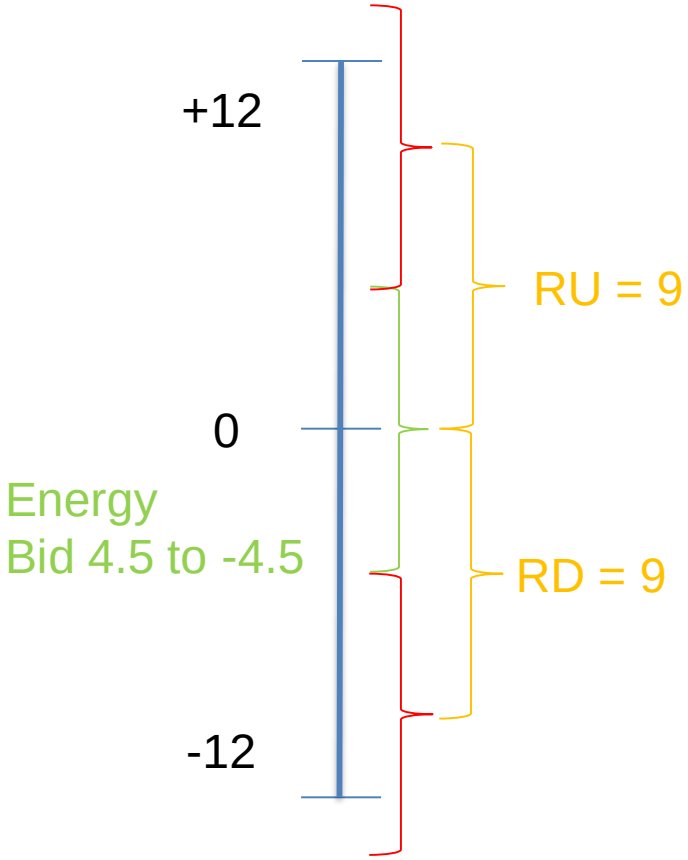


$$CF\left(RU_{i,t}\right) \leq -LCL_{i,t} - RD_{i,t}$$
$$0.5\ (8) \leq 12 - 0 \rightarrow True$$
$$CF\ RD_{i,t} \leq UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t}$$
$$0.5 * 8 \leq 12 - 8 \rightarrow True$$

Model can award RU=8, RD=8

- Implementation results are in alignment with the approved Final Policy

Example C : Reg Up=9, Reg Down=9, Energy Bid range is 4.5 to -4.5

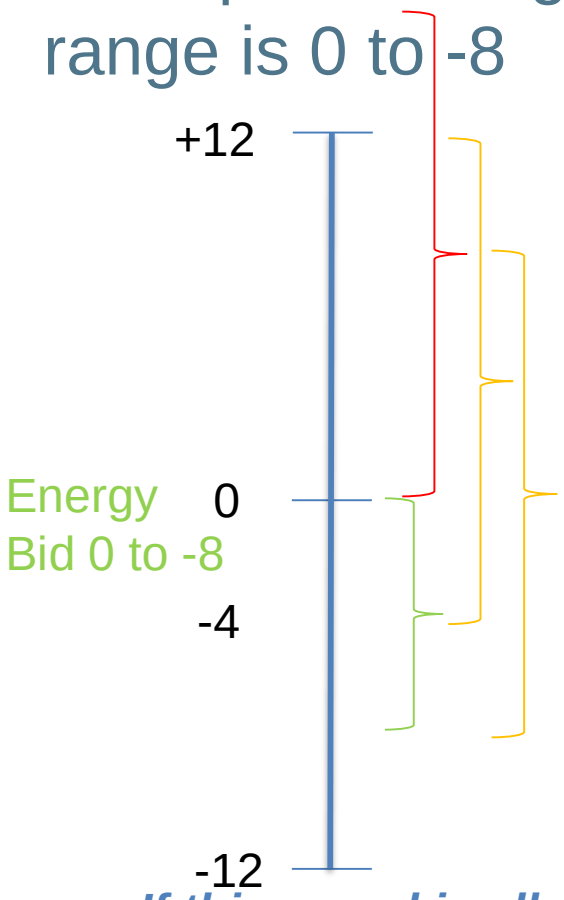


$$CF\left(RU_{i,t}\right) \leq -LCL_{i,t} - RD_{i,t}$$
$$0.5\ (9) \leq 12 - 9 \rightarrow False$$
$$CF\ RD_{i,t} \leq UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t}$$
$$0.5 * 9 \leq 12 - 9 \rightarrow False$$

Model will not award RU=9, RD=9

- Implementation results are in alignment with the approved Final Policy

Example D : Reg Up=16, Reg Down =0, Energy Bid range is 0 to -8



$$CF\left(RU_{i,t}\right) \leq -LCL_{i,t} - RD_{i,t}$$

$$0.5\,(16) \leq 12 - 0 \rightarrow True$$

$$CF\ RD_{i,t} \leq UCL_{i,t} - RU_{i,t} - SR_{i,t} - NR_{i,t}$$

$$0.5 * 0 \leq 12 - 16 \rightarrow False$$

Model will not award RU=16, RD=0
Example is not explicitly listed in Final Policy Paper

If this award is allowed by the model in Day-Ahead:

- ***Real-time Market would be forced to dispatch energy to 0MW when resource is fully charged regardless of economics***
- ***Results do not address the operational concerns regarding sustainability of Day-Ahead regulation awards in real-time***

Other details about the real-time energy bids.

- Energy self-schedules are not considered bids for this rule
- If SC's energy bid does not equal at least 50% of the AS award, the bid will be extended
- If SC does not submit an energy bid in SIBR, a bid will be inserted at the default energy bid price

Q&A

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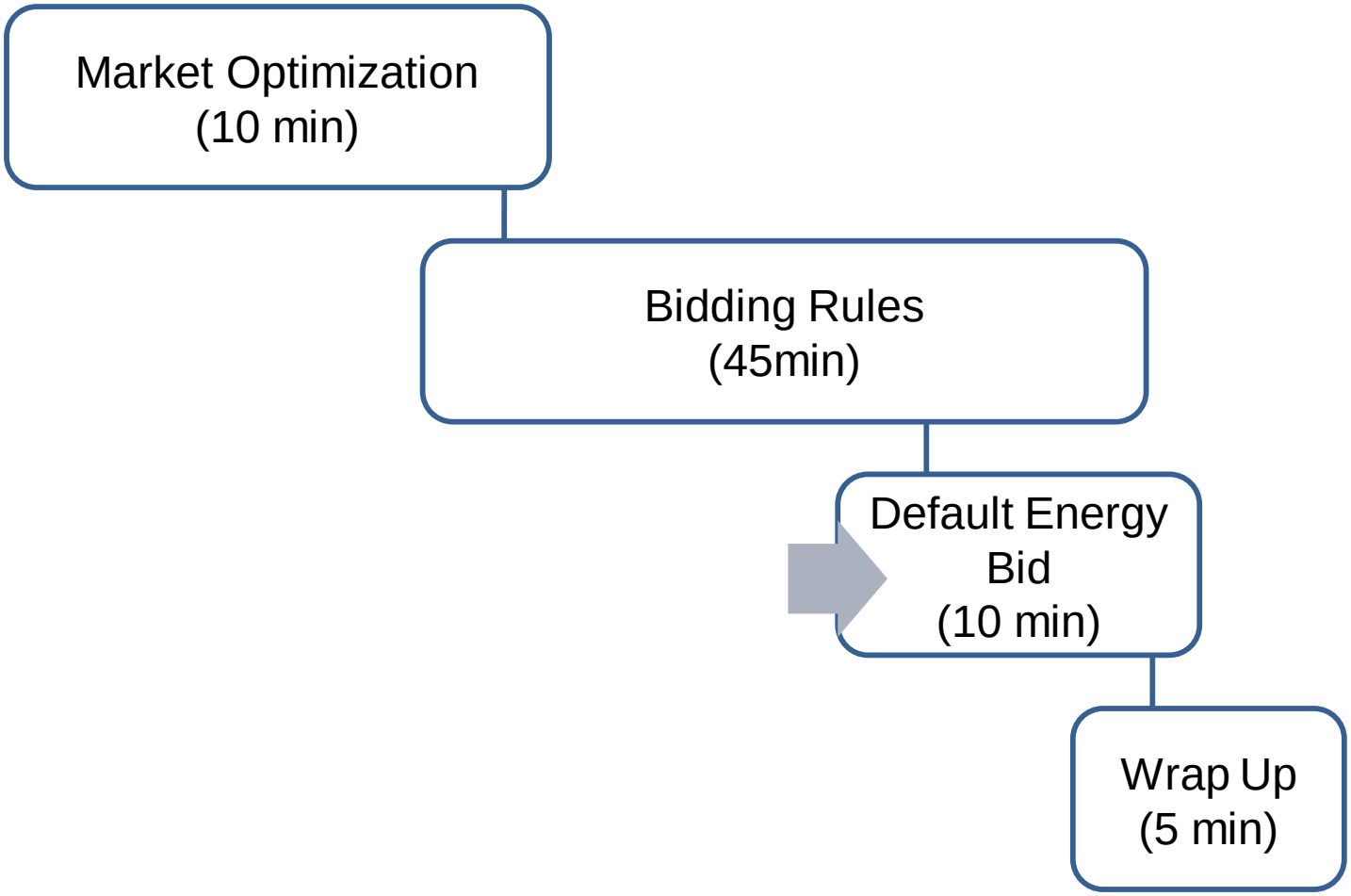

The issue: There were instances in the day-ahead market when the storage default energy bid (DEB) caused unanticipated results.

(Maximum of the energy cost and zero) plus the variable costs

10% adder

Day-ahead Storage Default Energy Bid

$$DA\ Storage\ DEB = \left(MAX\left(En_{\delta/\eta}, 0\right) + \rho\right) * 1.1$$

The solution: Include opportunity costs in the day-ahead storage DEB formula (mirrors the real-time storage DEB).

The maximum of the opportunity cost and:

(Maximum of the energy cost and zero) plus the variable costs

× 10% adder =

Day-ahead Storage Default Energy Bid

$$DA\ Storage\ DEB = Max\left[\left(MAX\left(En_{\delta/\eta}, 0\right) + \rho\right), OC_{\delta}\right] * 1.1$$

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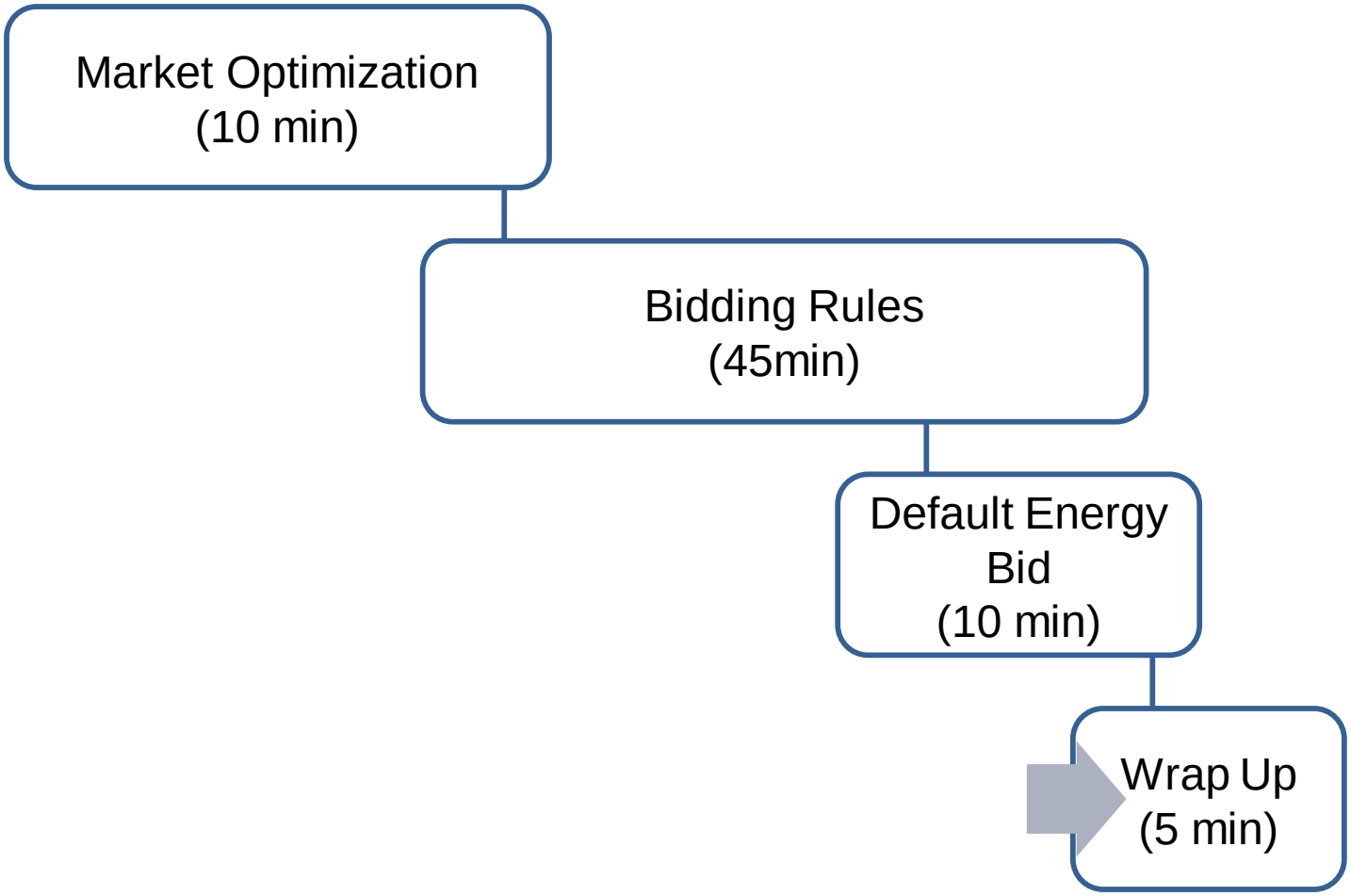

Final Q&A

Thank you for your participation!

For clarification on anything presented in this training, send an email to: CustomerReadiness@caiso.com

For any other questions or stakeholder specific questions or concerns, please submit a ticket.