Energy Storage and Distributed Energy Resources Phase 4

Issue Paper

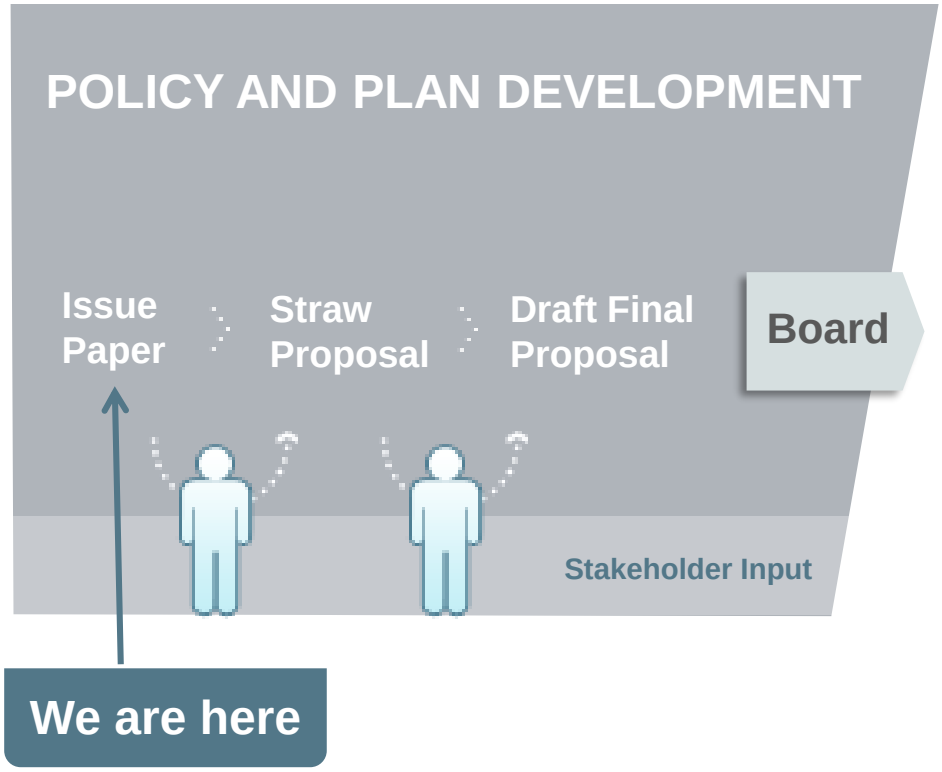
Stakeholder Workshop
March 18, 2019
10:00 a.m. – 4:00 p.m. (Pacific Time)

Agenda

Time	Item	Speaker
10:00 - 10:10	Stakeholder Process and Schedule	James Bishara
10:10 - 10:15	Introductions	Eric Kim
10:15 - 10:30	Objectives and Scope	
10:30 – 11:30	Non-Generator Resource Enhancements	Perry Servedio
11:30 – 12:30	*LUNCH BREAK*	
12:30 – 1:30	Bidding Requirements for Energy Storage	Gabe Murtaugh
1:30 – 3:00	Demand Response Resources	Eric Kim, Jill Powers, Lauren Carr
3:00 – 3:50	Discussion on BTM resources	John Goodin, Eric Kim
3:50 - 4:00	Next Steps	James Bishara

STAKEHOLDER PROCESS

CAISO Policy Initiative Stakeholder Process



OBJECTIVES / SCOPE

Objectives

- Discuss ESDER implementation timeline
- Set scope for ESDER 4
- Start deeper discussion on in-scope items with consideration of stakeholder comments

ESDER's goal is to lower barriers and enhance the ability of storage and DER to participate in the CAISO market

- ESDER Phase 2 implemented in Fall 2018
  - New baseline methodologies, changes to net benefits test, and tariff clarification of station power definition.

- ESDER Phase 3 approved by CAISO Board in September 2018
  - Split implementation for Fall 2019 and 2020.
  - **Fall 2019** - Hourly and 15-min DR bidding options
  - **Fall 2020** - Load Shift Resource, EVSE measurement, and removal of the single LSE requirement

Stakeholder Comments on Scope

- Stakeholders were generally in support of the scope with the exception of stakeholders who requested the ISO include additional items.

- There were several requests to expand scope to address participation of behind the meter resources.

ESDER 4 Scope

1. NGR Enhancements
   - SOC management
   - Reviewing multi-interval optimization
2. Bidding rules for energy storage
3. Demand Response
   - Reflecting DR operational characteristics
   - Weather sensitive DR

NGR ENHANCEMENTS

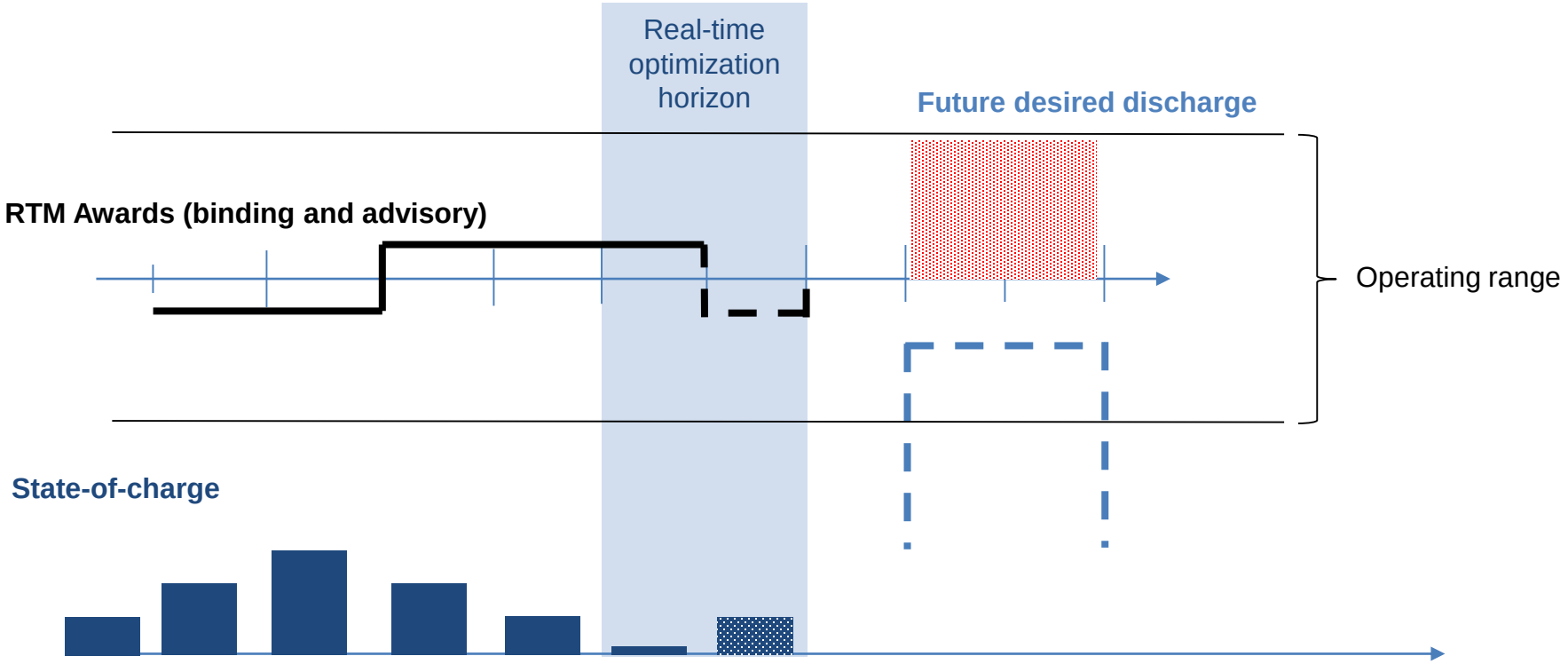
NGR enhancements

- Real-time state-of-charge management
  - Enhance real-time market to accept state-of-charge values for future hours and constrain NGR output to meet those values
  - Scheduling coordinator to submit desired state-of-charge levels in future hours throughout the day

- Effects of multi-interval optimization
  - No change to existing market design

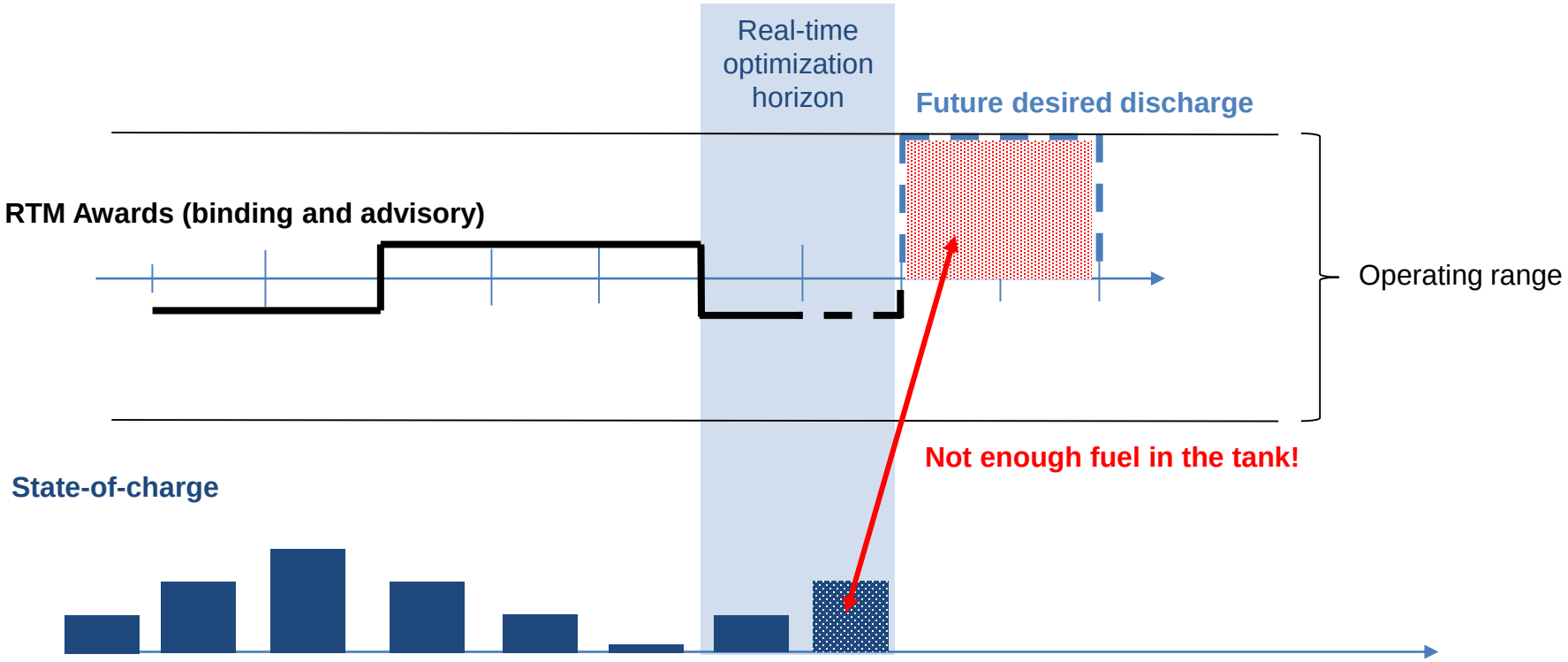
NGR enhancements: real-time SOC management

- The current real-time market optimization horizon may impede SCs from optimally managing their NGR over the day.



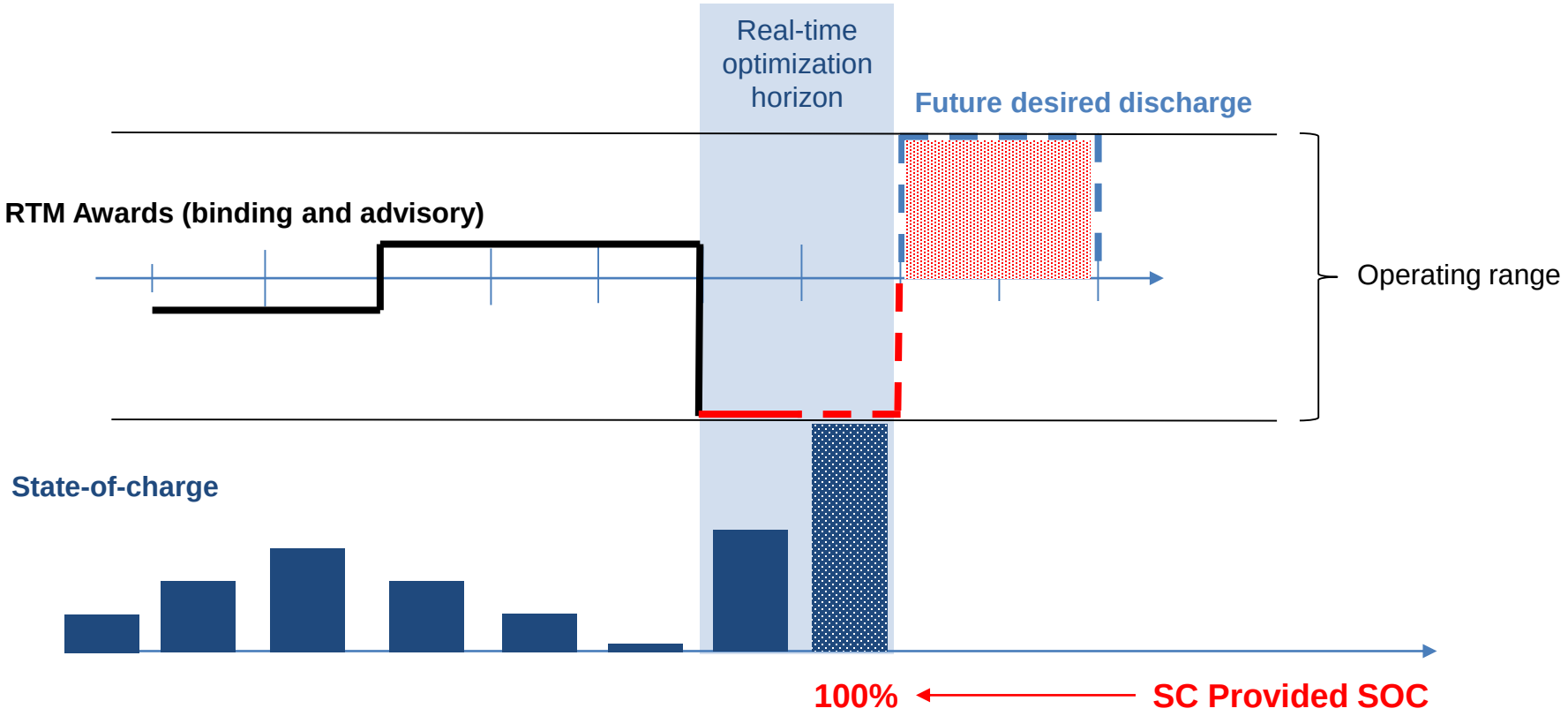
NGR enhancements: real-time SOC management

- The current real-time market optimization horizon may impede SCs from optimally managing their NGR over the day.



NGR enhancements: real-time SOC management

- In order to meet future desired discharge, NGR could provide desired state of charge of 100% in interval prior to discharge.



Stakeholder Comments

- Stakeholders generally supported the concept.
- Suggestions made by stakeholders
  - SOC parameter be optional for NGRs
  - Using additional outage cards to address MUA
  - End of day SOC rather than hourly

- The ISO is exploring an end of hour or end of day SOC parameter to inform policy design of SATA, MUA, and other needs identified by stakeholders.

NGR enhancements: effects of multi-interval optimization

- An NGR may appear to receive an uneconomic award when the entire optimization horizon is not considered.

	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7
Charge Bid	$20	$20	$20	$20	$30	$30	$30
Discharge Bid	$50	$50	$50	$50	$50	$50	$50

	Binding	Advisory	Advisory	Advisory
LMP	$25	$30	$40	$200
Awards	-30 MW	0 MW	0 MW	30 MW

Out of the money

However, NGR is economic over the optimization horizon

NGR enhancements: effects of multi-interval optimization

- An NGR may get real-time awards that do not cover their bid spreads by the end of the day.

	Hour 1	Hour 2	Hour 3	Hour 4	Hour 5	Hour 6	Hour 7
Charge Bid	$20	$20	$20	$20	$30	$30	$30
Discharge Bid	$50	$50	$50	$50	$50	$50	$50

	Binding	Advisory	Advisory	Advisory
LMP	$25	$30	$40	$200
Awards	-30 MW	0 MW	0 MW	30 MW

The expected higher price of $200 never materialized, but prices are still within the discharge bid in Hour 4.

	Binding	Binding	Binding	Binding	Binding	Binding	Binding
LMP	$25	$30	$40	$50	$49	$45	$40
Awards	-30 MW	0 MW	0 MW	30 MW	0	0	0

If prices never recovered by the end of the day, resource receives $150 ($5 x 30 MW) bid cost recovery.

Stakeholder Comments

- Stakeholder comments were limited but focused on reviewing BCR rules.
  - If BCR rules are reconsidered it must apply to all resources.
  - Stakeholder suggestion to opt-out of multi-interval optimization.

- The ISO does not believe it needs to reconsider BCR calculations or allow resources to opt out of multi-interval optimization.

BIDDING REQUIREMENTS FOR ENERGY STORAGE

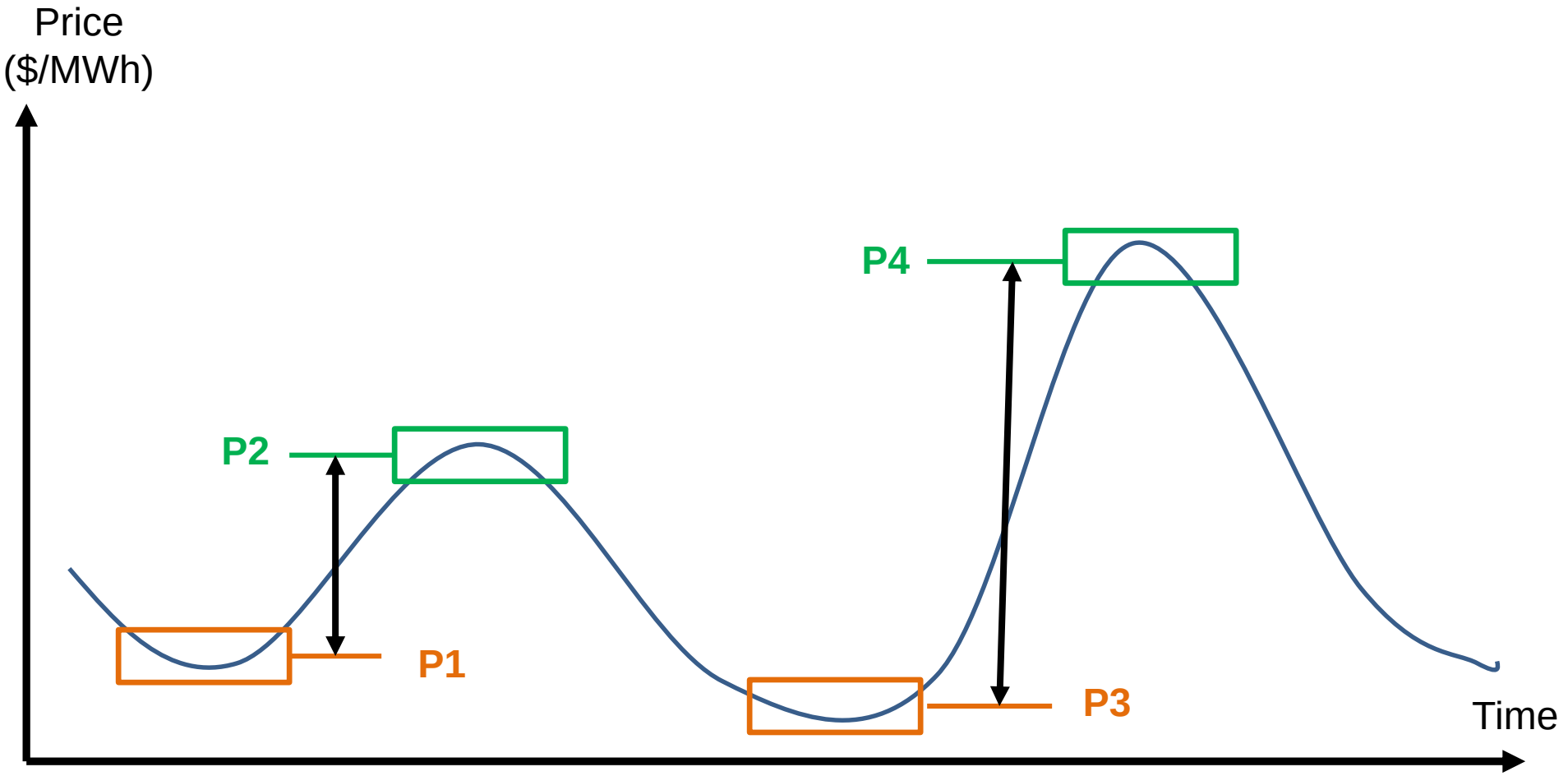
Default energy bids (DEBs) are used for local market power mitigation (LMPM)

- Default energy bids are constructed by the ISO to replicate marginal costs for resources to produce energy
  - For gas resources these may include fuel costs, heat rates, O&M, GHG costs, GMC…
  - Storage resources are different because they charge by purchasing energy from the market
- Default energy bids are used by the ISO with local market power mitigation to prevent resources from exercising market power
- Currently DEBs are not constructed for storage
- ESDER 4 will consider DEBs for storage given the anticipated growth and reliance on storage

The ISO encourages feedback on potential default energy bid calculations for storage resources

- SPP proposed that storage resources receive a DEB equal to expected energy prices for the next hour.
  - The ISO may consider a similar approach.
- The ISO may consider an approach using expected energy, explained further in this presentation.
- May also consider estimating actual charging costs for storage resources, combined with round-trip efficiency loss factors to set default energy bids.
- The ISO will consider additional stakeholder feedback on these possible solutions and others offered.

Potential profitable behavior for a 4-hour battery

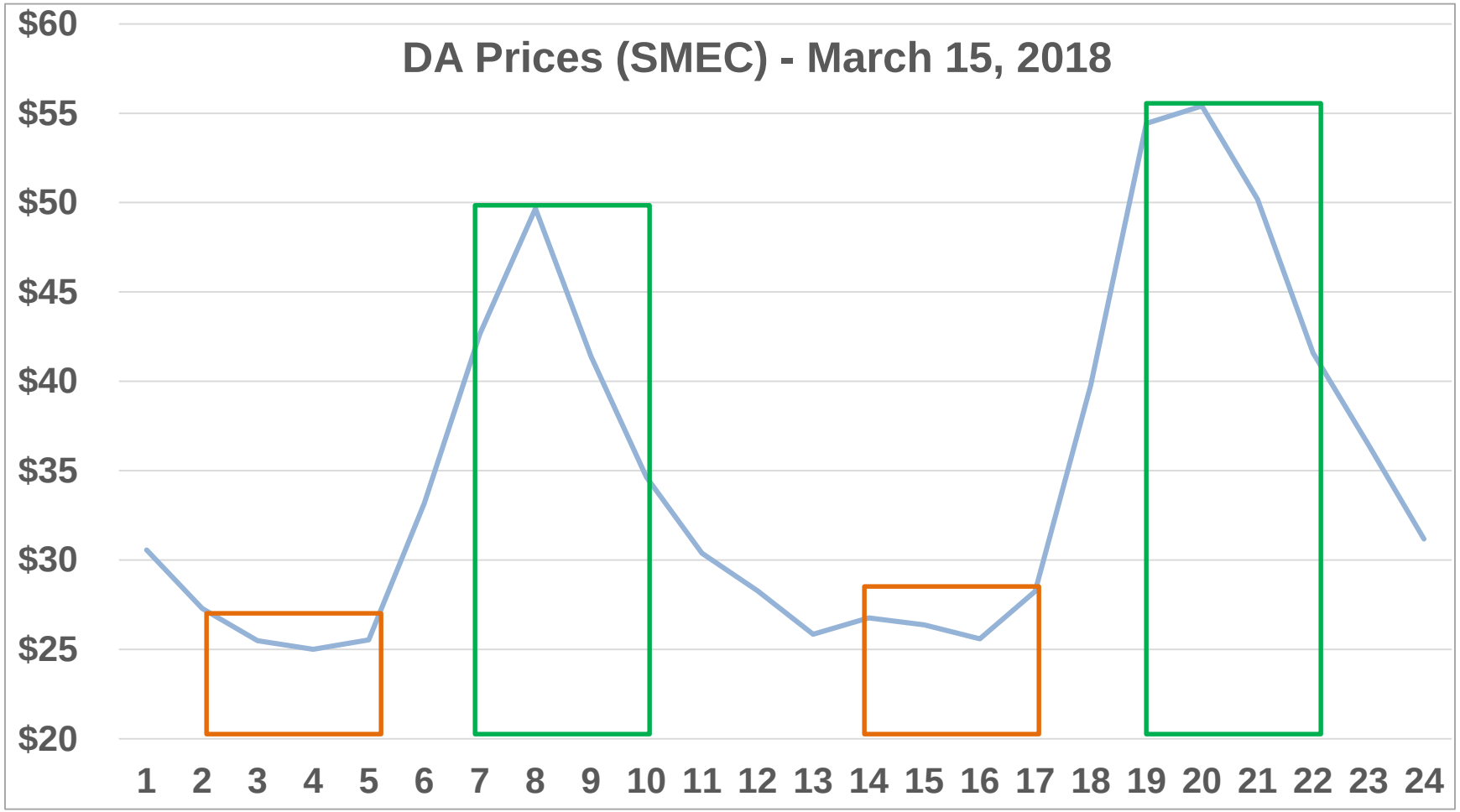


$$\pi = (P2*Q*loss - P1*Q) + (P4*Q*loss - P3*Q)$$

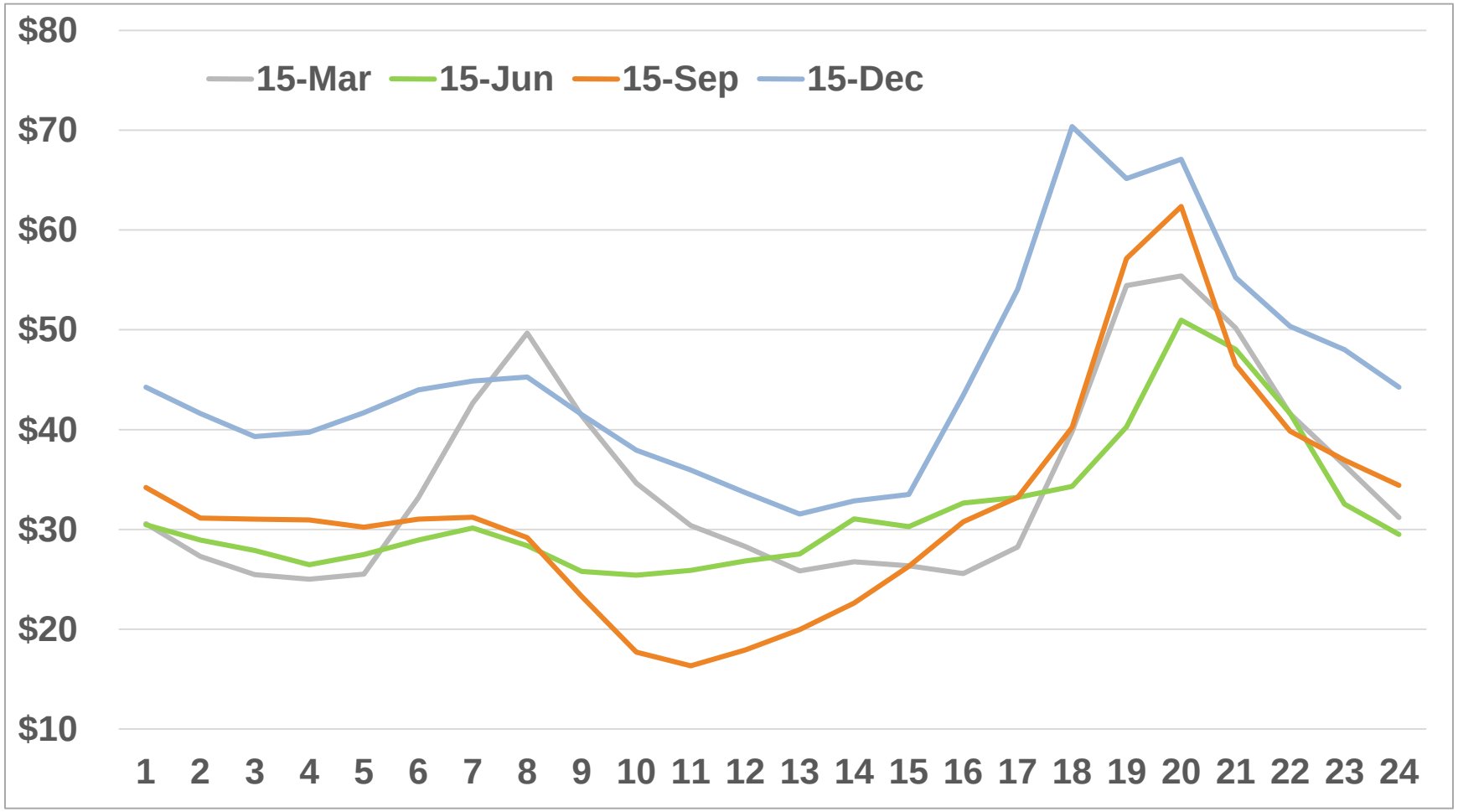
This example of a profit maximizing battery makes several simplifying assumptions

- The resource takes 4 hours to charge and 4 hours to discharge.
- There are no costs (or the costs are very low) for the resources to switch from charging to discharging.
- The resource is not selling energy as prices are increasing, to potentially increase profit.
- The representative day has two peaks and troughs: one in the morning and one in the afternoon.

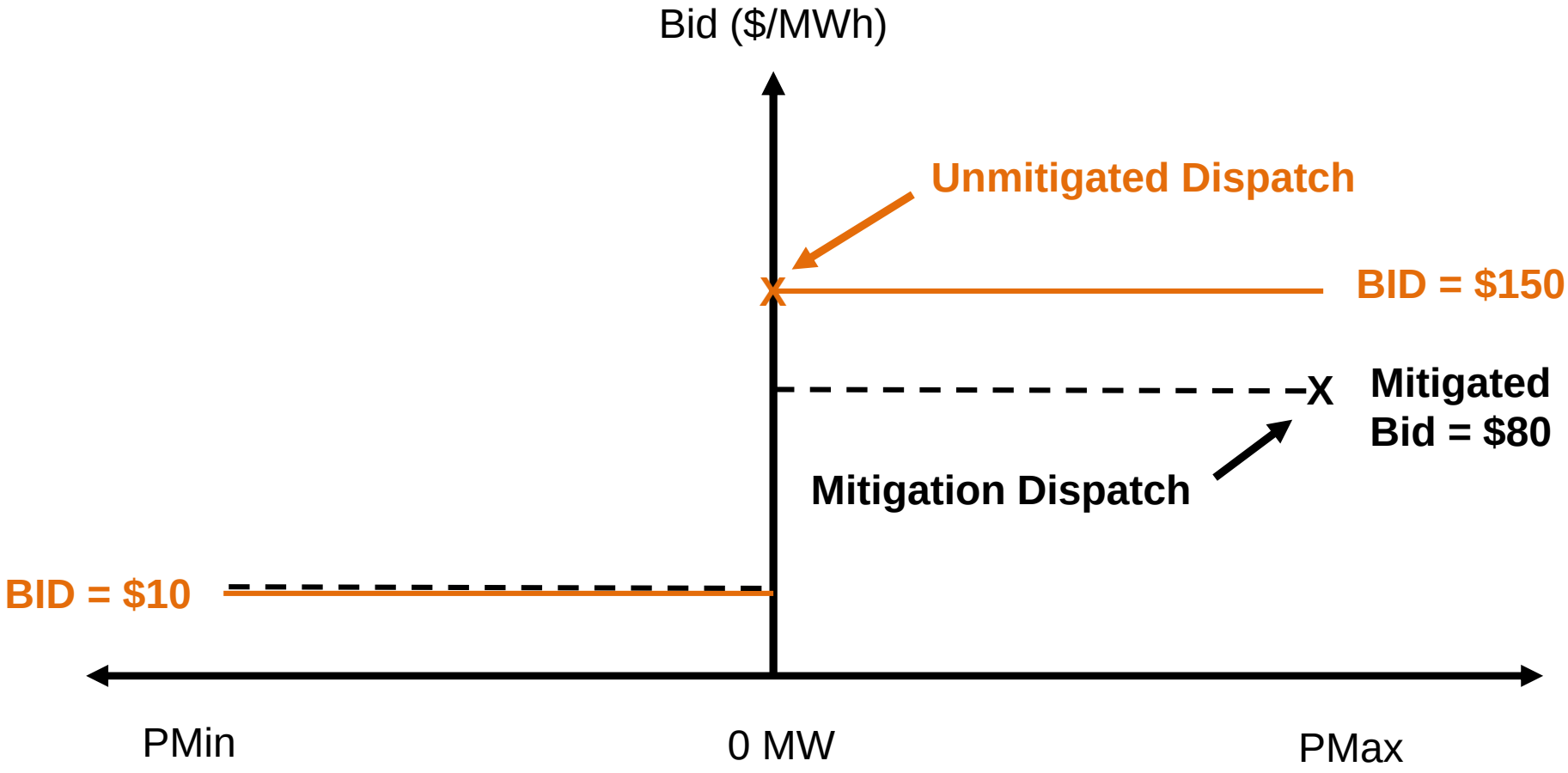
A sample day in March shows how a 4-hour battery could profitably operate



During different seasons the price curve is flatter in the morning, and may offer less opportunities for storage

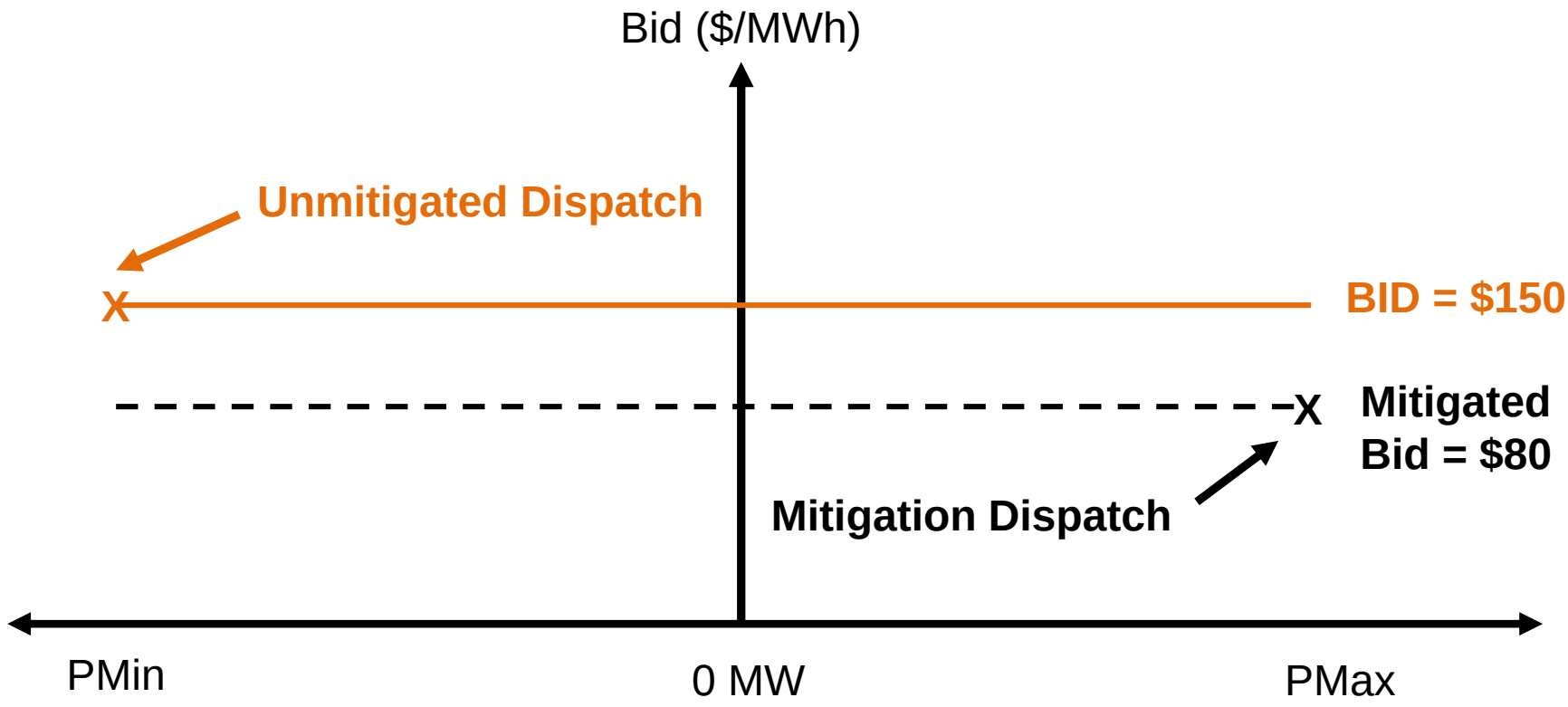


Storage resources may be mitigated, which could change dispatch instructions for resources



Suppose the market clears at $80/MWh, and the resource is mitigated to its DEB. The resource is then instructed to discharge, if ramp capability is available.

Storage may bid in a single value for entire range of operation; mitigation may reduce the entire bid curve



Suppose the market clears at $80/MWh, and the resource is mitigated to its DEB. The resource is then instructed to discharge, if ramp capability is available.

This default energy bid paradigm can work for various circumstances

- The charging and discharging time of 4 hours can be a variable input, and can be a specific calculation performed for these default energy bids.
- The model can accommodate single or multiple peaks and troughs during the day.
- The ISO may be able to model the costs for a storage resource to switch from charging to discharging.
- This default energy bid is meant to allow storage to continue to take advantage of short term opportunities to earn market revenues, while preventing resources from exercising significant market power.

DEMAND RESPONSE

Demand Response: Operational Characteristics

- DR with a Pmin of 0 MW face challenges reflecting operational limitations in CAISO market.

- DR resources receive dispatches to move between Pmin and Pmax.
  - Market respects minimum run time parameter because it will commit a DR resource to its Pmin.
  - Certain DR resources can only provide a single sustained response from its Pmin of 0 MW.

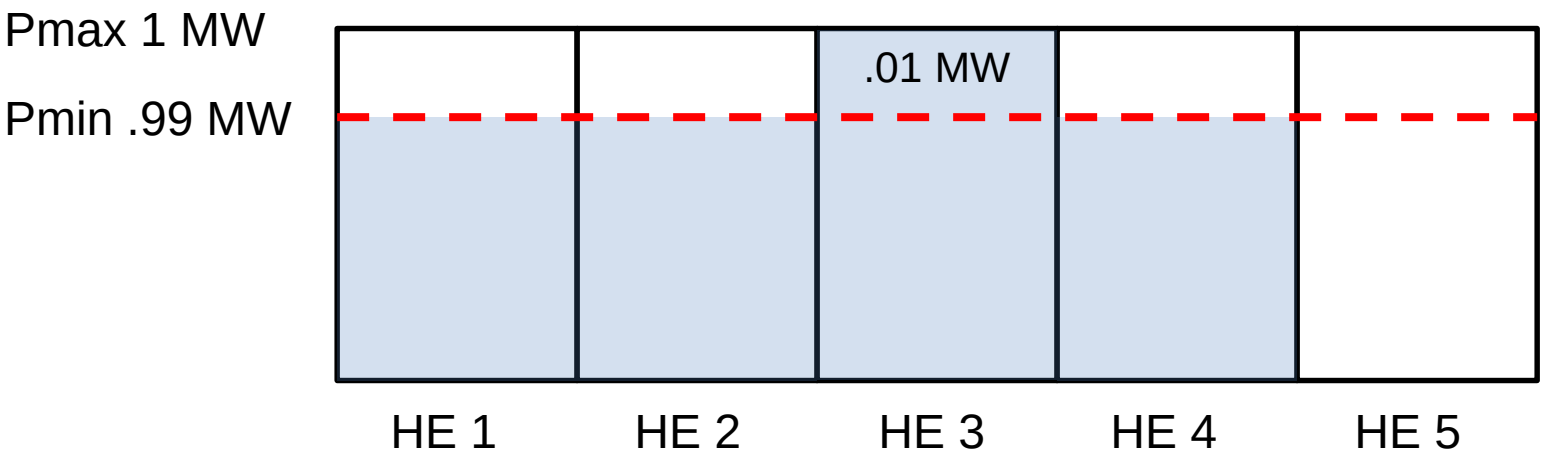
Reflecting DR resource with a non-zero Pmin

- A DR resource can use existing parameters
  - Register a Pmin just below its Pmax
  - Identify a minimum load cost (MLC)
  - Define its maximum daily energy limit
  - Choose an hourly bid option in MasterFile

- The DR resource's non-zero Pmin and identified MLC will be optimized in the residual unit commitment (RUC) process.

- If committed in RUC, the DR resource will be instructed to its Pmin (just below Pmax) and the market will honor the minimum run time and maximum daily energy limit.

Illustrative Example



- Pmax = 1 MW
- Pmin =.99 MW
- Minimum Run Time = 1 hour
- Maximum Daily Energy Limit = 4 MWh
- Startup = 1 per day
- Hourly block bid option

Weather Sensitive DR

- Maximum output of certain DR resources can vary due to their weather sensitive nature, much like other variable energy resources (VERs).
- CPUC/LRAs must establish an appropriate qualifying capacity methodology for weather-sensitive DR to count as RA.
  - To help inform and advance CPUC/LRA consideration, the CAISO will discuss with stakeholders how to perform a LOLE study and establish an ELCC value for weather-sensitive DR, similar to solar and wind.
- With stakeholder input, options about how to manage weather-sensitive DR in the CAISO market will be discussed.

Qualifying Capacity and Net Qualifying Capacity Determination

- The Local Regulatory Authority establishes Qualifying Capacity (QC) values.
  - CPUC adopted Load Impact Protocols (LIPs) to establish QC values for utility DR
  - For DRAM resources, QCs are based on a contracted amount
  - CPUC uses ELCC methodology to determine QC values for solar and wind
- CAISO establishes the Net Qualifying Capacity (NQC), which is the Qualifying Capacity reduced, as applicable, based on: (1) testing and verification; (2) application of performance criteria; and (3) deliverability restrictions.

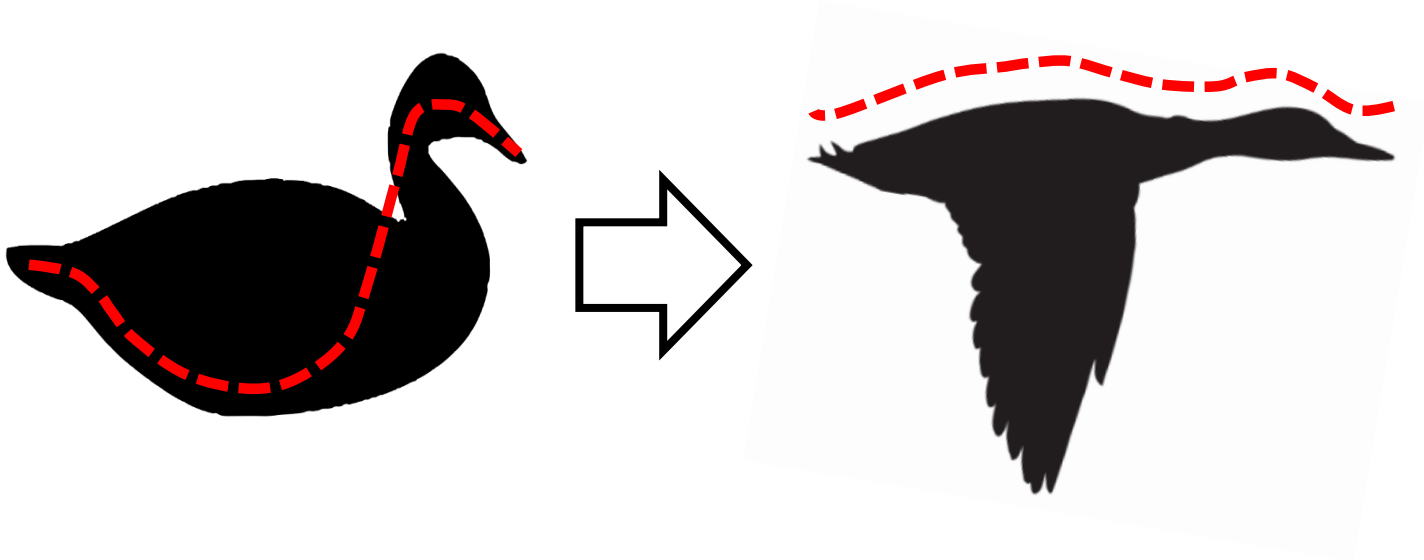
Must offer obligations, substitution rules, and RAAIM

- DR must submit bids for the full contracted amount of RA capacity.
  - Could be required to substitute when full RA value is not available due to weather sensitivity to avoid RAAIM.
- Variable Energy Resources must bid to their forecast.
  - VERs can either use a CAISO provided forecast or SC submitted forecast
  - VERs are RAAIM exempt for generic RA, non-exempt from flexible RA

The CAISO seeks feedback from stakeholders on potential forecasting methodologies for SC-submitted weather sensitive DR forecasts and how the CAISO could validate and approve these forecasts.

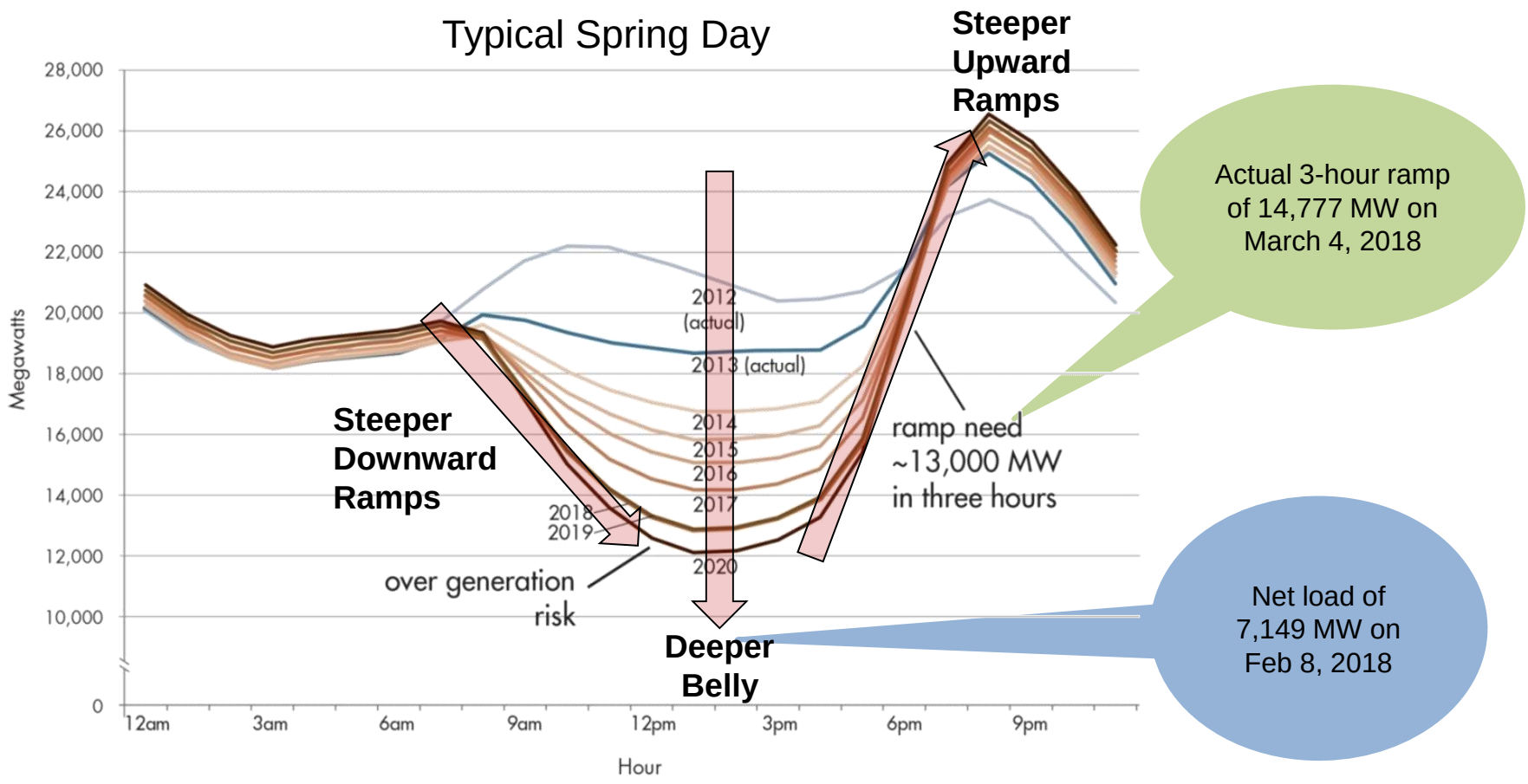
Discussion on BTM Resources

How are we going to ensure our energy future is resilient, sustainable and efficient?



We must make the duck fly!

Reliably operating the system has grown more challenging



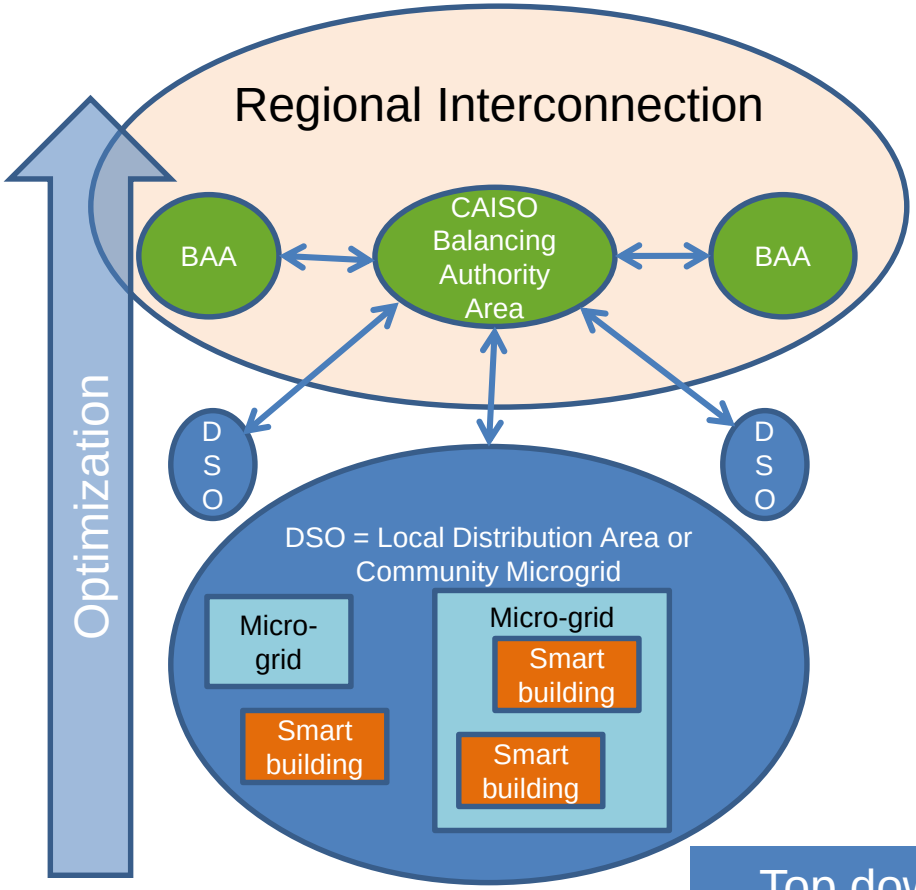
We must learn how to favorably shift and shape net load to maximize the use of clean, green energy

"Less Steep, Less Deep, and Lower Peak"

Industry-wide collaboration is required to help the duck fly so we can achieve the cost-effective, low carbon grid

Wholesale	Retail	Legal/Regulatory
Technology agnostic market participation models that allow large, small, and aggregate resources to participate	Grid informed time-variant and dynamic rates (TOU, RTP)	Electrification goals and mandates designed to create a sustainable and efficient grid
Market structures that reward flexibility and minimize uncertainty	Critical peak and critical consumption pricing periods	Grid harmonized building codes and appliance standards
Regional markets that leverage diversity and generate operational efficiencies	Load management programs that reward favorably shifting and shaping energy use	Retail markets, structures that create resiliency, grid-informed price signals, and low-friction energy exchange

We must consider the future grid architecture. Consider an "integrated decentralized" system with a layered hierarchy of optimizing sub-systems.



- Each layer only sees its interchange with next layer above & below, not the details inside other layers
- ISO optimizes regional bulk system only up to the T-D interfaces: DSO to ISO
- Layered control structure reduces complexity, allows scalability, and increases resiliency & security
- Resolve variability and volatility at the grid edge
- Deep and centralized situational awareness and control not required

Top down, centralized control of an increasingly decentralized system is likely not viable or desirable

Stakeholder Comments

- Requests to expand scope of ESDER 4
  - Multiple resource IDs under a single service account
  - Technology Agnostic PDR-LSR
  - Double-billing with BTM DERA charging
  - Removing 24x7 participation requirement for DERA
  - Explore pathways for DERAs to provide RA
  - Wholesale market settlement for net export under PDR

CAISO replies to stakeholder comments

- **Multiple resource IDs under a single service account**
  - The ISO cannot assign multiple resource IDs where a premise has a single service account assigned by the UDC.
  - Further discussion and vetting is needed with the UDC and LRA about the practicality and viability of this option and potential measurement & verification concerns.
- **Technology agnostic PDR-LSR**
  - Due to implementation delays, the ISO cannot pursue additional enhancements to the LSR model at this time, but is open to enhancements at a later time.

CAISO replies to stakeholder comments (cont'd)

- **Removing 24x7 participation requirement for DERA**
  - Interested in further discussion about this issue with the CPUC, and how this comports with MUA rules and ensuring system energy sufficiency.
- **Explore pathways for DERAs to provide RA**
  - The ISO is open to discussing potential pathways to RA qualification for DERAs.
  - Would like CPUC to further explore establishing QC for multi-tech type DERs.
- **Order 841 compliance with BTM charging**
  - The ISO must respond to, and implement, FERC orders and directives through its compliance filing.

CAISO replies to stakeholder comments

- **Wholesale market settlement for net export under PDR**
  - Distribution net export rules are covered through UDC interconnection processes, e.g. Rule 21 or WDAT.
  - The ISO does not restrict the ability for PDR to physically net export energy onto the grid.
    - The CAISO's net export rule prevents the CAISO from paying for energy exported from BTM resources under PDR.
    - PDRs that export onto the distribution system may receive compensation via a NEM tariff.
    - PDRs that export physical energy and seek wholesale compensation may be subject to "sale for resale" provisions under the Federal Power Act.

NEXT STEPS

Next Steps

Milestone	Date
Issue paper posted	February 6, 2019
Stakeholder web conference	February 14, 2019
Stakeholder working group	March 18, 2019
Stakeholder comments due	April 1, 2019
Post straw proposal	April 24, 2019

Written stakeholder comments on the issue paper are due by COB April 1 to InitiativeComments@caiso.com.

All material for the ESDER initiative is available on the ISO website at: http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx.