Storage DEB - Energy storage and distributed energy resources phase 4 discussion

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Market Surveillance Committee Meeting
General Session
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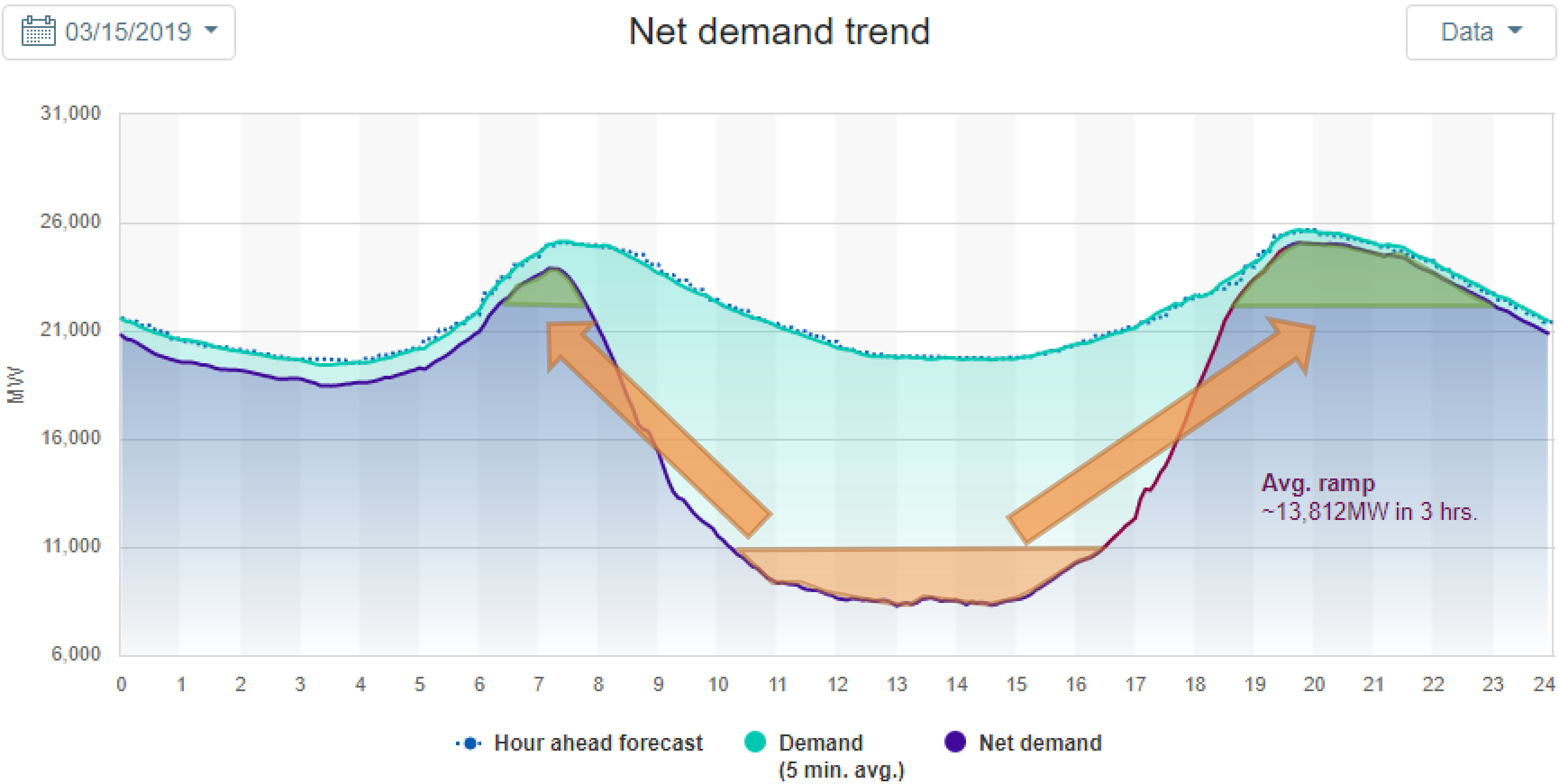
Agenda

- Background
- Storage resource costs
- Modelling constraints
- Proposed formulations for modelling cycle depth costs
  - Multiplier attached to SOC
  - Multiplier attached to the change in SOC

The ISO is proposing a methodology to calculate variable costs for storage resources in ESDER 4

- The ISO currently does not calculate default energy bids for storage resources
- There is a considerable amount of storage – particularly lithium-ion – in the new generation queue
- Storage is often suggested as a solution for local issues to mitigate the retirement of essential reliability resources
- Planning models used by the CPUC and the ISO tend to include 4-hour storage ‘moving’ generation from peak solar hours to peak net load hours
  - Generally the existing battery fleet is not doing this

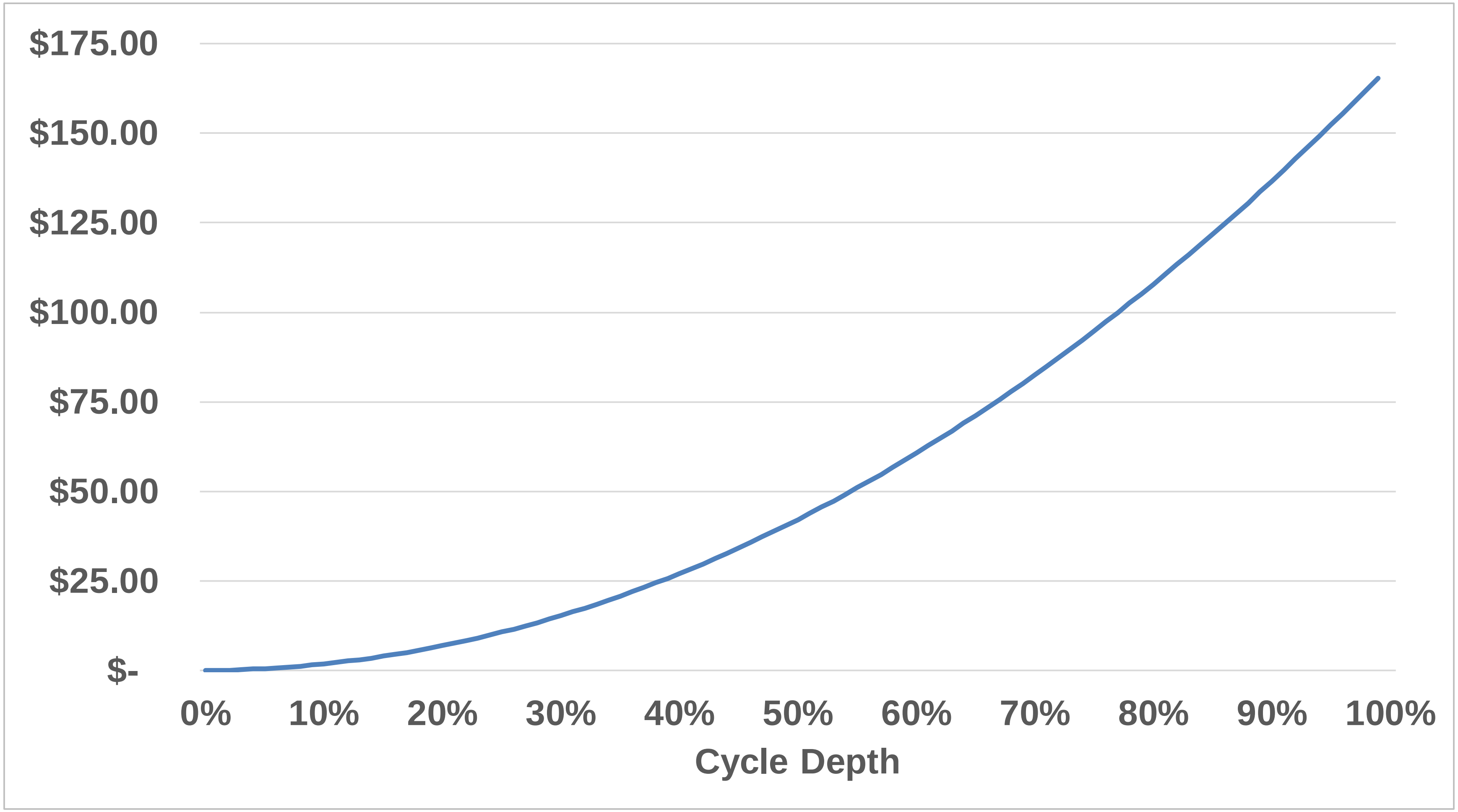
Batteries might be used to 'shift' energy from one time of the day to another



The ISO identified four primary cost categories for storage resources

- Energy
  - Energy likely procured through the energy market
- Losses
  - Round trip efficiency losses
  - Parasitic losses
- Cycling costs
  - Battery cells degrade with each “cycle” they run
  - Cells may degrade faster with “deeper” cycles
  - Cycling costs should be included in the DEBs, as they are directly related to storage resource operation
  - It is expensive for these resources to capture current spreads
- Opportunity costs

Estimated Costs for one discharge period with $300,000 replacement cost and 95% efficiency



Costs can be demonstrated in a relatively simple manner with respect to ***cycle depth***

$$Total\ Cost\ for\ Discharge = (Cycle\ Depth)^2$$

$$Marginal\ Cost\ for\ Discharge = 2 * Cycle\ Depth$$

where Cycle Depth is a value between 0 and 1

Cycle Depth (%)	Total Cost	Marginal Cost
1	0.10	0.2
20	40	4
40	160	8
60	360	12
70	490	14

The ISO has two potential ideas for modelling these costs using existing software

- Model energy with the state of charge

$$CD_{i,t} = v_{i,t}\,\rho_i\,(Max\ SOC\ - SOC_{i,t})$$

where:

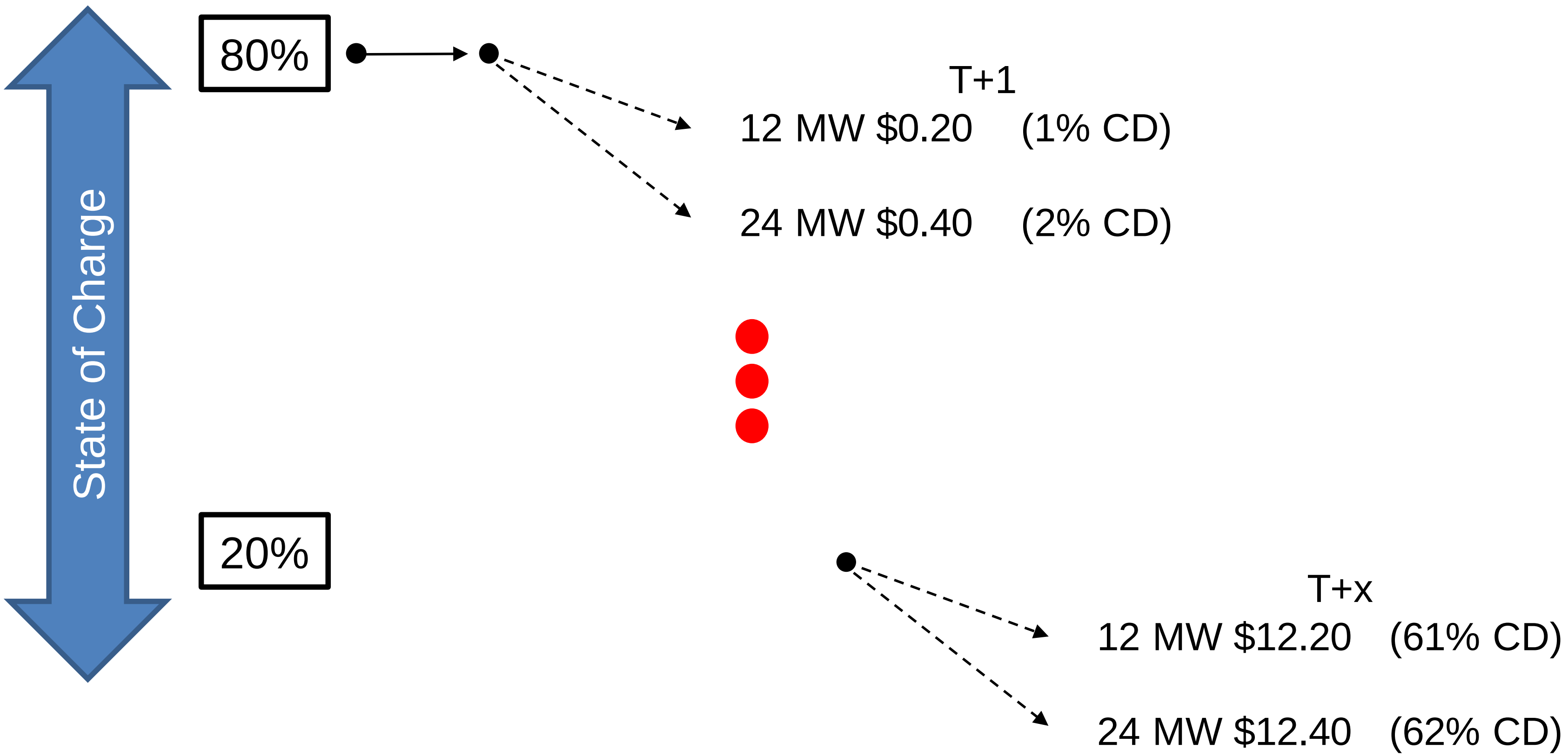
i: resource
t: interval

v: 1 when the state of charge is decreasing
ρ: constant

Max SOC: Maximum SOC available for dispatch
SOC: state of charge

Assume a +/-24 MW storage resource with 100 MWh of capacity and ρ = 20. Resource is forbidden to operate above 80 MWh or below 10 MWh (Max discharge = 70%).

Proposed DEBs reflecting marginal costs of cycle depths



There are several pros and cons to modelling resources based on total costs for cycle depth

Pros

- This model will always be greater than or equal to the cost to operate the battery
  – Aligns with increasing marginal costs
- Price for any discharge increases as state of charge decreases
  – Market outcomes will tend to charge the battery

Cons

- The model may grossly overestimate the cost to produce
  – This happens if the resource charges “mid-discharge”

A second option for modeling costs includes the change in SOC from the dispatch

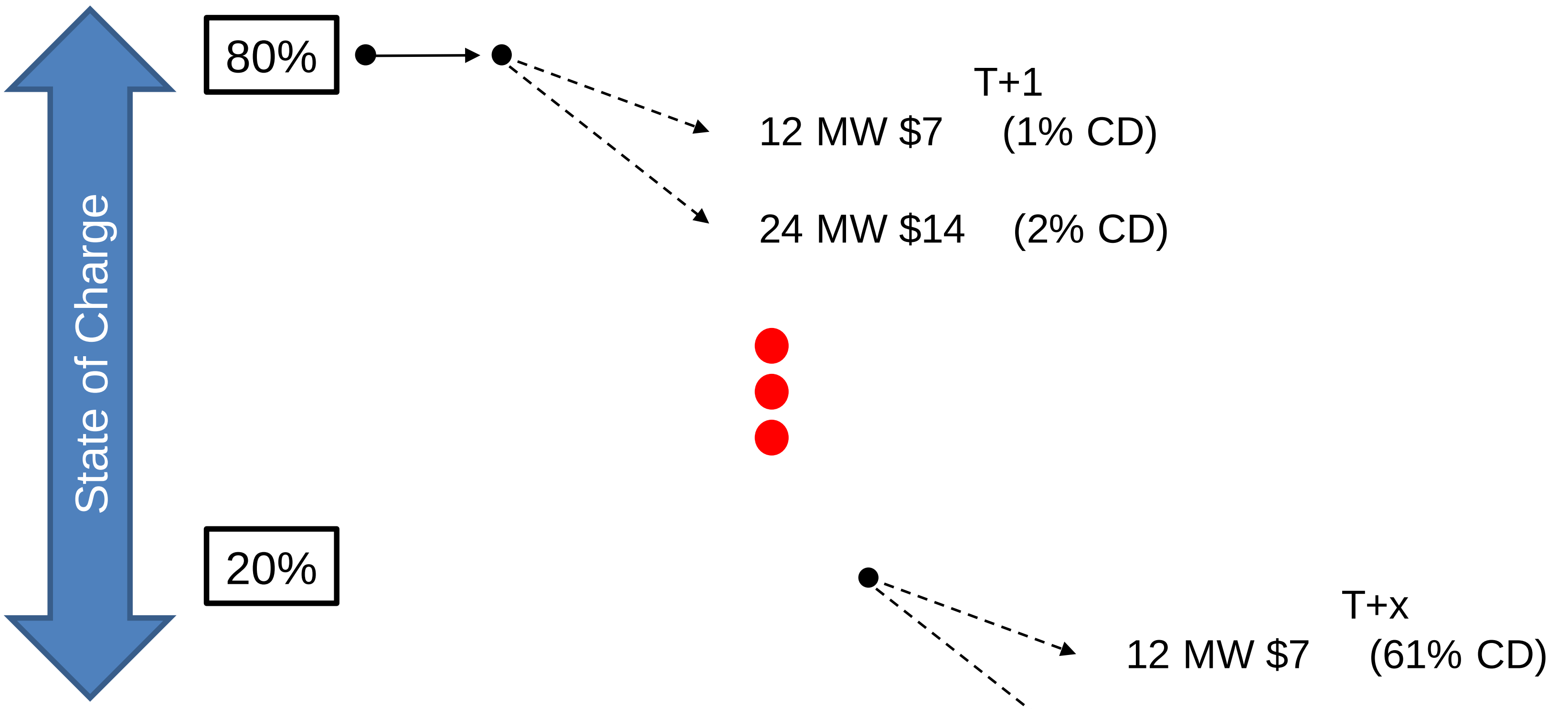
- Model energy with the state of charge

$$CD_{i,t} = u_{i,t}\,\rho_i\left(SOC_{i,t-1} - SOC_{i,t}\right)$$

$$= u_{i,t}\,\rho_i\,\frac{P_{i,t-1} + P_{i,t}}{2}\,\frac{\Delta T}{T}$$

Assume a +/-24 MW storage resource with 100 MWh of capacity and $\rho = 7$

Proposed DEBs reflecting total costs



There are several pros and cons to modelling resources based on total costs for cycle depth

Pros

- May more efficiently dispatch resources for energy (MWh)
- May more consistently produce the correct price on average

Cons

  - Overestimates costs for large dispatches when cycle depth is thin and under estimates costs for small dispatches when cycle depth is deep