

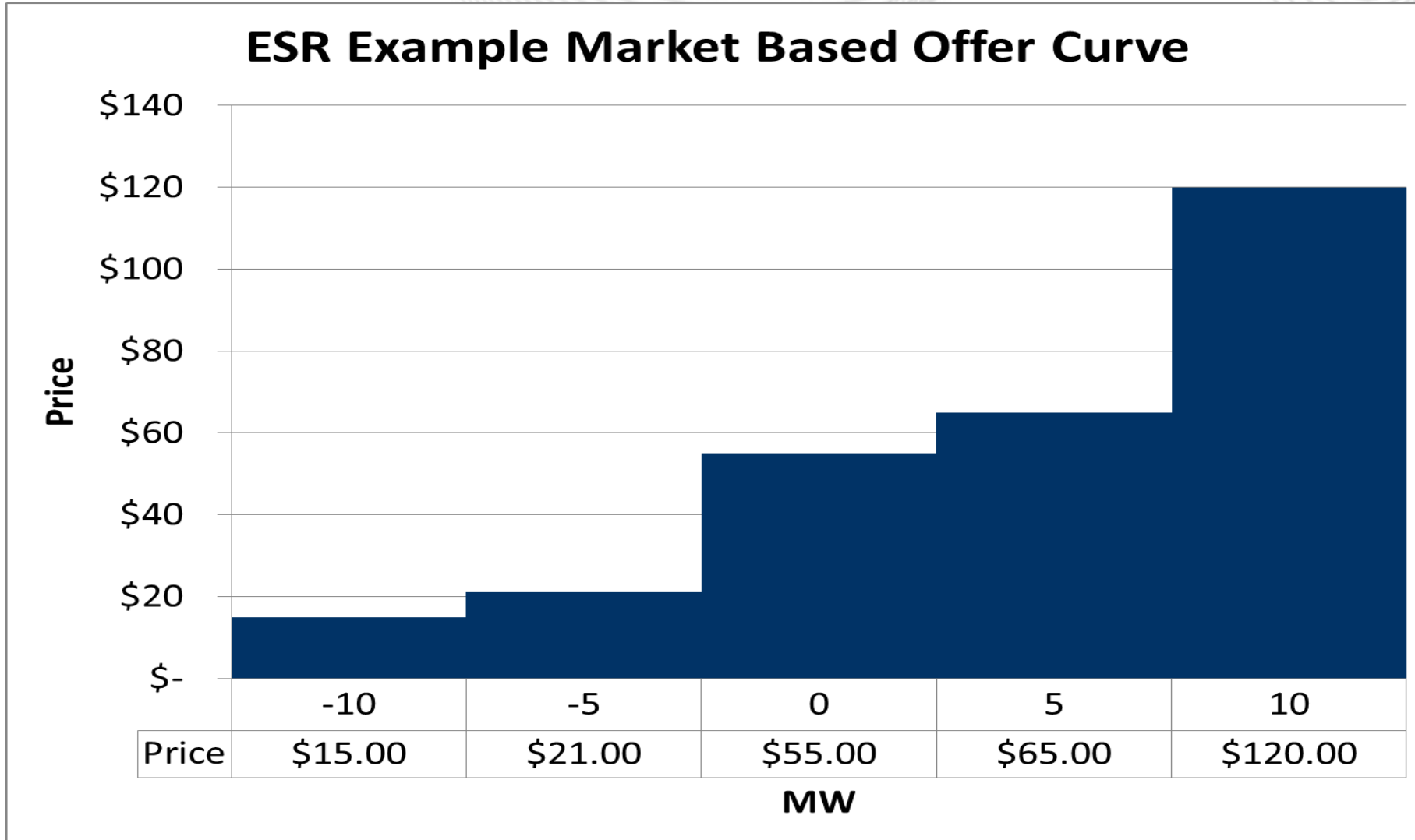
Order 841: Electric Storage Participation Model DA and RT Example for ESRs

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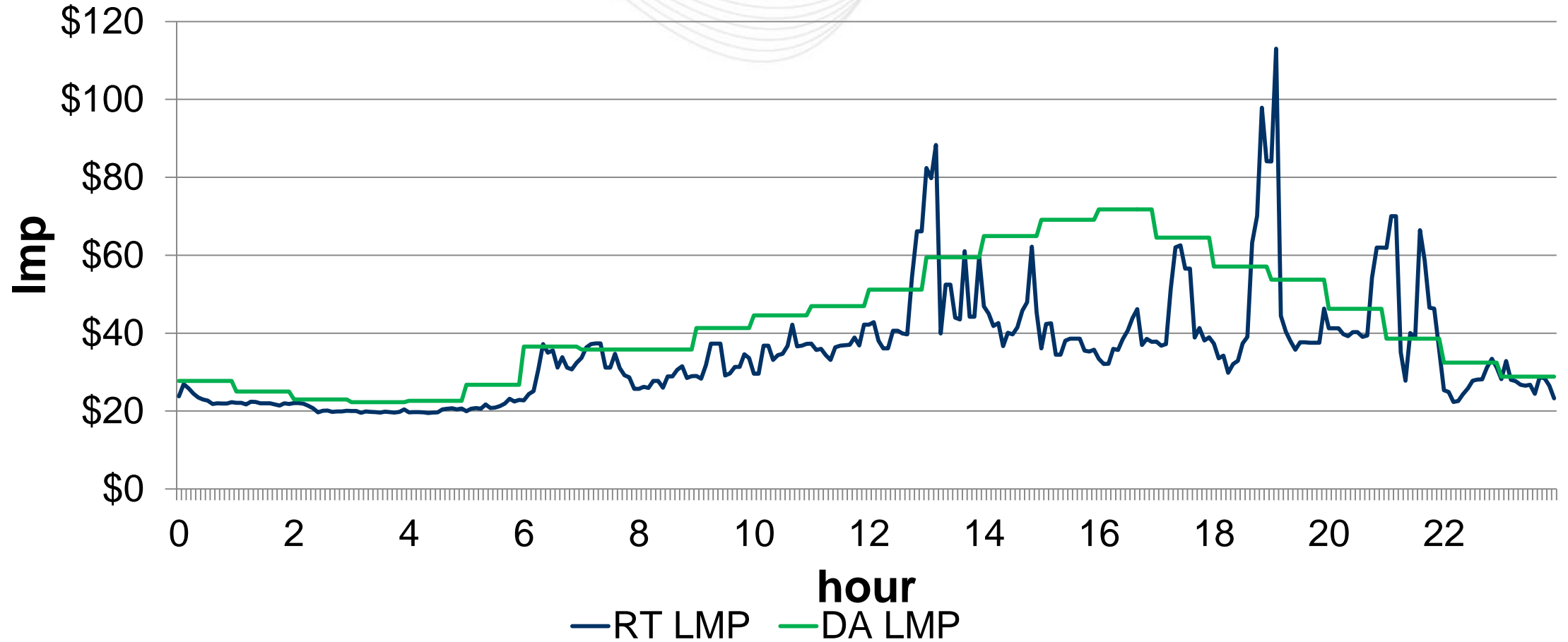
- November, 2016: FERC Notice of Proposed Rulemaking on Energy Storage and Distributed Energy Resources.
- February, 2018: FERC [final rule on storage](#) ...
 - **Filing due Dec 3, 2018.**
 - Implementation due Dec 3, 2019.
 - » Order: <http://pjm.com/-/media/documents/ferc/orders/2018/20180215-rm16-23-000.ashx>
 - » PJM Request for Clarification: <http://pjm.com/-/media/documents/ferc/filings/2018/20180316-rm16-23-000-ad16-20-000.ashx>

- Purpose of this presentation is to show an example of how a resource in the ESR Model could operate in Day Ahead and Real-Time Energy Markets.
- PJM does not recommend or inform how units should be offered into markets, there are multiple ways that an ESR owner could offer and operate.

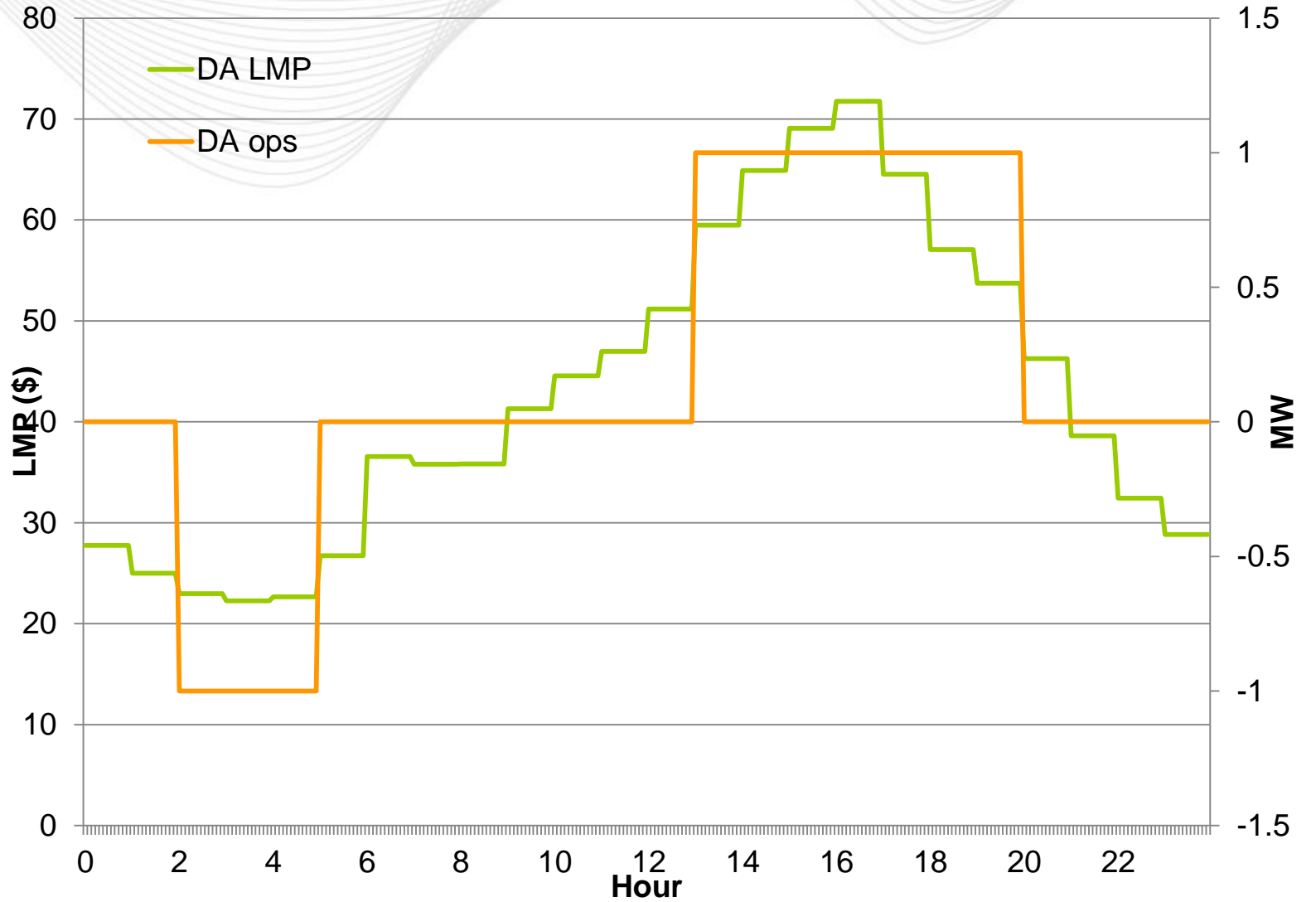
- Simplified Assumptions for example:
 - 10 MW, 10MWh battery
 - Perfectly efficient electric storage resource (100%)
 - Min/Max state of charge being self-managed by Max Charge/Discharge
MW = 9MW
 - DA and RT LMP from 10/10/2018
 - No Make Whole or Lost Opportunity Cost
 - No Ancillary Services



DA and RT Imp for 10/10/18

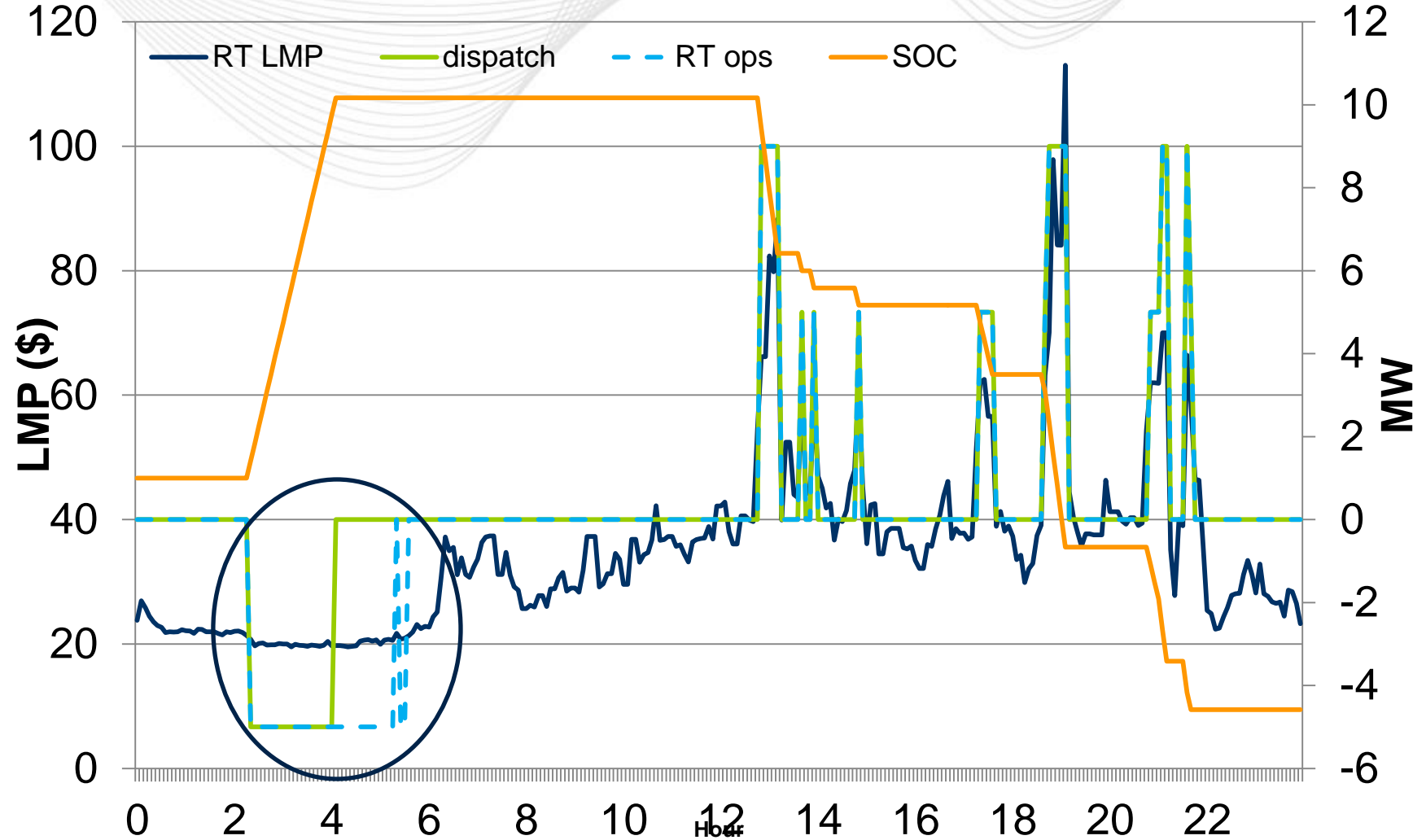


- Unit is Self-Scheduling in DA with Maximum Charge/Discharge at 1MW
- Unit is charging from HE3 –HE5 discharging from HE14- HE20
- Day Ahead Revenue (MW*DA LMP) = \$372.61



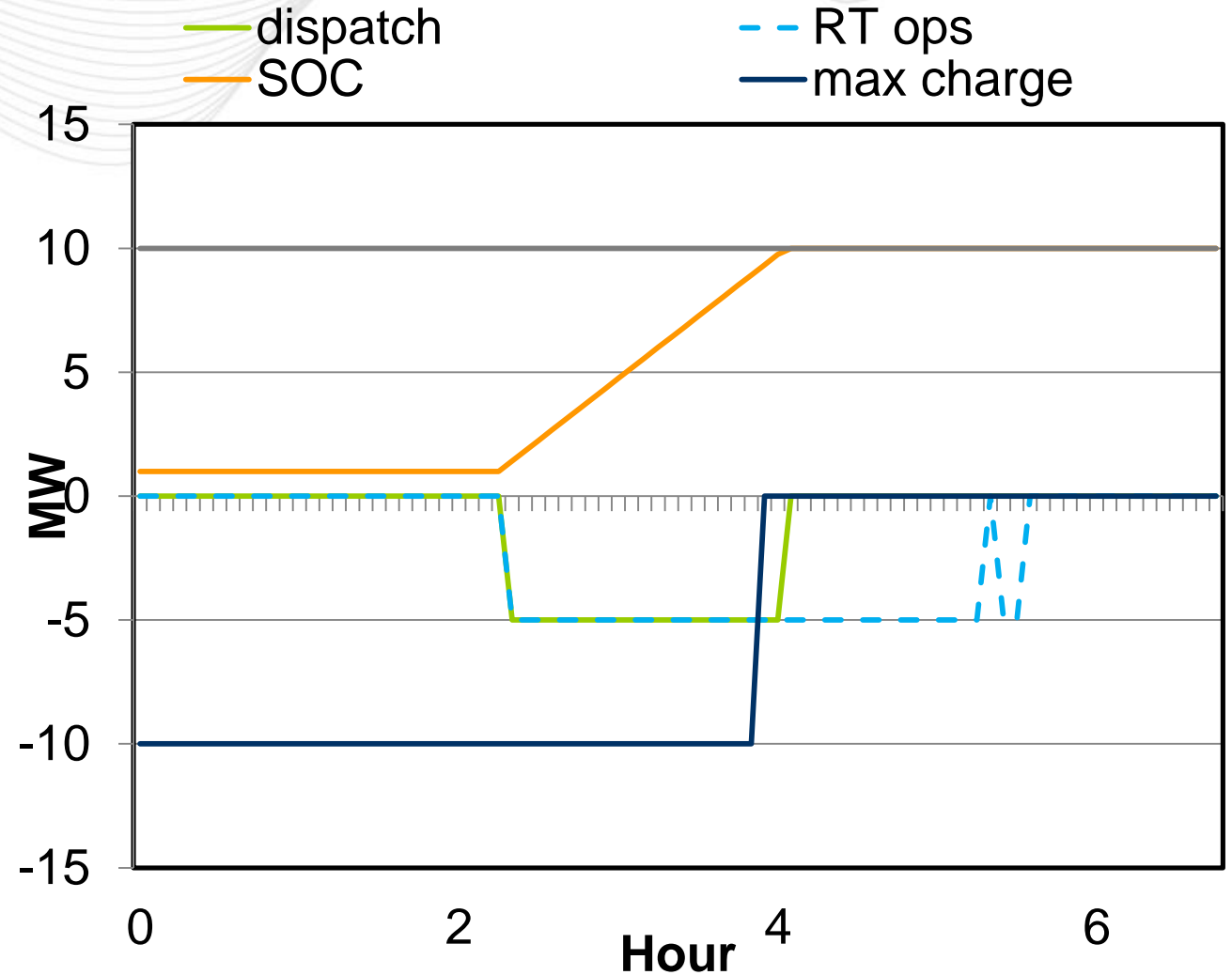
- Unavailable
- Self-Schedule in Charge and/or Discharge with or without a dispatchable range mode
- Self Schedule with a dispatchable range
- With a dispatchable range an ESR:
 - Could receive a DA schedule that cannot be followed in real-time
 - Could receive a DA schedule that does not maximize revenues
 - Could update offer per intra-day offer rules

- Real-Time Dispatch based on Bid Curve
- Blue Circle shows area where unit would run out of charge and resource will need to manage via MG updates
- Balancing Credits (RTMW-DAMW)
*RTLMP = \$502.55



Updating Parameters in Markets Gateway

- When ESR energy manager sees resource approaching max SoC they are controlling to they have the opportunity to update parameters in MG to not get an infeasible RT dispatch
 - Blue dotted line is where PJM would have dispatched the unit absent MG update. Green line is where PJM would dispatch the unit with MG update



- Operate in charge and/or discharge mode
- Change bid curve (decrease costs) to operate in additional hours
 - Must opt-in for Intra-day offers
- Self-Schedule non dispatchable to better control charge/discharge or block load unit
- Continually update maximum and minimum limits

- Day Ahead Revenue= \$372.61
- Balancing Credits = \$502.55
- **Net Daily Energy Revenue = \$875.16**

- Could have additional deviation charges for not following dispatch
- Could have additional revenue for ancillary services

Questions or Feedback?

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