Energy Storage Enhancements
July Working Group Meeting

Vistra Corporation

July 26, 2021

Phased approach needed

- While operating our Moss Landing battery facility over the last few months we have discovered practical challenges with operations.
  - These practical challenges should be near term focus.

- With additional market experience, it will be clearer what issues need solutions to the energy storage participation (NGR) model but these should not delay addressing known operational issues.
  - These issues should be medium term focus.

- What solutions are needed, if any, to market-wide functionality will require time to determine and should not delay near-term needs.
  - This impacts all use limited resources where their limitations cannot be captured by the current real-time horizon.
  - Real-time market limitations in capturing daily use limitations or charge limitations should be long term focus.

Potential path forward for phased approach

Phase 1
Q4 21 – Q2 22

- **Address near term needs introducing operational challenges.**
- **Implementation target:**
  - **ASAP but no later than Q4 2021 – elements not requiring FERC Tariff changes**
  - **Q2 2022 or sooner – elements requiring FERC Tariff changes**

Phase 2
Fall 2022

- Explore Non-Generator Resource functionality that may be resulting in storage operators observing inefficient market outcomes and/or limiting its ability to ensure it holds sufficient State of Charge during periods of highest real-time need.
- Implementation target: Fall Release 2022

Phase 3
Fall 2024

- If experience shows that there is sufficient benefit from broad enhancements to the real-time market design to better capture use limitations (daily or charge).
- Implementation target: Fall Release 2024

Phase 1 should address operational needs

- **Adopt dynamic modeling of foldback impact on Pmin/Pmax:** Resource modeling should reflect foldback impacts to minimum operating level (Pmin) and maximum operating level (Pmax) when battery is at the low or high end of its State of Charge capability.
  - Expect may require FERC approval.

- **Specify exceptional dispatch rules where requires specific treatment:** Exceptional dispatch rules specific to out-of-market dispatches for batteries should be included in the Tariff recognizing unique characteristics of storage.
  - Expect may require FERC approval.

- **Improve Outage Management System to better reflect outages:** Outage Management System should allow Scheduling Coordinators to better reflect conditions limiting battery operations.
  - Expect does not require FERC approval.

- **Address lessons learned after Minimum State of Charge event:** Minimum State of Charge enforcement should be communicated widely to the market prior day.
  - Expect does not require FERC approval.

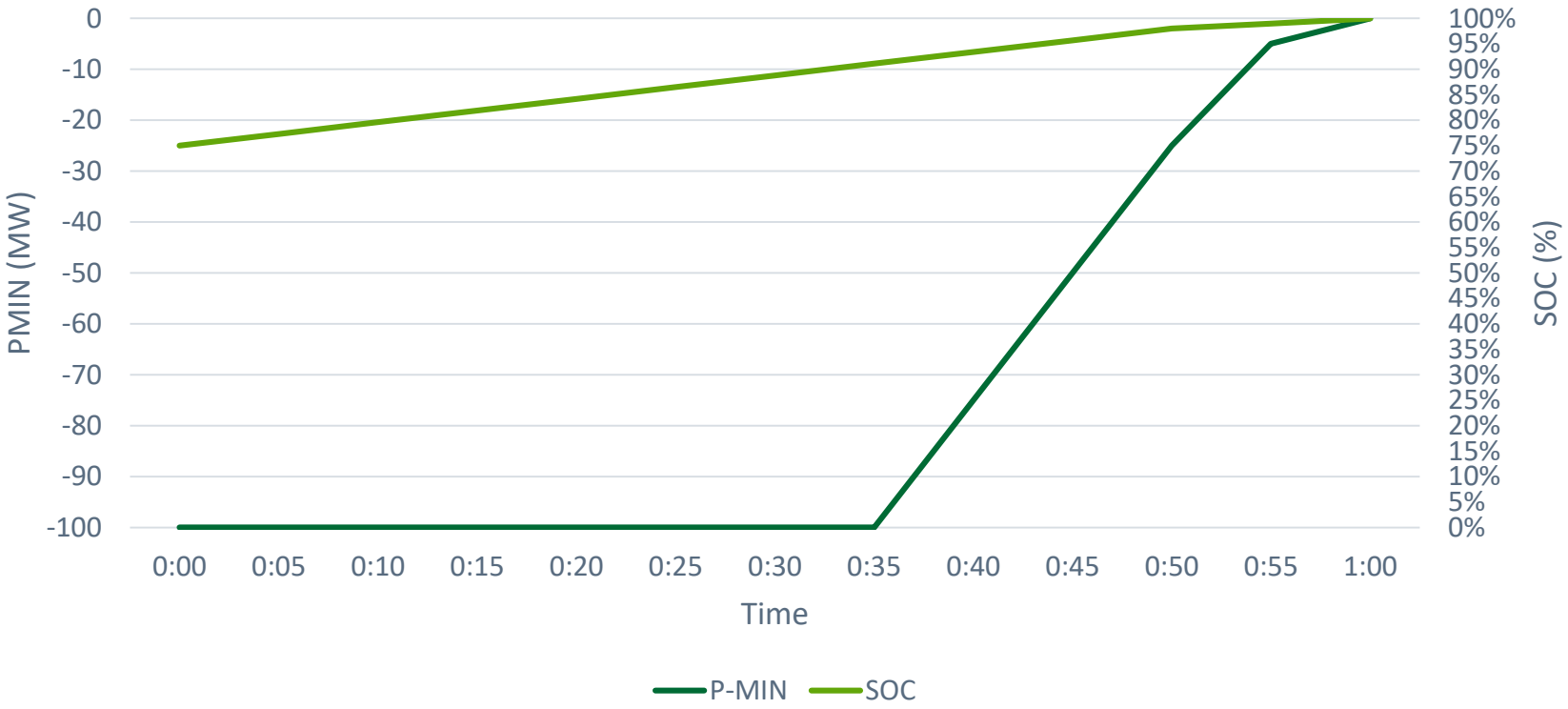
Adopt dynamic modeling of foldback (Q2 2022)

- Batteries experience foldback that reduces its Pmin/Pmax continuous amount when at low or high State of Charge (SOC) levels.
  - When a battery is at either high or low state of charge, the charging/discharging current must be limited to ensure the operating limits of the equipment are not exceeded.
  - Change in Pmin/Pmax given SOC is sloped.

- Today, we can only manage foldback through outage cards.
  - Misleading since it is expected operations not forced outage
  - Burdensome on battery operators since it requires “chasing” these Pmin/Pmax fluctuations submitting multiple outages.
  - Burdensome on CAISO operators since requires frequent approvals.

- Near term, we want to see a solution where the market dynamically adjusts the Pmin/Pmax in a given interval based on SOC levels.
  - Foldback impact can be estimated similar to ramp rates
    - Foldback may vary at a given SOC level across data points but there is an ability to pick a reasonable value for registering a resource characteristic for modelling purposes.
  - Establish resource characteristic potentially as either (1) Pmin/Pmax given SOC or (2) foldback rate given SOC.

Foldback example showing Pmin impacts



- Illustrative example
- Similar impacts to Pmax occur when nearing 0% SOC
- The amount of reduced Pmax capability is largely inverted to the shape above
- Reduction to Pmin capability is more severe than reduction to Pmax capability
- Recommend dynamic modelling both reductions to improve operations

Specify exceptional dispatch rules where requires specific treatment (Q2 2022)

- Charge ED should not exceed charging capability*

- Discharge ED should not exceed expected SOC at start time*
  - If operations *does not* pair with charge ED prior then should not exceed current SOC level plus sum of any advisory charging or discharging schedules between issuing ED and its start time
  - If operations *does* pair with charge ED prior then should not exceed SOC level at the end of the charge ED

- For verbal EDs not issued through Automatic Dispatch System (ADS), ED should not start sooner than battery is able to respond in manual mode.
  - Master File field could be leveraged to reflect response time.

- For hold EDs, all resources should be paid lost opportunity cost.

*CAISO customer service has communicated operations will perform this way, however we are asking for it to be formally documented.

Improve Outage Management System to better reflect outages (ASAP)

- Allow battery to submit overlapping outage cards across Pmin, Pmax, or Max Energy and that allow use of various NOW types.
  - NGR experience capability changes throughout the day to Pmin, Pmax, or Max Energy capability that are driven by different causes.
  - NGR need ability to submit overlapping outage cards so that we can more accurately reflect changes to unit capability across Pmin, Pmax, and Max Energy by NOW type.

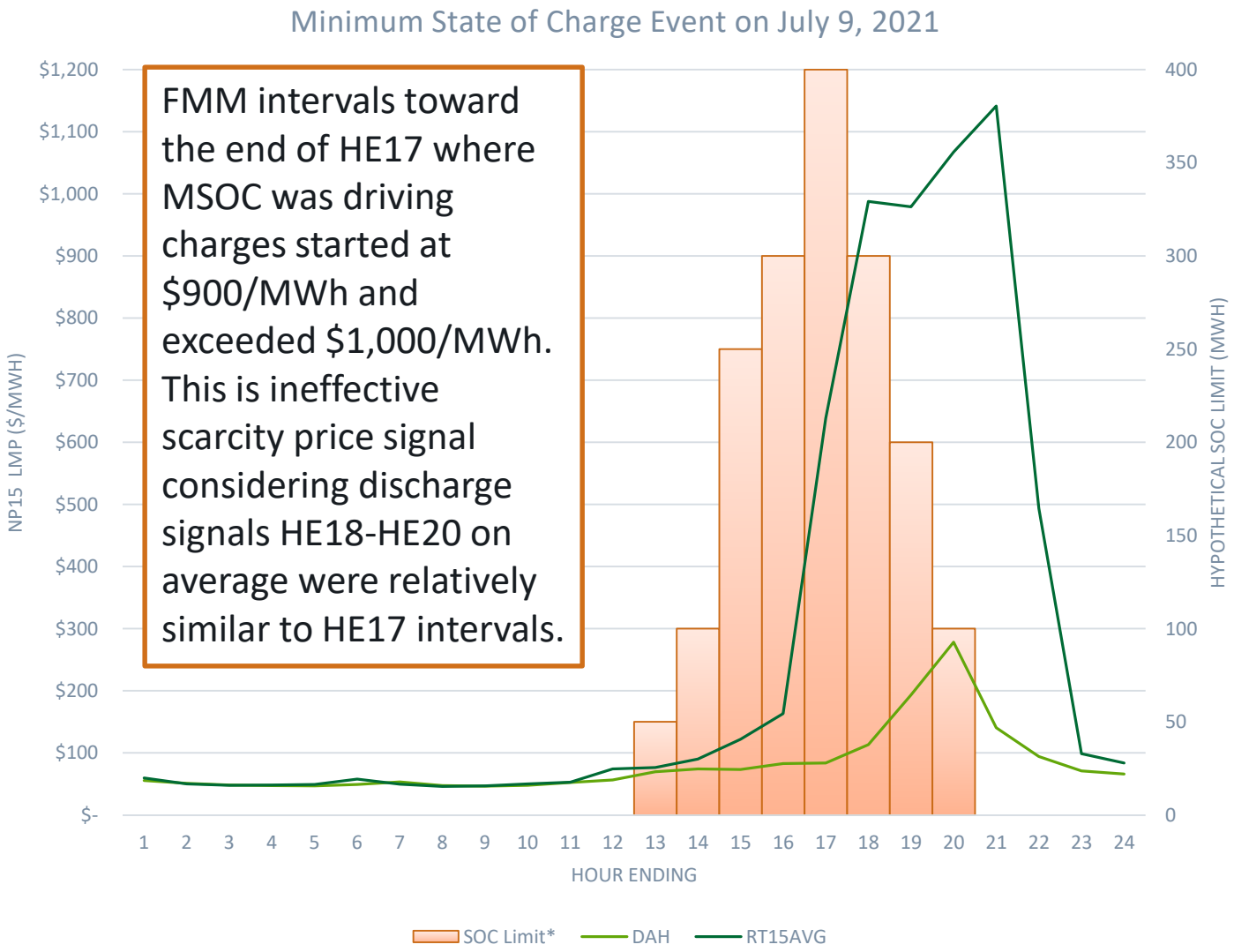
- Clarify nature of work expectations in BPM to improve outage reporting
  - Batteries should be consistently using the same NOW type to reflect similar impacts to Pmin, Pmax, and Max Energy including but not limited to:
    - BPM should specify which NOW should be used for inverter failures.
    - BPM should specify which NOW should be used for foldback impacts until market solution is implemented since not really a forced outage.
  - BPM definitions should note any card types that are inappropriate for NGRs

- Enhance outage cards for unit testing to reflect battery withdrawals prior to COD
  - Unable to submit outage card with the charge schedules
  - Requires direct communication with grid operations to ensure they are prepared for withdrawals instead of injections as the card could be incorrectly understood due to this technical limitation
  - This is inefficient for both plant operators and CAISO operators

Address lessons from MSOC event (ASAP)

- On July 9th, the CAISO triggered Min State of Charge requirement
- We found the approach to notifying Scheduling Coordinators lacked an additional layer of communication needed as a backstop
- CAISO should send out a notification if MSOC is triggered to make Scheduling Coordinators and rest of market aware
- CAISO should send this market-wide notification no later than TD-1 1500 following the day-ahead market results
- This adds additional layer of communication to ensure SCs check CMRI report and increases market-wide transparency
- Further, CAISO should not enforce SOC limits during hours when day-ahead award begins to remove confusion and allow market to function efficiently to meet real-time needs.

Address lessons from MSOC event cont.



FMM intervals toward the end of HE17 where MSOC was driving charges started at $900/MWh and exceeded $1,000/MWh. This is ineffective scarcity price signal considering discharge signals HE18-HE20 on average were relatively similar to HE17 intervals.

Enforcing specific SOC limits during HE18-HE20 where CAISO is discharging batteries seems unnecessary, confusing, and inefficient. Recommend not enforcing during these periods.

Q&A