MEMORANDUM

TO	Massachusetts Clean Energy Center and Department of Energy Resources
FROM	Michael Hagerty, Andrew Levitt, Ragini Sreenath, and Kate Peters, Brattle
SUBJECT	**Comments on June 2023 Meeting on Long-Duration Energy Storage**
DATE	June 28, 2023

On June 7, 2023, the Massachusetts Clean Energy Center (CEC) and the Department of Energy Resources (DOER) held a stakeholder meeting titled "The State of Energy Storage and its Future Role in the Commonwealth" as a part of the Long-Duration Energy Storage Study mandated by *An Act Driving Clean Energy and Offshore Wind,* passed on August 11, 2022.

We provide below our comments on behalf of Cypress Creek Renewables on the information provided during the stakeholder meeting and recommendations for improving the study.

- **High-Level Study Objective and Approach:** It is our understanding that the purpose of the current study of energy storage technologies is to evaluate the cost-effective deployment and utilization of mid-duration and long-duration storage resources and the need for future procurements of energy storage resources. The approach proposed by the study consultant, Energy Environmental Economics ("E3"), will evaluate the potential applications and market value of mid-duration and long-duration storage under a set of projected market conditions from recent studies for New England and Massachusetts. However, it is unclear how the study as proposed will be used to inform policymakers on the amount and type of storage resources to procure in future solicitations. To that end, it would be beneficial if the CEC/DOER could clarify how they envision this study impacting the procurement.

  Based on our review of the proposed approach, the study does not appear to provide insights into which types and amounts of energy storage will be most cost effective and when beyond the estimated capacity identified in the long-term capacity projected by the CECP study. Instead, the proposed study will provide an estimate of the value of each type of energy storage under a fixed set of market conditions with limited consideration of the

interactions of different energy storage technologies and durations. This will be provide useful information in how different technologies will operate under specific conditions, but does not identify the amount and type of technologies that should be included in future solicitations. To capture those tradeoffs and provide insights to inform future solicitations, a different approach would be necessary using a capacity expansion model that considers both the costs and benefits of each type of each storage and determines the cost effective mix of energy storage and other generation resources to achieve future policy goals.

- **Mid-Duration and Long-Duration Storage Technologies Considered**: E3 notes that "lithium-ion batteries remain the most cost-effective existing commercial technology for short duration applications." However, Li-ion can also be configured for mid-duration applications as well from 4 – 10 hour durations and it is unclear whether those configurations will be included in the study.

  E3 also provided a list of long-duration storage technologies to be considered on slide 26. However, it is unclear why there is primarily a focus on long-duration (10+ hours) and not also on mid-duration (4 – 10 hours), and which mid-duration technologies will be included in the study. The long-duration technologies listed are mostly early stage technologies that have potential over the long-term and are worth evaluating at a high-level, but are unlikely to inform near-term procurement decisions.

  Finally, we expected that this study would evaluate the cost effective deployment of hydrogen production, storage, and generation as a potential technology to achieve MA decarbonization targets. We recommend that CEC/DOER and E3 address in this study the role that they envision hydrogen playing as an energy storage resource in the future power system.

- **Reliability Modeling Approach**: E3 presented an approach for assessing the reliability value of storage leveraging the results of the Massachusetts Clean Energy and Climate Plan for 2050 (CECP) study for the future resource mix. It is unclear whether the proposed approach accounts for the tradeoffs between energy storage resources, renewable generation, and other resources. This is important because the type and quantity of energy storage deployed will result in a different mix of renewable generation and fossil generation resources to meet Massachusetts policy goals. The value of energy storage depends significantly on these interactions as additional energy can both reduce the amount of renewable resources needed and shift the resource mix between different technologies. For example, energy storage resource provide very different system benefits to a system made up primarily of renewables compared to a fossil or clean firm generation based system. For these reasons, it will be important for a study intended to identify the amount of cost

effective energy storage to incorporate these dynamics into the benefits of energy storage of different durations. It would be helpful for E3 to provide more information on how their modeling approach will account for the interactions between different resource types.

Similarly, the reliability value of energy storage will also depend on the amount and type of energy storage deployed. For example, the reliability value of long-duration energy storage will tend to decrease both with increased deployment of long-duration energy storage as well as short- and mid-duration energy storage. E3 should clarify how their proposed approach to evaluating the reliability value of energy storage will account for the amount and type of energy storage deployed.

- **RECAP Model:** The approach for modeling the dispatch of several resources in a model like RECAP can have significant impacts on the results. We have the following questions about how their dispatch of storage will be completed in RECAP.
  - Is the energy storage dispatch a net-peak-shaving heuristic, or is it a reliability-driven optimization? If it is an optimization, what is the objective function?
  - Are there restrictions on the operation of energy storage (e.g., only one or two discharge cycles per day)?
  - How does the model handle the dispatch interaction between the pre-existing storage resources of various durations and a new marginal unit, and the dispatch interaction among storage types with various durations (e.g., 4-hr vs. 20-hr)?
  - Can E3 confirm that they model a full year for each Monte Carlo draw? Does RECAP maintain weather-year historical alignment between wind/solar and weather/load?
  - How are temperature dependent outages of thermal resources modeled? Coincident unavailability of thermal generators under cold weather is a scenario of interest if not already included in the modeling.
  - The NREL WIND Toolkit only accounts for six years of historical wind data. We would recommend that E3 instead utilize wind generation profiles from the Variable Energy Resource (VER) Data Series developed by ISO-NE at this link.
- **AESC Market Prices:** The projected energy prices and capacity prices on slide 20 show limited change over time. We would expect significant changes in both energy prices and capacity prices throughout the clean energy transition. For example, capacity prices reflect historical market resource surplus and do not increase to reflect the need to attract new resources as demand increases due to electrification and fossil retirements. We recommend that the battery storage valuation account for higher capacity prices reflecting future needs for new capacity.

For energy storage, hourly variation in energy prices are more important than annual average prices. Additional information on the hourly energy prices is necessary to determine whether the current assumptions are sufficient.

Finally, E3 is proposing to use both the AESC results and CECP results to evaluate alternative energy storage technologies and durations. However, it is unclear whether the market prices from the AESC are consistent with the projected resources mixes from the CECP study. Using sources that are inconsistent will result in an inaccurate estimate of the cost effective deployment of energy storage in the future power system. We request that E3 provide more information on whether the AESC energy and capacity prices being used for estimating the market value of energy storage aligns with the CECP results that are being used for the reliability modeling. A better approach would be to use an internally consistent capacity expansion model to capture the dynamics necessary for analyzing energy storage technologies and durations.

- **Ancillary Service Revenues**: Ancillary service revenues can be a major driver of future energy storage deployment. Slides 21 and 22 show a significant decrease in ancillary service revenues for energy storage. E3 should provide additional information on the basis for the phase down in ancillary service revenues from 2023 to 2026 and the long-term revenues projected for later years.