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By email to grid@masscec.com and thomas.ferguson@state.ma.us

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Subject: **Comments on the modeling for the study to optimize the cost-effective deployment and utilization of both new and existing mid-duration and long-duration energy storage**

Dr. Ferguson:

RENEW Northeast, Inc. ("RENEW")[1] submits these comments in response to the Massachusetts Department of Energy Resources' (DOER) and Massachusetts Clean Energy Center (MassCEC) invitation to comment on the study that will be performed on how to optimize the cost-effective deployment and utilization of both new and existing mid-duration and long-duration energy storage in compliance with Section 80 of Chapter 179 of the Acts of 2022, *An Act Driving Climate Policy Forward* (Section 80). Thank you for the opportunity to comment. Energy storage can cost-effectively provide new capacity to the grid and complement renewable energy resources by absorbing their excess low-cost energy and storing it for later use.

RENEW is a non-profit association uniting environmental advocates and the renewable energy industry whose mission involves coordinating the ideas and resources of its members with the goal of increasing environmentally sustainable energy generation in the Northeast from the region's abundant, indigenous renewable resources. RENEW members own and/or are developing large-scale renewable energy projects, energy storage resources and high-voltage transmission facilities across the Northeast. They are supported by members providing engineering, procurement and construction services in the development of these projects and members that supply them with multi-megawatt class wind turbines. Its members are developing stand-alone transmission-interconnected energy storage systems and energy storage systems virtually or physically paired with renewable energy resources.

[1] The comments expressed herein represent the views of RENEW and not necessarily those of any particular member of RENEW. They were prepared with the assistance of Marc D. Montalvo and Chris Jylkka of Daymark Energy Advisors, Inc.

I. Background

The Clean Energy and Climate Plan for 2050 (CECP), released in December 2022, found that to meet economy-wide green-house-gas (GHG) emission reduction targets by 2050, a 93% reduction in electric sector emissions is required.[2] The CECP (Phase Scenario) forecasts a substantial increase in electric load in Massachusetts, from approximately 55 TWh to 127 TWh between 2020 and 2050. Over the same period, the CECP forecasts the addition of 23.5 GW of solar, 23.4 GW of offshore wind, and 18 GW of storage within the Commonwealth, 7 GW of which is from long-duration energy.

As required under Section 80, DOER and MassCEC with the help of its consultant, E3, are conducting a study to examine how mid- and long-duration energy storage could potentially benefit the grid and ratepayers, including through improving grid reliability. A stakeholder session was held on June 7, 2023, to preview work to date and raise several areas for discussion and feedback. The presentation laid out the workplan and objectives of the study, summarized modeling assumptions and methods, and raised several specific questions for feedback.

The choice of model framework and assumptions depends on how grid and ratepayer benefits are defined and the relevant timescale over which they are to be measured. Durable grid and ratepayer benefits will come from the technical integration of storage into the power system both as transmission resources and as generation or load. Compared to the modeling of traditional power system elements, the modeling of storage--particularly mid- and long duration storage--is little explored and the best methods for assessing benefits more uncertain. This uncertainty and the novelty of the work suggest that multiple modeling approaches, scenarios and sensitivities are required to gain a reasoned understanding of the likely performance of this technology and inform policy makers' decisions regarding procurement and incentive strategies.

As proposed, the modeling is too narrow and will not sufficiently reveal the benefits of adding incremental MWh of storage capability via combinations of mid- and long-duration storage to the portfolio mix. RENEW offers these comments as feedback on the methods and assumptions proposed in the June 7, 2023, presentation.

II. Comments

A. Study Objectives

The presentation (slide 13) lays out the following study objectives:

1. What is the current state of energy storage in the Commonwealth?
    a. How much storage is deployed?
    b. What programs exist to encourage deployment?
    c. What are the costs/benefits of current use cases for Short-Duration Energy Storage (SDES)?

[2] https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-plan-for-2050#:~:text=Also%20on%20December%2021%2C%202022,greenhouse%20gas%20emissions%20in%202050.

2. What is the market outlook for emerging mid- and long-duration energy storage (M/LDES) technologies?
    a. What is the level of maturity for various emerging M/LDES technologies?
    b. How are costs projected to evolve for M/LDES technologies?
3. What are potential applications of mid-and long-duration storage?
    a. How can LDES contribute to reliability in a decarbonized system?
    b. What benefits will M/LDES be able to provide at the distribution level?

The intended focus of the study is to understand whether Massachusetts should issue solicitations targeting the procurement of mid- to long-duration energy storage. A large part of the focus of the first presentation was on existing energy storage. When the presentation turns to a discussion of future deployment, we observe that the technologies that DOER and MassCEC identify on slide 26 are arguably all long-duration, with 25-to-100-hour durations. The study does not appear to consider mid-duration technologies, including Li-ion batteries, with durations in the 4-to-12-hour range, for example.

We recommend that the first objective be revised to focus on three questions: (1) how much storage is currently deployed and anticipated deployed through the study period, with distinctions between mid-duration, long durations and multi-day storage?; (2) of the storage to be deployed, how much is BTM or deployed on the bulk grid?; and (3) what has been the principal use cases and economic driver(s) for storage development in the Commonwealth (e.g., wholesale markets, SMART, Clean Peak, transmission owner self-build) and, over the long-run, how does the modeled system value of storage compare with market revenues (e.g., from SMART and Clean Peak programs)? The last question should assess the differences in the use and services provided by collocated and grid-scale short duration storage and the existing pump storage facilities. The purpose of answering these questions is twofold: (1) to ensure that the study model takes proper account of all existing short-term storage and ensures that future installations reflect prevailing market conditions and policy incentives; and (2) to inform policymakers regarding the incentive structures and solicitation designs that would most efficiently acquire mid- and long-duration storage capacity. For example, short-duration storage today faces numerous offtake barriers: wholesale market revenues and CPS payments are not sufficient to recover investments. Additionally, the length of the interconnection queue and local permitting opposition creates additional challenges. As procurements of beneficial mid- and long-term storage are designed, policy incentives and aligned regulatory reforms that address these existing barriers minimally are required.

With regards to objective two, the answers to these questions provide a snapshot of the state of mid- and long-duration storage and may offer some insight into the policy incentives that would be required to accelerate the deployment of the quantity of mid- and long-duration storage with the capabilities needed to accelerate the transition of the grid in line with the Commonwealth's clean energy targets. Additionally, given the uncertainties regarding the pace of development and cost of the long-duration technologies (presentation notes this uncertainty at slide 31), it is important to avoid overly precise statements predicting the maturation or costs trajectories of specific technologies which can be remedied by conducting cost optimized resource portfolios under a range of scenarios and technology cost sensitivities. A useful output of the study would be high and low estimated needs for mid- and long-duration storage and how the generation mix and portfolio costs differ in various scenarios. It might also be helpful if the study could offer insight into any tradeoffs between the amount of mid- and long-duration storage that are deployed depending on their relative per kWh costs.

The quantitative focus of the study should be on evaluating the benefits of mid- and long-duration storage via more a detailed assessment of anticipated power system needs that could be technically addressed with such technologies. This study should provide insights into the benefits of adding incremental MWh of storage capability to the system. The analysis can then be paired with the qualitative assessment of costs and maturation to provide information that can guide decisions around quantity, timing, and incentive structure of procurements.

B. Study Approach

The study assumes the CECP Phased Scenario loads and resource mix. The study will use E3's Renewable Energy Capacity Planning Model (RECAP)[3] to assess how the reliability (taking a resource adequacy view) of the system changes as additional mid- and long-duration storage is added. The DOER/E3 presentation is not clear on these details, but ostensibly the model begins with the resource mix, including storage, from the Phased Scenario and adds increments of storage with increasing duration until the system meets reliability criterion (1-day-in-10-years). We are concerned that this approach will limit available insights into the potential benefits of having mid- and long-duration storage as resources in the emerging clean energy portfolio – including the existing pump storage facilities. The approach starts with a fixed portfolio, so eliminates all real-world uncertainty associated with the timing of resource entry and exits, transmission and distribution expansion, and load growth. The modeling also appears to ignore the impact of location, transmission, and gas constraints on storage benefits, particularly in load pockets. Additionally, it is not clear how flexible demand is treated in the modeling.[4]

The anticipated key benefit of mid- and long-duration storage is that the resources will enable the deployment of the needed very high penetration of renewable resources and lower overall system costs, curtailment, and land-use impacts. The CECP Phased Scenario has posited such a portfolio, but this portfolio reflects only two representative storage types. It was designed to assess decarbonization pathways not to establish resource procurement targets; and it is lacking sufficient public detail about storage resource modeling inputs and outputs to inform policy decisions about the degree to which policy support is needed to ensure that storage resources are developed at the scale and pace that is necessary over the long run. The core question of this study is to what extent the inclusion of flexible and responsive resources like mid- and long-duration storage will allow the power system to decarbonize in a more cost-effective way and what procurement requirements DOER should establish for mid and long-duration storage to contribute to greenhouse gas emission limits, promote offshore wind energy

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[3] https://www.ethree.com/tools/recap-renewable-energy-capacity-planning-model/#:~:text=E3's%20Renewable%20Energy%20Capacity,energy%20storage%2C%20and%20demand%20response.

[4] The CECP identifies "innovative load flexibility" as a key balancing resource (CECP at p. 75).

and other renewables, transport energy from periods of low energy demand to high energy demand and enhance reliability at the minimum ratepayer cost. Because the proposed model holds the portfolio static, except for resource adequacy, there is no clear way to measure these benefits.

Understanding the above listed benefits is required to characterize fully the scope of the role mid- and long-duration storage may play in the future system. Modeling all these benefits explicitly would require the ability assess transmission, distribution, and operations level impacts with some degree of granularity and may be beyond the scope of this study. DOER and MassCEC may be able to qualitatively assess avoided grid expansion and operational flexibility benefits. At a minimum, we suggest that DOER and MassCEC consider adopting a model that does not assume a portfolio, but rather one that evaluates the benefits of storage across multiple scenarios. The study scenarios could examine, for example, the impacts of varying renewable project costs, loads, demand response, wholesale market conditions, and interconnection locations.5

Ideally, the study would use a capacity expansion model that builds out a least cost portfolio of resources to achieve the state's decarbonization goals and reliability standards. The approach that DOER/MassCEC proposes takes energy and capacity prices from the New England Avoided Energy and Supply Cost (AESC) study, which extends through 2032, extrapolating values out to mid-2050. In the wholesale market, wholesale energy and capacity prices are a consequence of the resources in the market. To the extent that the CECP phased buildout case and the AESC assumptions are not aligned, the market revenues will not reflect the supply and demand conditions. Performing a proper capacity expansion would ensure that the cost revenue tradeoffs are explicitly and intuitively linked.

This approach would explicitly measure the diversity benefit of storage and could inform an assessment of the ability of mid- and long-duration storage to replace other traditional dispatchable generation (e.g., fossil-fuel-fired plants) on the system. For example, an assessment of whether mid- or long-duration storage could replace fossil-fuel-fired plants could be done by assuming no existing gas resources on the system in the study year, including gas projects as an expansion option with mid- and long-duration storage to determine whether the model select for fossil-fuel-fired plants even if mid- and long-duration storage is available. Sensitivities could then be run to determine what resource characteristics are required so that fossil-fuel-fired plants are no longer selected.

The approach we recommend explicitly recognizes the high level of uncertainty associated with attempting to forecast benefits out 25-plus years and the results would more directly address the key objective of characterizing the kinds of storage that will be needed and the extent to which mid- and long-duration storage could enable the cost-effective deployment of carbon free resources and the results would contribute to addressing questions regarding

[5] The location of facilities matters from a system operations and grid expansion perspective and from policy perspective. If the most beneficial locations to site storage are outside of the state of Massachusetts, the Commonwealth's available unilateral policy options are constrained. Such information would be useful as it may call for multi-lateral engagements with other states and/or regional market-based approaches.

mechanism that incentivize deployment. Ideally the outputs should shed light on the ideal composition of short and long duration storage resources for each sensitivity.

C. Study Assumptions

The assumptions discussed in the presentation on slides 19 and 20 seemed to be directed at the analysis proposed for evaluating existing storage projects and programs. Our concerns regarding the proposed analysis of the existing storage fleet notwithstanding, on the assumption that DOER/MassCEC would adopt common assumptions, as applicable, for all aspects of the study, we offer the following comments on the assumptions and several of the embedded questions.

Slide 17. Which value streams are most attractive to developers? Are there other value streams we should be considering? Data/opportunities to measure other value streams?

While the potential sources of value are many, a priori it is inappropriate to assume a positive value for any of the identified categories. There will be positive value, where there is need, and thus demand. It is reasonable to assume that developers/investors will pursue projects that are able to capture maximum value. As we discuss in our comments on approach, the services that are most valuable are those that lower the delivered cost of carbon-free energy under the broadest set of portfolio outcomes (scenarios), subject to reliability constraints. The set of benefits is not constant across all portfolio mixes, and some may exist (have a positive value) only under certain portfolio outcomes; moreover, not all storage projects that add value to the system deliver value from the same service. For example, a storage facility might be sited in a location where its principal benefit is shifting production, while another's principal benefit might be the provision of contingency response. The above notwithstanding, it is likely anticipated that most of the storage facilities in question will seek to enter the market in response to a combination of wholesale market (capacity and energy arbitrage) revenue expectations and policy incentives. Developers appreciate less volatile and more secure revenue streams. In order to more fully assess the types and magnitude of incentives that may be required to move beneficial mid- and long-duration storage projects forward, the study should assess across a set of scenarios likely access to market revenue streams.

Slide 20. Other assumptions. Storage costs and operating characteristics -- Lazard, NREL, E3's Pro Forma

Lazard is not a reasonable resource for emerging non-lithium-ion energy storage technology types, which are generally excluded from that report until they have achieved commercial operations. For non-lithium-ion long-duration energy storage resources, we recommend referring to other public studies and reports such as a report by McKinsey and the

LDES Council,[6] which benchmarked various long-duration storage technologies. Additionally, E3 could refer to its own work funded by the California Energy Commission, which included broad assumptions about emerging long-duration energy storage resources and lithium-ion storage.[7]

The modeling should solve for a mix of energy storage durations assuming a reasonable round-trip efficiency for each. Approaching the assumptions this way will allow the study to reveal how different classes of energy storage will provide different operational benefits to the grid.

Retail rates -- National Grid, Eversource, Until

Retail rates are not constant through time. How are they assumed to evolve? What assumptions, if any, will be made regarding time of use and incentive rates for flexible load participation?

Energy prices, Capacity prices, Marginal emission rates, T&D deferral -- Avoided Energy Supply Components in New England (AESC), with adjustments base E3's judgement

This data is likely to have little relevance to the actual system in 2030 to 2050 as the capacity market structure, supply and demand mix, technological state, cost of equipment and construction, constraints on supply chains, siting, permitting, regulations, and macro-economic conditions evolve. Knowing these assumptions are wrong (not an indictment of the assumptions, just a realty that must be faced when performing this type of study), we suggest that DOER and MassCEC consider the proposed a data point and perform sensitivities around that to assess the relative importance of changes in the assumed values on the results to provide proper perspective and deeper insights.

Slide 26. Are there other technologies and is our technology readiness assessment accurate?

We recommend that the study cast a wide net on technologies and assume that the readiness assessment is wrong – i.e., recognize that the readiness assessment, even if bang-on accurate today, is not likely to offer much insight into what technology will emerge first. It would be best to present this data as a summary of our current best understanding, making it clear that this chart could look radically different next year this time – both as regards the characteristics of the resources listed and the possibility that new technologies emerge that need

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[6] See "Net Zero Power: Long duration energy storage for a renewable grid," available at https://www.mckinsey.com/~/media/mckinsey/business%20functions/sustainability/our%20insights/net%20zero%20power%20long%20duration%20energy%20storage%20for%20a%20renewable%20grid/net-zero-power-long-duration-energy-storage-for-a-renewable-grid.pdf

[7] See E3, Assessing the Value of Long Duration Energy Storage, May 15, 2023, available at https://efiling.energy.ca.gov/GetDocument.aspx?tn=250157

to be added. For the purpose of the study, we continue to suggest that DOER and MassCEC focus on attributes.

Slide 28. E3 developed load and renewable output profiles for ISO-NE for 39 weather years.

ISO New England (ISO-NE) has developed matched load (adjusted for energy efficiency) and onshore and offshore wind and BTM and grid-connected solar production data for use in its studies. This data is publicly available on the ISO-NE website, and it has been prepared for the purpose of a study such as this.8 This dataset is built on 23 years of detailed weather, load and production data and includes projections for new resources, such as offshore wind. ISO-NE uses this data in its studies. We recommend that DOER and MassCEC adopt this ISO-NE data. E3 can adjust the ISO-NE weather matched load data to reflect the assumed 2050 load shapes and generate corresponding weather matched renewable production profiles. Additionally, the ISO-NE data offers the ability to perform explicit 8760 system modeling, rather than the sample period approaches that are often used (it is unclear from the presentation how the proposed modeling will represent loads). The hourly-level granularity more accurately reveals the benefits of storage. E3 need not devote resources to developing new load and production curves and its use will eliminate discrepancies between load and production assumptions used in other studies performed by ISO-NE, several on behalf of the NESCOE, and this study, thereby allowing the results more easily understood and integrated into the existing body of study work.

III. Conclusion

Thank you for the opportunity to offer these comments.

Sincerely,

Francis E Pullaro

Francis Pullaro
Executive Director

[8] https://www.iso-ne.com/system-planning/planning-models-and-data/variable-energy-resource-data/