CHARGING FORWARD: ENERGY STORAGE IN A NET ZERO COMMONWEALTH

A REPORT OF THE DEPARTMENT OF ENERGY RESOURCES

IN CONSULTATION WITH THE MASSACHUSETTS CLEAN ENERGY CENTER

DECEMBER 31, 2023

INTRODUCTION

Exploring the role that energy storage plays in a clean energy and net zero emissions future for the Commonwealth began in 2015, as solar and terrestrial wind generation grew in the region and the promise of intermittent, offshore wind ("OSW") came closer to reality. The Department of Energy Resources ("DOER") launched the Energy Storage Initiative in May 2015 as the Commonwealth's first documentation on the potential ability and value of energy storage to meeting its energy and climate goals. The *State of Charge*,[1] the key report of the Initiative, laid out use cases and value propositions for energy storage, demonstrated that energy storage could capture immense system benefits for ratepayers, and examined policies and programs to support deployment.

Having established the value of energy storage through *State of Charge* in 2016, in 2017 the Energy Storage Initiative selected 26 demonstration projects testing a variety of use cases identified in *State of Charge* for grants totaling $20M through the Advancing Commonwealth Energy Storage ("ACES") Program. Later, the 2018 Act to Advance Clean Energy[2] established an energy storage target of 1,000 MWh for the Commonwealth by December 31, 2025.

Since the *State of Charge*, the landscape for energy storage has changed dramatically, driven by cost declines of lithium-ion batteries, technology improvements and innovations, policy mandates, regulatory changes, and the deployment of renewables. For example, between 2010 and 2019, costs for energy storage declined over 80%[3] and market reforms created a more level playing field for a broader range of technologies to compete. This evolution is reflected in 11.4 GW of non-hydro energy storage deployed across the U.S. as of 2022, driven almost entirely by lithium-ion battery projects. Despite this progress, major barriers, including many identified by the *State of Charge*, remain and impede greater deployment and use of energy storage in the Commonwealth.

Recognizing the key role energy storage must play in meeting our energy and climate goals and the ongoing challenges to its deployment and use, Section 80(a) of the 2022 Climate Act[4] authorized DOER

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[1] *State of Charge*: https://www.mass.gov/doc/state-of-charge-report/download.

[2] St. 2018, c. 227, section 20.

[3] NREL, 2021. Storage Futures Study: Storage Technology Modeling Input Data Report (nrel.gov).

[4] St. 2022, c. 179, section 80.

and the Massachusetts Clean Energy Center ("MassCEC") to conduct a study (the "Study") to provide: 1) An overview of the existing energy storage market in the Commonwealth; 2) A market report focused on emerging mid- and long-duration energy storage technologies ("MDES" and "LDES," respectively),[5] and; 3) A study concerning the potential benefits of MDES and LDES technologies to Massachusetts ratepayers as the Commonwealth seeks to achieve its Clean Energy and Climate Plan ("CECP")[6] targets through 2050. Section 80(b) of the 2022 Climate Act directs DOER to submit a report and recommendations to the Clerks of the Senate and House of Representatives and to the Chairs of the Joint committee on Telecommunications, Utilities, and Energy based on the results of the Study (the "Report"). The Study is included as an Appendix to this Report.

Together, this Report and the attached Study fulfill DOER's obligations under Section 80 of the 2022 Climate Act. DOER's recommendations, which include the announcement of $50M to be spent on catalyzing energy storage deployment in the Commonwealth, intend to lower the barriers for energy storage deployment and use, improve the siting process, increase resiliency across the Commonwealth, particularly for environmental justice ("EJ") and low- and moderate-income ("LMI") communities, and spur the commercialization of MDES and LDES technologies, which will provide critical grid reliability in the coming decades as the Commonwealth meets its grid decarbonization goals.

BACKGROUND

To support the Study, DOER and MassCEC procured the services of Energy and Environmental Economics, or E3. DOER, MassCEC, and E3 undertook a robust stakeholder process. This included two 90-minute public sessions and over 30 stakeholder interviews with over 50 different organizations.[7] The first public stakeholder session had over 90 stakeholders in attendance on Wednesday, June 7, 2023 and covered the Study purpose and timeline and provided initial findings while soliciting ongoing feedback. The second public stakeholder session had over 110 stakeholders in attendance on Wednesday, August 16, 2023, and provided detailed findings on (1) current energy storage business cases; (2) grid reliability modeling out to 2050; and (3) the potential role of MDES and LDES technologies to help meet grid reliability needs through 2050. Collectively through public sessions, interviews, and written comments, participating stakeholders represented diverse perspectives:

- Energy storage project developers and operators

[5] The 2022 Climate Act adds new definitions for "Long-duration energy storage system" and "Mid-duration energy storage system." Mid-duration energy storage must be able to discharge at rated power for between four (4) and ten (10) hours, and long-duration energy storage must be able to discharge at rated power for over ten (10) hours. In this Report and the Study, short-duration energy storage ("SDES") refers to systems that must be able to discharge at rated power for four (4) hours or fewer.

[6] Massachusetts Clean Energy and Climate Plan for 2050: https://www.mass.gov/info-details/massachusetts-clean-energy-and-climate-plan-for-2050.

[7] Stakeholders also submitted a total of 24 written comments.

- MDES and LDES energy storage technology developers
- Energy storage industry advocates
- Distribution and transmission arms of Massachusetts's utilities
- Massachusetts municipal light plants and system operators
- ISO-NE
- Energy consultants
- Massachusetts Executive Office of Energy and Environmental Affairs, Department of Public Utilities, and Department of Environmental Protection
- Environmental advocates
- Regional planning commissions
- Municipal planning boards and a municipal conversation commission
- Academics

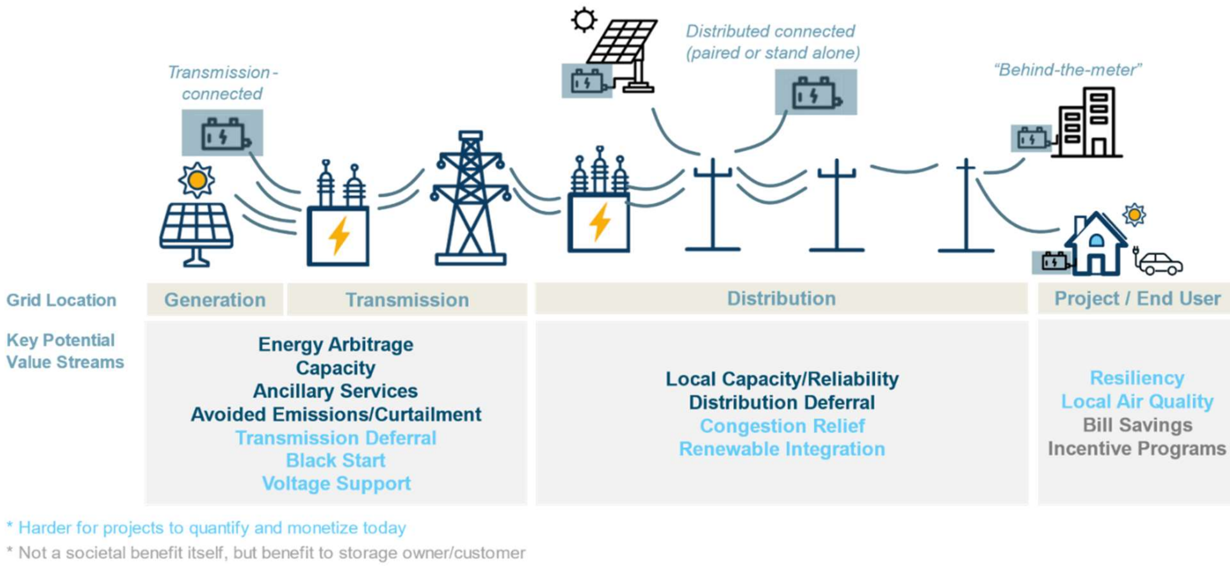
KEY FINDINGS

DOER identifies the following Key Findings based on the results of the Study. For the details and analyses underlying these Key Findings, please see the Study, attached hereto as an Appendix. In the next section of this Report, Recommended Policy & Program Designs, DOER includes recommendations on the steps the Commonwealth should take to mitigate barriers and realize benefits described in the Key Findings.

1. **The deployment and use of energy storage systems is a critical and cost-effective strategy for the Commonwealth to encourage in meeting its goals under the 2050 CECP.**

   As initially laid out in the Commonwealth's *State of Charge* and re-affirmed in the Study, energy storage has the ability to provide a variety of services throughout the electricity chain – from the transmission system to a behind-the-meter ("BTM") customer, as illustrated below in Figure ES-1 from the Study. The value of these services to the grid will evolve over time and increase as the mix of generation resources off of which energy storage charges is based less on dispatchable fossil fuel resources and more on intermittent renewable resources.

Figure ES-1. Energy Storage Provides Multiple Potential Benefits on Path from Electricity Generation to Customers



In addition to providing grid services, energy storage can promote the integration of OSW and other renewable resources, the firm delivery of renewables from periods of low energy demand to those of high energy demand, and enhance the reliable delivery and security of electricity to consumers. Energy storage enables wholesale electricity markets to integrate renewable energy and absorb and shift excess renewable generation, which will ultimately lower wholesale energy costs and reduce the need for new grid infrastructure, directly benefiting the Commonwealth's ratepayers.

The Study looked at current predominant energy storage use cases in the Commonwealth to understand how the value of energy storage will evolve over time. The Study includes cost benefit analyses ("CBA") for these use cases from three different perspectives: energy storage project developer or system owner, societal or the Commonwealth, and ratepayer. Overall, most use cases have at least one positive CBA today from the three perspectives analyzed, and CBAs should improve over time as the grid decarbonizes and energy storage economics depends more on wholesale markets and less on state incentives. Thus, the Commonwealth should continue and increase its support for energy storage today to ensure it will be on the grid at scale as the need grows.

2. Increasing renewable generation is key to unlocking environmental, economic, and reliability value propositions for energy storage.

Energy storage can support increased intermittent renewable generation through renewable energy firming and the reduction of emissions in the electric sector. The emissions profile of an energy storage system depends on the energy resource from which it charges. Energy storage co-located with a renewable generator can charge directly from that resource, but energy storage that charges from the grid will be supplied by grid energy and will have the emissions profile of the marginal generator.[8] More renewable generation is necessary to shift marginal generation away from natural gas.

The Commonwealth has already deployed significant amounts of renewable generation. For example, the Commonwealth has increased its solar capacity by three orders of magnitude from 2008 to today: 0.003 GW to over 3 GW AC. Despite this progress though, today renewables are rarely on the margin and thus energy storage systems charging from the marginal generator have negligible emissions benefits. As we move forward and meet our portfolio goals under the CECP to increase renewable generation and displace fossil resources, however, energy storage will be key to contributing to compliance with statewide greenhouse gas emissions limits and sublimits under chapter 21N of the General Laws.

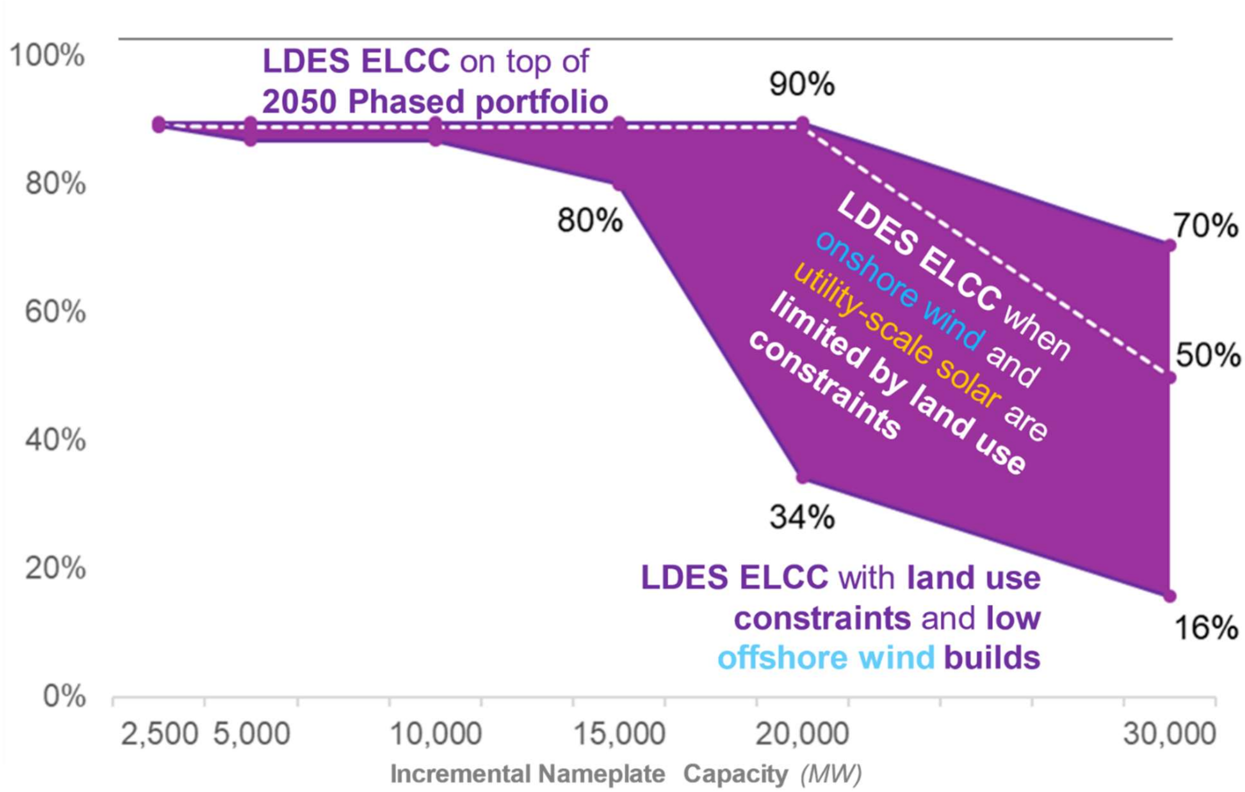
As the Commonwealth's energy mix becomes increasingly renewable, the economics of energy storage will continue to improve through more pronounced energy arbitrage[9] opportunities in wholesale markets. Presently, firm generators such as natural gas make up the vast majority of the ISO-NE resource mix. The firm nature of these resources limits the arbitrage opportunity in the wholesale market, which increases with increasing supply volatility. As the supply mix in ISO-NE shifts to one that is dominated by intermittent renewables, wholesale markets will send stronger economic signals to encourage the dispatch of energy storage resources, and in turn storage will play a critical role in smoothing volatility.

Finally, the Effective Load Carrying Capability ("ELCC") of energy storage, which is a measurement of a resource's ability to contribute to grid reliability, also increases with increasing renewable generation. For LDES resources, this is shown in Figure ES-13 of the Study, also shown below. The top line shows LDES' ELCC under the CECP Phased scenario, which has over 100 GW of renewable deployment throughout New England. Here, the ELCC of LDES remains at 90% even with high levels of incremental LDES capacity added to the system, about 20 GW. This is in contrast to the bottom line, which models a portfolio with about 40% less renewable deployment than in the CECP Phased scenario. In this case, the Study found the ELCC for 20 GW of incremental LDES capacity falls to 34%. In this case, the low renewables net load shape provides fewer opportunities for energy storage to charge and periods of generation need that are both long and deep.

[8] The Study, Key Findings, p. 7.

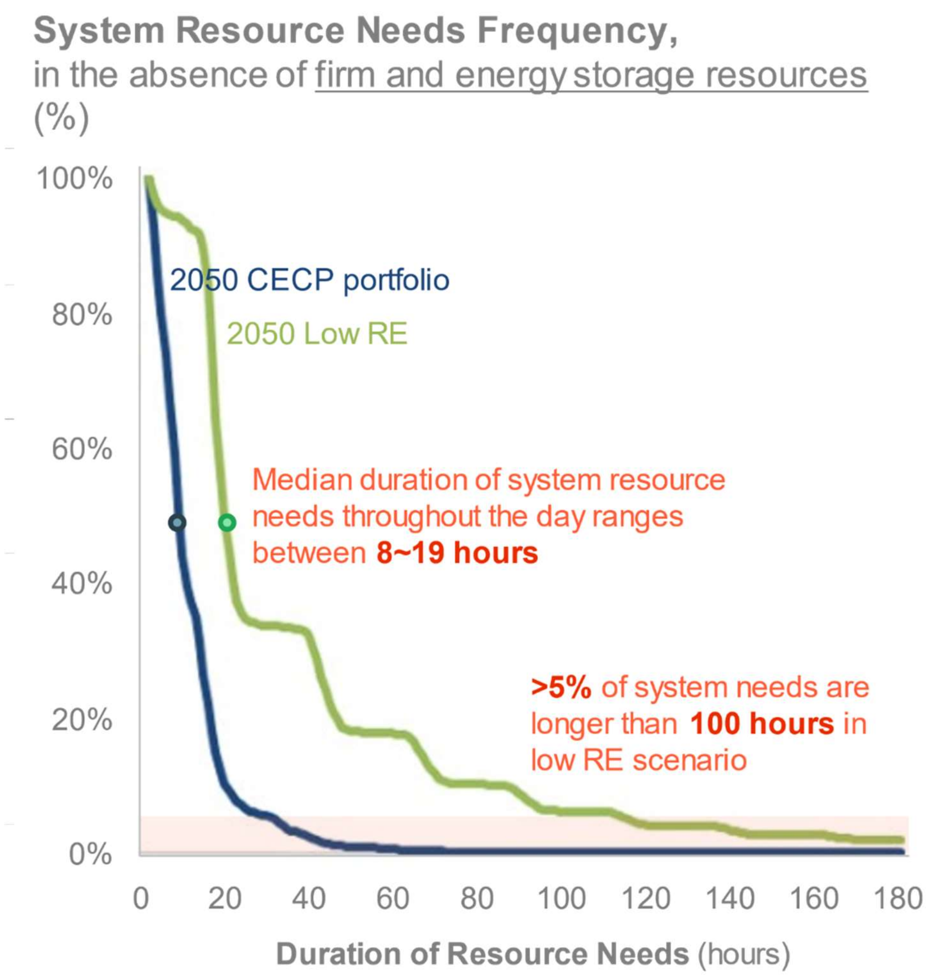
[9] Energy arbitrage for energy storage systems refers to economic benefit derived from buying low price electricity to charge the system and later selling the stored energy at a higher price when discharging.

Figure ES-13. 100-Hour Storage Incremental ELCC



Furthermore, the Study found that as the level of renewables on the system increases, the need for long durations decreases, illustrated below in Figure ES-12 from the Study. Under the CECP Phased scenario, about half of all periods of resource need last 8 hours or less. This is in contrast to the modeled portfolio with about 40% less renewable deployment (labeled "2050 Low RE" in Figure ES-12 below), where the median duration of system resource needs more than doubles from 8 hours to 19 hours. Under lower renewable generation deployment scenarios, the system's net load becomes flatter and a more sustained need for capacity exists. On the other hand, with more renewables deployed, periods of dispatchable resource need are interrupted by spurts of renewable generation.

Figure ES-12. Length of System Resource Needs Before Firm and Energy Storage Dispatch



3. **Financial, siting, permitting, interconnection, operational, technological, and supply chain barriers must be overcome to allow for the deployment and use of energy storage systems to the level needed for the Commonwealth to meet its goals under the CECP.**

   The Study found that the Commonwealth is more than halfway to its installed energy storage goal of 1,000 MWh by 2025 with the Electric Distribution Companies ("EDCs") reporting 550 MWh as of February 15, 2023.[10] While energy storage policies and programs in the Commonwealth have played a key role in spurring this deployment, barriers remain to unlocking the full potential of energy storage for the Commonwealth.

[10] The Study, Section 2.1.1, p. 30.

The financial, siting and permitting, interconnection, operational, technological, and supply chain barriers facing energy storage are as follows:

I. Financial

The Study modeled five common use cases of energy storage that are either seeing deployment or are in the interconnection queue in the Commonwealth: 1) Standalone transmission-connected; 2) Standalone distribution-connected; 3) Front-of-the-meter ("FTM") distribution-connected solar plus energy storage; 4) BTM solar plus energy storage for a commercial and industrial ("C&I") customer; 5) BTM solar plus energy storage for a residential customer.

For the standalone cases, wholesale market revenues are not enough to incent deployment, making revenue from Clean Peak Energy Credits ("CPECs") from the Clean Peak Energy Standard ("CPS") critical. However, as the CPS is a market-based program and CPEC prices fluctuate, stakeholders cite long-term revenue uncertainty in the CPS, driving up the cost of project financing and challenging deployment. The distribution-connected case is more challenging than the transmission-connected case due to higher total costs and current charging tariffs that challenge wholesale market participation. Per Section 72 of the 2022 Climate Act, the EDCs plan to file wholesale distribution tariffs for such systems with FERC and have been working with energy storage industry stakeholders on tariff design. On October 31, 2023, the EDCs provided notice to DPU of their intent to promptly file the wholesale distribution tariff with FERC.[11]

Pairing energy storage with solar through the SMART program significantly improves the economics of FTM distribution-connected energy storage from the developer's perspective, with the SMART energy storage adder adding benefits to outweigh costs. In fact, the Study found that the majority of recent energy storage deployment in the Commonwealth are small systems (i.e., <5 MW) that are paired with solar through SMART.

For BTM systems, the C&I case is favorable from the developer's (or system owner's) perspective, as they are able to use energy storage to stack CPS, SMART, and Mass Save's ConnectedSolutions benefits and reduce demand charges. Even though this use case is already favorable for the average C&I customer without the value of resiliency, resiliency can make up a large proportion of the benefit stack for those customers with high Value of Lost Load ("VOLL"), which represents the cost a customer is willing pay for uninterrupted electricity. On the other hand, a typical residential BTM system is cost prohibitive due to high capital cost and different rate structures.

Finally, for energy storage systems owned and operated by a municipal light plant ("MLP"), energy storage's primary value proposition is to reduce ISO-NE peak hour (i.e., ICAP tag) and transmission

[11] DPU Filings: National Grid under DPU 23-115, Eversource under DPU 23-126, and Unitil under DPU 23-117.

zone (i.e., RNS) charges, but operational and data access issues have challenged the consistent realization of these benefits.

While capital costs for energy storage systems should come down over time and increased renewable penetration will create more wholesale market opportunity, further state intervention now is needed. And with regard to longer duration resources like MDES and LDES that would mainly serve reliability, it is uncertain how they should be compensated for that service and by whom.

II. Siting and Permitting

Both energy storage project developers trying to site projects in the Commonwealth's municipalities as well as local officials responsible for permitting these projects articulated barriers, concerns, and the need for state guidance on the zoning of energy storage projects.

For developers, they must comply with state and local regulations and bylaws; this becomes particularly challenging on the local side, where processes and requirements can vary considerably from municipality to municipality.

For municipalities and local officials, because battery energy storage deployment is still in its infancy, many do not account for these systems in their bylaws and do not know how to evaluate projects or respond to constituent questions and concerns. In particular, these stakeholders cite safety, environmental, equity, end-of-life, and aesthetic concerns.

III. Interconnection

Energy storage developers cited interconnection as one of the top barriers to deployment. Queues in both ISO-NE and in EDC territories can be many years long, with developers tending to submit multiple interconnection requests for the same project as an attempt to improve their approval odds.[12] Rapidly increasing interconnection queues, as exemplified in the EDC territories, exacerbate the issue.[13] Developers also stated that grid operators make conservative assumptions regarding energy storage system operations, leading to long study times, imposition of overly restrictive operational schedules, and/or expensive interconnection costs.

Interconnection and siting challenges overlap for developers with what they say are insufficiently detailed EDC hosting capacity maps. This lack of detail leads to the submission of speculative projects as described in the prior paragraph, as it is the only way for developers to determine siting feasibility and cost.

IV. Operational

[12] The Study, Section 2.1.2, p. 37.

[13] 2022 ES Target Reports: https://www.mass.gov/info-details/esi-goals-storage-target.

Today, energy storage located in EDC territories must navigate operational signals from a variety of sources that depend on the connection point of the energy storage to the grid. As an example, distribution-connected energy storage participation in wholesale markets could lead to situations where a wholesale market signal encourages the storage to charge or discharge, but where doing so could result in an adverse impact on the distribution system. This is because the part of the distribution system the storage is connected to may be operating under different conditions at that moment in time than the bulk power system. This can pose reliability challenges to EDC grid operators who lack the ability to control these systems, which has led to the EDCs giving developers the choice of paying for grid upgrades to allow for unrestricted operations or to operate under restricted charge/discharge schedules. Developers report major challenges on both fronts, with the former option being too expensive and the latter being too restrictive to allow for economic dispatch and making the energy storage system non-compliant with ISO-NE rules.

For MLPs who own and operate energy storage systems, their major operational issue with energy storage is access to data from ISO-NE to help them best time energy storage dispatch to mitigate transmission-related charges.

V. Technological and Supply Chain

Lithium-ion is the dominant technology in recent energy storage deployments across the country and in the Commonwealth. Because of this dominance, supply chain issues and constituent raw material costs will impact project deployment timelines and capital costs. Diversifying energy storage technologies may mitigate these challenges.

Since lithium-ion, grid-scale energy storage projects are still relatively new, some early adopter operators reported technical issues, both hardware and software related, that led to operational problems and significant downtimes for system maintenance, which can have a large impact on project financials.

Finally, lithium-ion systems do have some associated fire risk that requires appropriate codes, standards, and regulations.

On the other hand, while pumped hydro does not suffer from the aforementioned issues, environmental advocates cite environmental damage to the facility's respective river ecosystem and to migrating fish populations.

4. **Energy storage can provide high resiliency value at the distribution circuit level and for end-use customers, particularly critical facilities. Determining the value of resiliency for an energy storage use case requires site-specific investigation.**

Energy storage can provide resiliency as a source of backup power for critical loads during an outage. The value of resiliency for energy storage is site-specific and will be high where: 1) There is a high VOLL, 2) Loss-of-load events are relatively frequent, and 3) Alternative solutions are unavailable or unfavorable to the site owner. Critical facilities (including hospitals), sites serving as storm shelters, and sites serving as cooling centers may be strong candidates for resiliency from energy storage based on high VOLL. Energy storage at these critical facility sites can also further the Commonwealth's decarbonization goals by replacing fossil fuel-based backup generators.

At the distribution circuit level, radial circuits that are prone to outage may be strong candidates based on event frequency and possibly slow restoration times. Figure ES-10 in the Study provides a first pass at identifying candidate distribution level circuits by highlighting those with historically frequent outages in Eversource and National Grid territories from 2019 through 2022. For most circuits, short duration energy storage ("SDES") could provide adequate backup power, though a large proportion would require MDES or LDES.[14]

5. **Energy storage of varying duration can help the Commonwealth's grid reliability risks as it decarbonizes out to 2050.**

   The timing and nature of the region's reliability risk will evolve in the coming decades as electrification increases overall load (including during peak periods of demand) and that load is served increasingly by renewable generation. By 2030, like today, SDES can help shave or fill daily peak demand. With more solar development between now and 2030, that daily peak shifts further into the evening, with the greatest loss-of-load risk for the year occurring from 5-7 P.M. in the summer months. By 2040, the grid will go from summer peaking to winter peaking, and the reliability challenge will change from meeting a short daily peak to meeting needs that can be a day or more in length. Energy storage technologies that are commercial today and those that are under development could satisfy these varying reliability needs while aiding the integration of more renewable generation.

6. **While there are some commercially available MDES and LDES technologies, more technology options will be needed. A variety of MDES and LDES technologies are under development but require further de-risking in order to achieve commercial scale.**

   Commercial MDES and LDES technologies do exist, including pumped hydro energy storage in the Commonwealth that has been operating for decades and on average can generate over 1,700 MW for about 7 hours. However, the eventual need for MDES and LDES deployments cannot be satisfied by pumped hydro energy storage alone, and other commercial MDES and LDES technologies may also have their own sets of challenges to deployment in the Commonwealth.

   Several novel MDES and LDES technologies that are mechanically, thermally, chemically, or electrochemically based are under various stages of development. Some technology types, such as metal-air batteries, flow batteries, and gravity-based energy storage have already seen some commercial deployment or have announced projects with planned deployments within the next few

[14] The Study, Section 3.5.1, p. 85-86.

years. The Study demonstrated that the ability of energy storage to provide critical electric grid needs grows over time, meaning that these technologies must be supported now such that when the need arises, there will be commercially deployed, safe, and reliable systems ready to fulfill that need.

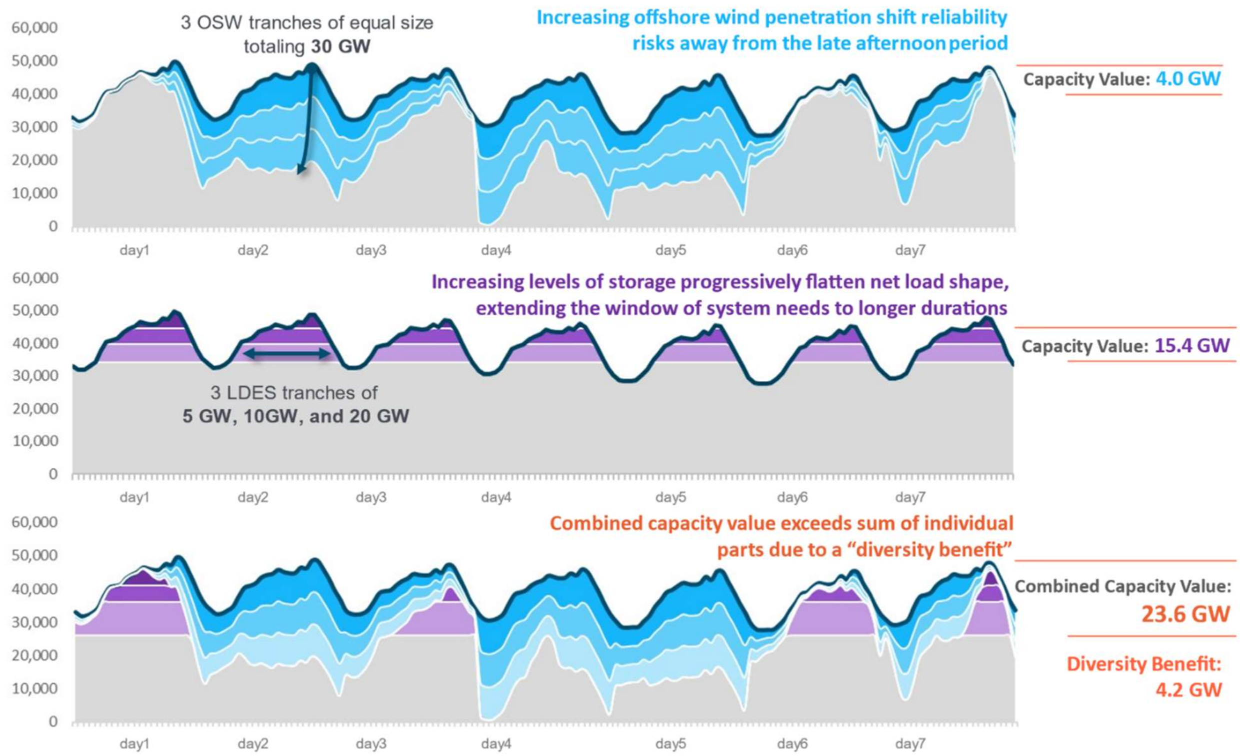
7. **Due to their complementary nature, energy storage systems when paired with renewables can exhibit diversity benefits, where the paired capacity value exceeds the sum of the individual capacity values.**

Storage and renewable generation are likely to have significant diversity benefits. E3 evaluated selected examples of this, including solar and SDES and OSW and LDES.

For solar and SDES, solar additions act to create a sharper "net peak" demand on the system, which reduces the hours over which energy storage must discharge to reduce peak; solar also provides a source of energy for charging. Thus, the combined impact of the two resources is greater than the sum of the two parts. As the Commonwealth moves toward 2050 and a winter peaking system, because of the timing and duration of the peaks, the diversity benefit for solar plus SDES becomes less pronounced.

An illustration of the OSW and LDES diversity benefit is shown below in Figure 4-4 from the Study. In this case, OSW provides a source of charging for LDES, mitigates later afternoon peaks, and spreads resource needs throughout the day. This spread of resource needs gives LDES the opportunity to discharge for multiple hours and further shave peak. At very high penetrations of OSW and LDES, the Study found that these diversity benefits can be up to 15% higher than the sum of the individual capacity contributions.

Figure 4-4. Illustration of Diversity Benefit between LDES and OSW Resources

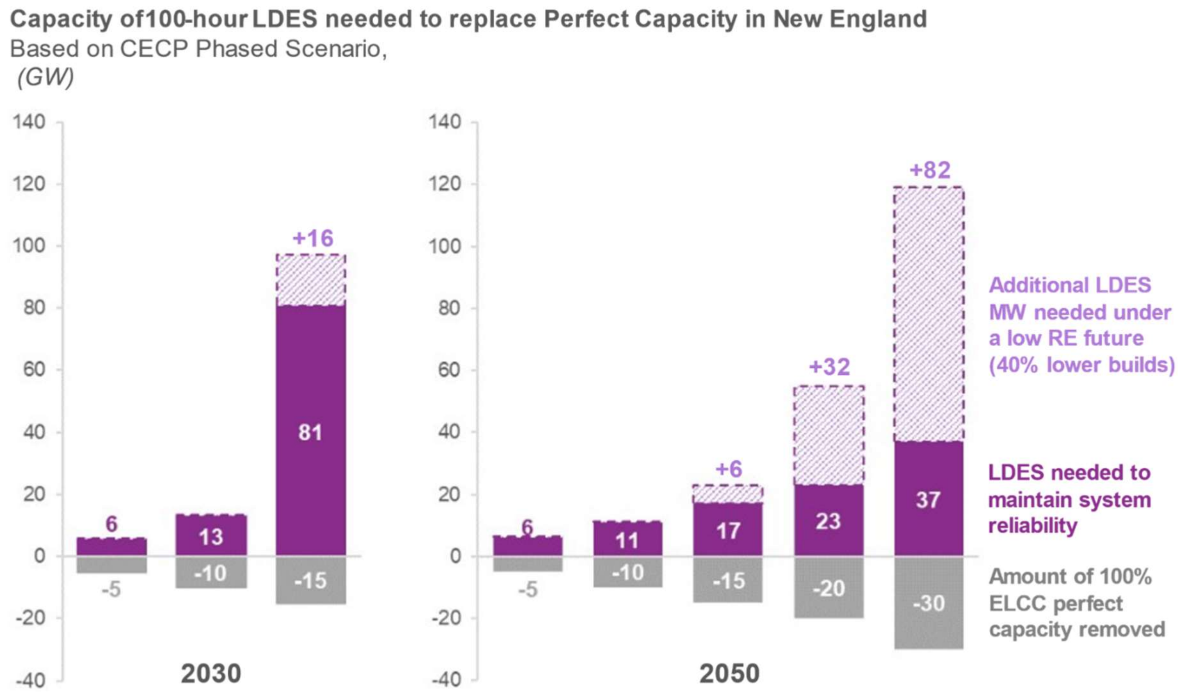


8. **Long duration energy storage has the ability to supplant significant quantities of dispatchable, thermal capacity in futures with high renewable deployment.**

   If additional LDES technologies are commercially available, safe, and cost effective at scale, when New England hits renewable buildouts in line with the 2050 CECP, about 10-20 GW of 100-hour energy storage has the ability to substitute for theoretical "perfect" firm capacity on a nearly 1:1 basis. This is shown below in Figure ES-14 from the Study.

   In particular, the CECP 2050 planning system retains about 14 GW of fossil combustion-based generation (natural gas) and 3.5 GW of traditional nuclear resources, though the fossil resources operate far fewer hours and contribute less energy than they do today. The same planning scenarios currently build about 7 GW LDES as part of the cost-effective portfolio. If cost competitiveness and scale are achieved, additional LDES can provide an alternative form of firm capacity, potentially displacing fossil resources and providing additional emissions reductions.

Figure ES-14. LDES as an Alternative to Support System Reliability in 2030 and 2050



RECOMMENDED POLICY & PROGRAM DESIGNS

One of the Report's Key Findings is the deployment and use of energy storage systems is a critical and cost-effective strategy for the Commonwealth to encourage in meeting its goals under the 2050 CECP. To incentivize storage deployment, DOER proposes:

- $50 million in program funding targeted toward specific use cases, to improve energy storage siting, and to lower commercialization barriers for MDES and LDES;
- Procurements or other mechanisms for incentivizing storage deployment;
- Creating refined interim targets for energy storage deployment that connect the targets to renewable generation deployment;
- Reviewing existing programs that incentivize storage, including the CPS; and
- Continued stakeholder collaboration on other issues impacting energy storage deployment.

I. <u>Provide direct project funding to support near-term energy storage deployment and MDES and LDES technology development</u>

Grant programs to offset project cost requirements can incentivize the near-term deployment and use of energy storage. The Study identified several use cases that demonstrated positive benefits but still face financial risks that limit their deployment. Funding should be focused on projects that can be operational in the near term and provide CPECs for CPS compliance as initial funding for programs would come from CPS Alternative Compliance Payments (“ACP”). A grant program can also help to de-risk developing MDES and LDES technologies. DOER proposes allotting $50 million to developing programs that target the following areas:

A. **Standalone Bulk Storage**
B. **Resiliency**
C. **MDES/LDES Technology Commercialization**
D. **Energy Storage Siting**

For each program area below, DOER includes potential program parameters. Further stakeholder engagement and feedback is needed prior to determining funding allocation amongst the proposed programs and other input toward program concepts, designs, and implementation. DOER targets a release of a straw proposal for programs A-C by April 1, 2024. Further information on the proposed programmatic timeline can be found in the Next Steps and Timeline section below.

A. **Standalone Bulk Storage Programs** – As the Study demonstrated, bulk energy storage deployment must accelerate so sufficient capacity is online toward the end of this decade to provide cost and emissions reductions.[15] Bulk energy storage can also help spur CPEC generation through participation in the CPS, reducing ACP and thus saving ratepayer costs. Finally, for some sites, energy storage could provide an opportunity to benefit communities traditionally most burdened by fossil-fuel resources by reducing local air pollution through replacing idle or retired power plants or being an alternative to building a new fossil-fuel resource.

    Program Elements

    - Both transmission and distribution connected energy storage would be considered for this program, though incentive levels may differ.
    - Eligible projects must be new facilities, dispatch into the Massachusetts distribution system or be interconnected to the transmission system and be located in Massachusetts after the effective date of this funding program, have a minimum round-trip efficiency, an executed interconnection service agreement (“ISA”), demonstrated site control, and obtained non-ministerial permits.
    - The program would require CPS registration and a minimum level of performance within the program.
    - Incentive structure would be a fixed $/kWh of capacity payment, disbursed according to certain project development milestones.
    - Performance requirements would include submitting 15-minute interval data to DOER for at least 5 years after the project’s commercial operation date.
    - Projects that are sited at or near fossil-based peaker plant sites or brownfields would receive additional incentives. Specific carveouts for such projects are also being considered.

[15] The Study, Key Findings, p. 7.

- Distribution-connected projects that can demonstrate benefits to LMI or EJ communities would receive additional incentives. Specific carveouts for such projects are also being considered.

B. **Resiliency programs** – For BTM applications, the Study found that resiliency is one of the major drivers of CBA. Energy storage can provide power during an outage to critical facilities that serve a community or a region.

Program Elements

- Grant to help offset project costs and provide technical assistance, with portions to be paid according to certain project development milestones. There will be a minimum cost share percentage as well as an overall cap to DOER's per project award.
- Applicants must clearly demonstrate anticipated project benefits, including hours of resiliency designed for and islanding ability of critical loads from non-critical loads, and commit to performance reporting requirements to DOER if funded under this program.
- Encourage microgrids and/or pairing energy storage with renewables, though projects must specifically have energy storage and funds can only be used for energy storage-related costs.
- Projects encouraged to participate in other incentive programs (e.g., CPS, ConnectedSolutions) and wholesale markets, but must address how such participation will not impact resiliency use case.
- Projects that can demonstrate benefits to LMI or EJ communities would receive additional incentives. Specific carveouts for such projects will be assigned.
- Project identification requires understanding of site energy needs and energy assessments that may not have been completed at the time of program deployment. LMI or EJ communities may need additional support to identify sites.
- Siting BTM storage for resiliency must be coordinated with DOER's proposed efforts on storage siting, described in subsection I.D ("Energy Storage Siting") below, including fire and safety considerations.

C. **MDES/LDES Technology Commercialization Grants** – While the need for MDES and LDES is not immediate, many of these technologies require significant de-risking before commercialization. DOER proposes funding to support these technologies to reach commercial readiness, such that they will be on the grid and ready to provide reliable, safe operation when needed.

Program Elements

- Technologies must be at least 8 hours in duration at maximum rated capacity and cannot include lithium-ion or pumped hydro.

- Technology must have achieved demonstration phase in maturity (e.g., Technology Readiness Level ("TRL") of at least 5, based on NASA's TRL system[16]).
- Applicants must clearly demonstrate how the project will meaningfully advance technology commercialization, including securing a host site.
- Funding will have portions to be paid upon completing certain project development milestones. There will be a minimum cost share percentage as well as an overall cap to DOER's per project award.
- Projects that can demonstrate resiliency or OSW integration, repurposing of idle or abandoned fossil-based energy generation or brownfields, or that could serve as resilient infrastructure for LMI or EJ communities are strongly encouraged.

D. **Energy Storage Siting** – In collaboration with other state agencies, DOER will utilize resources, including federal funding from the Department of Energy, to draft energy storage model bylaws, provide municipal training, and create educational materials for different stakeholder groups on the value of and best practices surrounding energy storage systems. DOER will also continue to coordinate with current state efforts to improve energy storage siting, including the Commission on Clean Energy Infrastructure Siting and Permitting ("CEISP"). As this work around energy storage siting evolves and CEISP makes its recommendations, if further gaps are identified that may benefit from funding programs, DOER may create and fund these programs.

Given the challenges stakeholders expressed in the developer-initiated siting process for energy storage projects in communities, DOER proposes one alternative method for exploring energy storage siting as a community-initiated and driven process with technical education – consent-based siting. A consent-based approach would focus on the needs and concerns of communities, centering equity and environmental justice. DOER will discuss this approach with the CEISP.

II. Procurements

A. **CPS Procurement** – As described below in Section IV.A., DOER will review the CPS Program in 2024. In its review DOER may include further investigation into the efficacy and structure of a CPEC procurement. DOER has the authority to implement procurements as part of the CPS Program (Ch. 25A section 17(c)), as described in 225 CMR 21.05.

B. **MDES and LDES Procurement** – DOER recognizes the value in procuring MDES and LDES technologies; however, the need is not immediate. Therefore, DOER recommends reserving its procurement authority, pursuant to Section 80(c) of the 2022 Climate Act. DOER may announce a Section 80 storage procurement at such a time where the development of new MDES and LDES capacity will benefit Massachusetts ratepayers. Such a procurement could also incent the

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[16] https://www.nasa.gov/directorates/somd/space-communications-navigation-program/technology-readiness-levels/.

pairing of LDES with OSW to take advantage of the diversity benefit found in the Study of increased capacity values through pairing, described above in Key Finding 7. As part of the DOER investigation into future procurements, DOER will investigate the use of alternative procurement strategies, including the Index Storage Credit,[17] that could provide cost-protections for Massachusetts ratepayers.

III. Targets

The 2050 CECP includes an Energy Storage Benchmark of 5.8 GW in 2050 for the power sector, inclusive of both new and existing MDES and LDES systems. On May 11, 2023, prior to the completion of the Study, DOER filed a letter with Secretary Tepper recommending no change to this energy storage benchmark at that time, but that DOER may recommend changes to the target upon conclusion of the Study if reasonable.

Given that the optimal amount of energy storage will depend upon the amount and mix of renewables deployed, DOER recommends that energy storage targets be tied to renewable deployment. Additionally, a distinction between energy storage capacity and duration is necessary. Initially, the major value proposition for energy storage to the grid is peak shaving and energy shifting within a day, which can be best served by high-efficiency energy storage technologies such as lithium-ion. For such a use case, adding storage capacity is more important than duration. However, as renewable penetration and electric sector load growth both increase between now and 2050, the Study found that the resulting reliability gaps increase in duration, necessitating the greater incentivization over time for energy storage technologies with longer durations, such as MDES and LDES technologies.

DOER recommends the following interim targets to the 2050 CECP Energy Storage Benchmark:

- **2030**: 250 MW of energy storage in Massachusetts for every 1 GW of deployed renewables
- **2035**: 200 MW of energy storage in Massachusetts for every 1 GW of deployed renewables , inclusive of at least 1 GW of MDES or LDES

These interim targets do not modify or replace the 2050 CECP Energy Storage Benchmark; rather, they reflect refinements based on the Study results. Targets should be refined with each iteration of CECP, which will be next published in 2025. The CECP, which describes the comprehensive strategies, policies, and actions the Commonwealth will take to achieve net zero greenhouse gas emissions by 2050, is more appropriate for target setting than the modeling approach used in the Study, which is specifically examining portfolio reliability.

IV. Current DOER energy storage programs review

[17] The Index Storage Credit incentivizes storage deployment by stabilizing a storage project's revenue stream. For a description of how the Index Storage Credit works, please see The Study, Section B.5, p. 143.

A. **Clean Peak Energy Standard** – In 2024, DOER will conduct a review of the CPS Minimum Standard, pursuant to 225 CMR 21.00. DOER will review the entirety of the CPS program, after which DOER may propose changes to the Regulation and/or Guidelines. The review will build on the stakeholder feedback during the Study highlighting long-term revenue uncertainty within the program challenging project financing.

B. **SMART Storage adder** – DOER is currently working with Sustainable Energy Advantage, LLC to review the financial requirements to build solar and storage, including through SMART program incentives and adders (i.e., the energy storage adder). Analysis results will inform DOER review of all solar and solar+storage programming.

C. **ConnectedSolutions** – Discussions regarding draft 2025-2027 Energy Efficiency Investment Plan(s) began in 2023, led by the Massachusetts Energy Efficiency Advisory Council ("EEAC") with state energy efficiency program administrators. Negotiation of the draft plans will continue throughout 2024, with regulatory approval is expected in early 2025. ConnectedSolutions is a program component expected to continue through the 2025-2027 Plan(s), pending Department of Public Utilities ("DPU") approval. Changes to the plan for ConnectedSolutions are likely, as driven by possible value changes in the 2023 Avoided Energy Supply Cost study and overall EEAC planning process.

V. <u>Other issues impacting energy storage</u>

Energy storage deployment and use on the electric grid is complex and requires many coordinated stakeholder processes to develop consistent and workable standards. There were several issues raised by stakeholders during the Study that impact the deployment of energy storage but are best addressed by coordinating stakeholders in established working groups and investigations. These efforts should result in specific actions by the EDCs and ISO-NE. DOER supports the continued work by these diverse stakeholder groups and looks forward to participating in these efforts:

A. **Interconnection**: Several working groups seek to standardize and improve energy storage interconnection processes on the distribution system. The Technical Standards Review Group ("TSRG") focuses on interconnection technical standards. The Energy Storage Interconnection Review Group ("ESIRG") focuses on process recommendations to the DPU that are not related to technical topics. The Interconnection Implementation Review Group ("IIRG") will focus on distributed generation interconnection in the Commonwealth and processes overseen by the DPU.[18] DOER participates in each working group and will disseminate relevant Study findings to stakeholders.

In addition to these working groups the Grid Modernization Advisory Council ("GMAC") is charged with reviewing and providing recommendations to the EDCs' electric-sector

[18] Established under DPU 19-55 on June 6, 2023: https://gridforce.my.site.com/s/article/Interconnection-Implementation-Review-Group.

modernization plans ("ESMPs"), and recommendations include those related to interconnection.[19]

FERC Order 2023, issued on July 28, 2023, requires ISO-NE to reform its transmission interconnection procedures and agreements with the objectives of speeding the interconnection process and reducing the queue. With regard to energy storage, Order 2023 directs ISO-NE to incorporate the interconnection customer's planned operating assumptions for energy storage system charging; however, ISO-NE may make an exception if any of the customer's operating assumptions would pose grid reliability challenges.

B. **Operational**: On October 31, 2023, each EDC submitted an operational parameters tariff to the DPU for energy storage connected to their distribution systems, as directed by the 2022 Climate Act.[20] The operational tariffs set operational and technical parameters in three key areas: (1) energy storage operational schedules; (2) limits on energy storage system capacity based on feeder and substation capacity; and (3) Distributed Energy Resource Management System ("DERMS") readiness. DOER anticipates these proceedings will further develop operational parameters for distribution-connected energy storage systems to maximize their benefits for the distribution system and for ratepayers.

C. **Rate Design**: On October 31, 2023, each EDC provided notice to DPU of its intent to promptly file a wholesale distribution tariff with FERC to apply to standalone energy storage systems connected to the distribution system that transact in wholesale markets. The EDCs have been working with energy storage industry stakeholders on tariff designs through the Wholesale Distribution Tariff Working Group. DOER supports the continued collaboration of this working group as deemed necessary and for group consensus to be reached prior to the EDCs filing their tariffs with FERC.

Under DPU 23-115, National Grid proposed an ESS-1 rate that is intended for standalone energy storage customers that do not elect to enroll in the wholesale distribution tariff or who are not eligible to enroll. Station service for any energy storage systems enrolled in the wholesale distribution tariff would be required to be served by the ESS-1 rate. National Grid intends for the structure of the ESS-1 rate to largely parallel that of the wholesale distribution tariff it anticipates filing with FERC, with the primary difference being that some additional charges may apply at the distribution level.

D. **ISO-NE Investigation into Reliability Products:** New wholesale markets could compensate MDES and LDES technologies for reliability services and incentivize new development and deployment. ISO-NE will investigate this in the currently underway Future of the Grid Reliability Study Phase

[19] Observations and Recommendations of the Grid Modernization Advisory Council: https://www.mass.gov/doc/gmac-final-report/download.

[20] DPU Filings: National Grid under DPU 23-115, Eversource under DPU 23-126, and Unitil under DPU 23-117.

2, which will evaluate the reliability attributes and revenue sufficiency associated with potential future resource mixes.[21] DOER will share relevant results from the Study with ISO-NE, including Key Finding 7 of diversity benefits that arise when pairing renewables and energy storage, such as OSW and LDES.

NEXT STEPS AND TIMELINE

DOER invites public comment on this Report and its recommendations until **Wednesday, January 31, 2024**. Please submit comments via email to Tom Ferguson, Energy Storage Programs Manager at DOER: thomas.ferguson@mass.gov.

DOER proposes that the straw proposal with a targeted release date of April 1, 2024 contain three funding programs:

1) Standalone Bulk Storage
2) Resiliency
3) MDES/LDES Technology Commercialization

DOER welcomes the following types of comments with regard to these programs:

- Feedback on DOER's proposed Programs I.A, I.B, and I.C and associated elements as described in the Recommended Policy & Program Designs section above.
- Feedback on other forms that programs on 1) Standalone Bulk Storage; 2) Resiliency; and 3) MDES/LDES Technology Commercialization could take.
- Feedback on other types of funding programs to better meet overall goals of the findings of this Report.

After considering public comments on the straw proposal, DOER proposes the following schedule for the programs: Release finalized program designs by Thursday, August 15, 2024. Applications will be due Tuesday, October 15, 2024, with awardees to be announced Monday, December 16, 2024.

The following table summarizes the targeted timeline for the Programs:

Item	**Target Due Date**
Comments on Report and recommendations to DOER	January 31, 2024
Straw proposal released by DOER	April 1, 2024
Straw proposal comments to DOER	May 1, 2024
Program posted and applications open	August 15, 2024
Applications due to DOER	October 15, 2024
Awards announced by DOER	December 16, 2024

[21] ISO-NE, Economic Planning for the Clean Energy Transition: Stakeholder-Requested Scenario: Future Grid Reliability Study Phase 2, April 20, 2023: https://www.iso-ne.com/static-assets/documents/2023/04/a06_2023_04_20_pac_fgrs_update.pdf.

For the Energy Storage Siting work described herein under Section I.D of Recommended Policy & Program Designs, DOER also targets completion of by the end of 2024.

APPENDIX

The Study "Charging Forward: Energy Storage in a Net Zero Commonwealth" is attached.