

<p style="text-align: center;">National Grid CY 2022 Massachusetts DOER Energy Storage Target Annual Report</p>

I. Introduction

Massachusetts law sets a statewide target for 1,000 megawatt hours (“MWh”) of energy storage systems (“ESS”) to be installed by December 31, 2025.

National Grid is strongly committed to serving as a clean energy catalyst for the region and views energy storage as a core component of the clean energy transformation required to achieve the Commonwealth’s goal of net-zero greenhouse gas emissions by 2050.

As of December 31, 2022, National Grid had approximately 2,940 MWh_{ac} and 888 MW_{ac} of ESS either installed ESS or in the pipeline in its service territory, representing over 100 percent of the statewide ESS target.¹ National Grid had approximately 488 MWh_{ac} and 177 MW_{ac} of installed ESS in its service territory, representing 48.8 percent of the statewide ESS target. National Grid also had 2,452 MWh_{ac} and 711 MW_{ac} of ESS in the pipeline in its service territory.² National Grid’s pipeline ESS increased from 843 MWh_{ac} in 2021 to 2,452 MWh_{ac} in 2022.

What follows is National Grid’s detailed Energy Storage Target Annual Report (“Report”) to the Massachusetts Department of Energy Resources (“DOER”) for the year ended December 31, 2022.

II. Reporting Requirements

An Act to Advance Clean Energy, Section 20 of Chapter 227 of the Acts of 2018, amended An Act Relative to Energy Diversity, Section 15 of Chapter 188 of the Acts of 2016, by striking out Section 15 in its entirety and replacing it with a new Section 15 containing a new statewide energy storage target of 1,000 MWh, to be achieved by December 31, 2025, and a requirement for the electric distribution companies (“EDCs”) to report annually to the DOER on the new target by February 15, beginning in 2019, documenting the energy storage installations in their respective service territories.

As set forth in An Act to Advance Clean Energy, to achieve this statewide energy storage target of 1,000 MWh, the DOER “may consider a variety of policies to encourage the cost-effective deployment of energy storage systems, including the refinement of existing procurement methods to value energy storage systems properly, inclusion in energy portfolio standards, the use of alternative compliance payments to develop pilot programs and the use of energy efficiency funds under section 19 of chapter

¹ This increase from 2021 to 2022 was the result of multiple large standalone energy storage systems filing interconnection applications in 2022 and can be found in the list of pipeline projects.

² Customers provide information about their ESS project size in energy (kWh) in alternating current (AC) or in direct current (DC). To demonstrate progress against the statewide target, which is measured in AC, National Grid applied a conversion factor of 95 percent to DC-coupled projects to account for the roundtrip efficiency losses. For example, a 100 kWh_{dc} ESS would be estimated to be 95 kWh_{ac} after applying the 95 percent conversion factor.

25 of the General Laws if the department determines that the energy storage system installed at a customer's premises provides sustainable peak load reductions on either the electric or gas distribution systems and is otherwise consistent with section 11G of chapter 25A of the General Laws."

This is National Grid's sixth annual Report to the DOER and covers the period January 1, 2022 through December 31, 2022.

A. Data Collection

National Grid obtains uniform data and information for EDC-owned and non-EDC-owned ESS projects through the distributed generation ("DG") interconnection process. For purposes of annual Reports to the DOER, the EDCs have been requesting data and information for ESS projects they do not own from customers and developers of existing ESS projects already connected to their electric distribution systems and are requesting such data and information from customers and developers of new projects that have applied to interconnect to their respective electric distribution systems. As of December 3, 2019, the Department of Public Utilities ("DPU") issued an Interim Guidance regarding ESS requiring all interconnection applications that include ESS to submit a completed ESS Questionnaire to provide technical and operational data about the proposed ESS.³ Proposed revisions to the EDCs' distributed generation interconnection tariffs would incorporate these ESS data requests into the interconnection application process. The collected data and information will be used to demonstrate measurable progress towards the achievement of the ESS 1,000 MWh target of installed ESS. These data and information include:

- ESS Installed, that is, Interconnected (MWh_{ac} and MW_{ac});
- ESS in the Pipeline to be installed (MWh_{ac} and MW_{ac});
- Policy Sources of ESS (e.g., SMART program);
- ESS Specifications (e.g., technology type, manufacturer);
- Operational Information (e.g., installation type, system configuration); and
- Applications/ Intended Use Cases (e.g., Peak Shaving/ Load Leveling).⁴

The EDCs are including the above-mentioned data and information on the ESS installed and pipeline projects in their annual reports to the DOER, to the extent such data and information have been provided to them. However, for non-EDC-owned projects, such data and information must be obtained from customers and developers. Beginning in 2020, the consistency of data collection and reporting has improved with the requirement for applicants to provide a completed ESS Questionnaire. The Company receives the completed ESS Questionnaire from all applicants with an ESS project. However, some information in the ESS Questionnaire may be incomplete and the Company does not perform detailed confirmation of the information. The ESS Questionnaire is the source of the information in this report.

³ See DG Interconnection, D.P.U. 19-55, Interim Guidance – Energy Storage Systems (December 3, 2019).

⁴ *State of Charge* report, issued on September 16, 2017. According to the report, a use case is defined as an integrated set of grid services performed by a technology at a distinct site or location on the grid. <http://www.mass.gov/eea/docs/doer/state-of-charge-report.pdf>.

B. Attachment A

Attachment A to this Report includes installed ESS projects, and ESS projects in the pipeline as of December 31, 2022. For purposes of this Report, an “installed” ESS project means an ESS project that has been interconnected to an EDC’s electric distribution system.

C. Policy Sources of ESS

The EDCs have jointly identified several state policies, programs, and funding sources intended to drive the installation of ESS in the Commonwealth. Where the EDCs are aware of the state policy, program or funding source associated with an ESS project, the EDCs have identified that policy source in Attachment A. Some ESS projects may participate in multiple state policies, programs and funding sources. Policy sources of ESS projects include, but are not limited to:

- Utility-owned ESS for transmission and distribution operation and management for the benefit of customers (“Utility-Owned T&D”);
- Utility-owned ESS for research and development purposes, such as those projects supported by U.S. Department of Energy grants, or utility-scale solar plus storage projects developed to support research programs (“Utility-Owned R&D”);
- ESS to be paired with large-scale offshore wind proposals for consideration under Section 83C of the Green Communities Act (“Section 83C”), which requires solicitations for the procurement of up to 5,600 MW of offshore wind capacity;
- Customer-owned ESS enrolled in a Program Administrators’ energy efficiency/ demand response demonstration project or program (“Energy Efficiency/DR program”);
- Customer-owned ESS enrolled in the EDC’s Solar Massachusetts Renewable Target (“SMART”) program that qualify for the SMART storage adder (“SMART program”);
- Customer-owned ESS funded by the DOER’s or Massachusetts Clean Energy Center’s (“MassCEC”) Advancing Commonwealth Energy Storage (“ACES”) and Peak Demand Reduction Grant programs, which include projects to which the EDC has provided in-kind and/or financial support (“DOER/ MassCEC Funded Projects”);⁵
- Customer-owned ESS enrolled in the Clean Peak Energy Portfolio Standard (“Clean Peak Standard”) program under section 225 CMR 21.00 promulgated pursuant to M.G.L. c. 25A, § 17(c);
- Utility-owned solar and storage authorized under M.G.L. c. 164 § 1A(g) to assist a municipality at high risk from the effects of climate change in furthering its climate adaptation and resiliency goals by constructing, owning and operating solar generation facilities paired, where feasible, with energy storage facilities (“Utility-Owned Climate Act”); and
- EDCs and municipal aggregators with certified energy efficiency plans may submit whole building efficiency offerings that promote the adoption of and installation of onsite

⁵ Any ACES or Peak Demand Reduction Grant project where the EDC is the award recipient or the EDC partner on the project.

renewable energy generation and energy storage to assist low and moderate income customer groups. See Chapter 179, Section 87A of the Acts of 2022.

D. Applications and Intended Use Cases

Based on the *State of Charge* report and the EDCs' own expertise, the EDCs have identified the following primary applications and use cases for ESS. This list may be modified as the EDCs monitor relevant industry trends and gain further hands-on experience with energy storage.

- i. Wholesale Market (i.e., Energy, Capacity, Ancillary Services): ESS have the potential to participate in all major categories of the wholesale market.
 - a. In the wholesale energy market, ESS may be able to produce revenue by arbitraging hourly electricity prices, charging when the wholesale price is low and discharging when the wholesale price is high.
 - b. ESS may participate in the Independent System Operator-New England ("ISO-NE") Forward Capacity Auction and earn revenue by contributing to ISO-NE's installed capacity.
 - c. ESS may also be able to generate revenue by participating in the ancillary services market (e.g., operating reserves and frequency regulation).
- ii. Peak Shaving / Load Leveling: ESS can store energy during hours of low demand and discharge energy when the system is peaking. This may reduce the entire system peak and result in lower utilization of inefficient and expensive gas and oil units. It can also reduce ISO-NE capacity and regional network service costs.
- iii. Generation Support (e.g., Peaker Replacement): ESS can discharge when the system is peaking, thus acting in place of peaking capacity. ESS have the potential to be cleaner and more reliable than a traditional combustion turbine unit.
- iv. T&D Asset Alternative: Strategic deployment of ESS has the potential to defer or eliminate traditional transmission and distribution upgrades in specific locations. The potential for transmission and distribution deferrals needs to be studied on an individual basis in consideration of local circumstances and system characteristics.
- v. Power Quality (e.g., Voltage/VAR Support): ESS can provide voltage/VAR support and may possibly receive compensation through the ISO-NE OATT for doing so (subject to meeting certain eligibility requirements). Reactive power cannot be efficiently transmitted over long distances, which makes distributed ESS an attractive alternative to traditional voltage/VAR support supplied by generating units in some locations.
- vi. Customer Bill Savings (e.g., Demand Charge Management): Individual customers can utilize ESS to shave the peaks and fill the troughs of their load. By reducing peak load, customers may be able to mitigate their installed

capacity tag. Commercial and industrial customers may also have the potential to realize bill savings by lowering their peak demand and avoiding a demand charge. Customers with time varying rates can also use ESS to perform arbitrage by charging the ESS during less expensive off-peak times and discharging for their own use during more expensive peak periods.

- vii. Renewable Energy Integration (e.g., Ramping, Smoothing): ESS can quickly follow the variable generation of renewable resources making it smooth and dispatchable. ESS can thus support the further integration of renewable resources.
- viii. Renewable Energy Shifting: ESS have the potential to store energy generated by renewable resources when system demand is low and discharge when system demand is high.
- ix. Reliability and Resiliency: ESS can support reliability and resiliency by locally providing energy during an outage event.
- x. Microgrid: ESS can help promote a cost-effective and reliable microgrid. By storing energy produced by renewable resources or by combined heat and power (“CHP”) for use when those assets are not generating, ESS can support microgrid “islanding” and going off the main grid at times when there is an electric distribution system outage or when it would be otherwise advantageous to the microgrid operator.
- xi. Black Start: Some eligible ESS may be able to provide black start capability and if counted by ISO-NE for system restoration purposes, be compensated.

E. Target Results

See Attachment A for data and information regarding installed (e.g., interconnected) ESS projects and ESS projects in the pipeline to be installed.

i. Installed Projects

As of December 31, 2022, National Grid had approximately 488 MWh_{ac} and 177 MW_{ac} of ESS installed, that is, interconnected, in its Massachusetts service territory.

ii. Pipeline Projects

As of December 31, 2022, National Grid had approximately 2,452 MWh_{ac} and 711 MW_{ac} of ESS in the project pipeline.⁶

⁶ The exact amounts of energy and power of the proposed projects in AC ratings could not be confirmed at the time of Report submittal, but will be known as the projects move from the pipeline to the installed list.

F. Cost-Effectiveness and Viability

Energy Efficiency/ Demand Response

In Massachusetts, the energy efficiency program administrators (“PAs”) use a Total Resource Cost (“TRC”) test to determine the cost-effectiveness of an offering, initiative, or program. The PAs assess the total cost of the project and compare that against the total benefits of the project and determine if the benefits exceed the costs.

Beginning in the 2019-2021 Three Year Energy Efficiency Plan, the PAs proposed two pathways for incentivizing customer-owned and sited behind-the-meter storage assets through their Active Demand Response offerings (often referred to publicly as “ConnectedSolutions”). The first is focused on residential-scale battery installations and utilizes a direct load control approach to automatically dispatch the battery via the system’s inverter, connected through the PA’s Energy Hub. The second is via the Daily Dispatch offering, an approach in which curtailment service providers (“CSPs”) work with large customers to develop project-specific dispatch strategies.

Both offers have a “pay for performance” incentive structure in which customers are paid based on the actual curtailment delivered during event windows. Because the costs of battery systems are currently too high and the PAs are unable to cost-effectively offer incentives for batteries, the PAs have instead incentivized the dispatch and performance of equipment already installed at a customer’s home or business. Therefore, when assessing the cost-effectiveness of these storage offerings, the PAs look only at the incentive amounts they are proposing to offer and compare these against the value of the system benefits from the expected reduction in capacity.

In the 2019-2021 Three Year Plan order, the DPU did not initially approve the full-scale statewide deployment of battery dispatch because it was determined to be an untested form of dispatch but did support learning more through demonstration. The PAs evaluated demonstrations in which they dispatched batteries in both residential and commercial applications in summer 2019 and presented^{7 8} those findings to the Massachusetts Energy Efficiency Advisory Council (“EEAC”), secured an EEAC resolution in support of the inclusion of batteries as a full program offering, and submitted a Compliance Filing (D.P.U. 20-33 through D.P.U. 20-36 to the DPU in Q1 2020. The DPU approved the inclusion of the batteries program offering on July 28, 2020.

⁷ Residential Energy Storage Demand Response Demonstration Evaluation: https://ma-eeac.org/wp-content/uploads/MA19DR02-E-Storage_Res-Storage-Summer-Eval_wInfographic_2020-02-10-final.pdf

⁸ C&I Daily Dispatch Battery – Post-Summer 2019 Report

In the 2022-2024 Three Year Plan order, issued on January 31, 2022, the DPU approved the PAs' proposal to continue offering incentives for the dispatch of batteries, in both residential and commercial installations.

G. Market Barriers and Solutions to Market Participation of Energy Storage

FERC Order 2222

On September 17, 2020 the Federal Energy Regulatory Commission ("FERC") issued Order 2222 requiring that all Regional Transmission Organizations or Independent System Operators establish participation models for distributed energy resource aggregations in wholesale markets so those resources are allowed to provide and receive compensation for all market services for which they are technically capable.⁹ The Order includes a diverse list of distribution system-sited technologies that fall under the distributed energy resources umbrella, including both behind-the-meter and front of the meter ESS.¹⁰ ISO-NE led a stakeholder engagement process, of which the Massachusetts EDCs were active participants, through the NEPOOL Markets Committee and other channels to develop a compliance proposal for submission to FERC. ISO-NE filed their compliance proposal with FERC on February 2, 2022, which included a proposed implementation date of Q4 2026. As of December 31, 2022, FERC has not yet issued an Order on the ISO-NE compliance proposal. Absent an Order from FERC on the ISO-NE compliance proposal, it would be unreasonable to speculate on the effectiveness of any forthcoming market rule changes in creating new, practical and economically viable market participation opportunities for ESS.

Inability to Propose an ESS as a Transmission Solution to a Stated Transmission Need

Since 2019, discussions have been on-going between ISO-NE and the region's stakeholders about the ability to consider ESS as a solution to an ISO-NE-identified transmission need. In 2019, ISO-NE stated its position¹¹ that the current ISO-NE tariff and agreements did not provide for ESS to be treated as transmission and that ESS should be considered similar to a generation facility under the tariff. Under this treatment, an ESS would be included in ISO-NE transmission planning studies after obtaining a Capacity Supply Obligation in a FCA. The EDCs understand that modifying the ISO-NE tariff, transmission planning procedures, and cost allocation rules to allow for the treatment of ESS as a transmission facility would be a significant undertaking. Any proposal would also need to comply with the FERC's guidelines, commonly known as the "seven factor test," for the identification of transmission and distribution facilities. This topic was considered by ISO-NE and stakeholders in 2022.

⁹ FERC Order No. 2222 at 130. https://www.ferc.gov/sites/default/files/2020-09/E-1_0.pdf

¹⁰ Id., 114.

¹¹ See https://www.iso-ne.com/static-assets/documents/2019/08/a00_rc_tc_2019_07_16_17_minutes.doc, page 15

On December 29, 2022, ISO-NE filed section 205 filing with FERC containing proposed revisions to the ISO-NE Tariff and Transmission Operating Agreement (“TOA”) to incorporate rules that will enable electric storage facilities to be planned and operated as transmission-only assets (“SATO”) to address system needs identified in the regional system planning process.

Dual Participation

In 2020, FERC conditionally approved several ISO-NE market rule changes filed in compliance with FERC Order 841, which required each RTO/ISO to establish market participation models for ESS. Specifically, FERC required RTOs/ISOs to “account for the physical and operational characteristics of electric storage resources through bidding parameters or other means” and to ensure that ESS resources are “eligible to provide all capacity, energy, and ancillary services that [they are] technically capable of providing.”¹²

ISO-NE addressed Order 841 requirements primarily through the creation of the Continuous Storage Facility (“CSF”), a participation model that allows ESS resources to participate simultaneously as Generating Assets, Dispatchable Asset-Related Demand (“DARD”), and Alternative Technology Regulation Resources (“ATRRs”). For resources that do not wish to participate as CSFs, ISO-NE market rules also accommodate several other participation models, including combined models such as Settlement-Only Generator (“SOG”) and ATRR. Models other than the CSF model may limit an ESS’ ability to provide certain products (e.g., Reserves), but they may also afford ESS resources additional operational flexibility relative to the CSF model.

A key requirement for Order 841 compliance is the ability for ESS resources to serve both retail and wholesale markets (also called “dual participation”). In its conditional acceptance of ISO-NE’s tariff revisions issued in August 2020, FERC accepted ISO-NE’s response to FERC’s requirement to submit a further compliance filing “to explain how its Tariff allows for electric storage resources to participate in both wholesale and retail markets.”¹³ ISO-NE’s compliance filing, submitted to FERC on February 10, 2020, proposed new tariff language to state that ESS will “not be precluded from providing retail services so long as it is able to fulfill its wholesale Energy Market and Forward Capacity Market obligations including, but not limited to, satisfying meter data reporting

¹² Federal Energy Regulatory Commission Order 841, ¶320, available at <https://www.ferc.gov/media/order-no-841>

¹³ FERC Order on ISO-NE Order 841 Compliance Filing, August 4, 2020, available at https://www.iso-ne.com/static-assets/documents/2020/08/er19-0470-004_8-4-20_order_accept_compliance_further_compliance_req_order_841.pdf

requirements and notifying the ISO of any changes to operational capabilities.”¹⁴ ISO-NE’s tariff revisions took effect March 1, 2021.

FERC Order 2222 also includes the determination that a single distributed energy resource can participate in both retail and wholesale programs and be compensated in each, so long as it is distinctly providing different services (i.e., dual-participation is permitted, but duplicative compensation for the same service is not permitted).¹⁵ As of December 31, 2022, FERC has not issued an Order on ISO-NE’s compliance filing for Order 2222 made on February 2, 2022, which includes ISO-NE’s proposal for how to ensure that dual-participation does not result in duplicative compensation.

DC Coupled Solar Facilities with Storage

Solar facility developers are incentivized to pair their solar capacity with battery storage capacity to take advantage of the Commonwealth’s SMART program storage adder and enhance the operational capabilities of the solar generation asset. Many of these are designed to be a co-located, alternating current (AC) connection, meaning that each component, the solar PV and battery storage system, has its own dedicated inverter(s) and the battery charges from AC-power flowing into its inverter. However, some projects connect the battery storage to the solar PV output behind the inverter as a direct current (DC) connection. Such systems have combined AC output for both resources through a single AC meter.

This type of connection is allowed by the EDCs’ Standards for Interconnection of Distributed Generation, and the DOER’s regulations of the SMART program. The DOER and industry participants have highlighted that the PV output that is used to charge the ESS directly is not fully compensated under the SMART program, due to roundtrip efficiency losses of the ESS. In addition, the industry has previously noted ISO-NE market participation barriers related to this system configuration.

In early 2020, the EDCs, DOER and industry stakeholders continued discussions about resolving SMART program compensation issues related to DC-coupled storage systems. These discussions resulted in a high-level consensus proposal for resolving this compensation issue that would ensure DC-coupled systems were not disadvantaged in the SMART program. Incorporation of the true-up payment process into the SMART Tariff is pending a decision on the second phase of proceedings in D.P.U. 20-145. As of December 31, 2022, the DPU has not yet issued a decision on the second phase of this proceeding.

¹⁴ Docket No. ER19-470-000, ISO-NE Revisions in Compliance with the Order No. 841 Order on Compliance, at 11 (February 10, 2020), available at https://www.iso-ne.com/static-assets/documents/2020/02/compliance_filing_order_841.pdf

¹⁵ Federal Energy Regulatory Commission Order 2222, ¶164 https://www.ferc.gov/sites/default/files/2020-09/E-1_0.pdf

Similarly, in August 2020, ISO-NE updated Operating Procedure 18 (“OP-18”) to better accommodate market participation by DC-coupled solar and storage systems.¹⁶ The outcome of the OP-18 modification process established metering configurations that allow apportionment between solar and storage assets for market participation purposes. Still, a number of issues around market settlement and participation remain unresolved at the ISO-NE with DC-coupled system owners, as many would like to participate in the (above-mentioned) CSF market product. However, doing so as a single asset, as required, complicates the division of proceeds between the SMART program (as a credit to customers for the solar energy), and the system owners for the storage capabilities.

Finally, on December 30, 2021, the DPU issued an Order on Phase I SMART tariff revisions, which expanded the overall capacity of the SMART Program by 1,600 MWs, for a total of 3,200 MW statewide. This expansion included program changes, such as, all projects 500kW AC and greater are required to be paired with battery storage. As a result, many new ESS are anticipated to be connected through MA SMART in the years to come.

¹⁶ https://www.iso-ne.com/static-assets/documents/rules_proceeds/operating/isone/op18/op18_rto_final.pdf