Nancy D. Israel
Counsel for National Grid

February 15, 2018

VIA E-FILING

Judith F. Judson, Commissioner
Department of Energy Resources
100 Cambridge Street, Suite 1020
Boston, MA 02114

Re: Energy Storage Target Annual Report of Massachusetts Electric Company and Nantucket Electric Company each d/b/a National Grid

Dear Commissioner Judson:

On behalf of Massachusetts Electric Company ("MECo") and Nantucket Electric Company ("Nantucket"), each d/b/a National Grid ("National Grid" or the "Company"), enclosed please find the Company's Energy Storage Target Annual Report for the year ended December 31, 2017.

Thank you for your attention to this filing. Please contact me with any questions.

Very truly yours,

Nancy D. Israel

Attachment

cc: Will Lauwers,
Emerging Technology Director

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MA DOER Energy Storage Target Annual Report

I. Introduction

On June 30, 2017, the Massachusetts Department of Energy Resources ("DOER") adopted an aspirational statewide energy storage target for electric distribution companies ("EDC" or "utility") to procure 200 Megawatt hours ("MWh") of viable and cost-effective energy storage systems ("ESS") by January 1, 2020.[1] The purpose of the target is to "serve as a demonstration phase to further the Commonwealth's knowledge of the potential for this technology" and "learn about the most cost-effective and viable deployment of energy storage..."[2] National Grid fully supports the Commonwealth's target, and agrees that there is an array of potential benefits from increased energy storage deployment. At this time, National Grid can report that, based on the standards for eligibility outlined below, it has procured approximately 61 MWh_{ac} and 11.5 MW_{ac} of ESS, representing 30.6% of the statewide goal.

National Grid has actively been proposing and deploying grid-connected ESS to explore these benefits since 2009. National Grid continues to actively investigate how energy storage can potentially play a role in energy system optimization, that is, support operational flexibility, enhance the integration of renewable distributed generation, and reduce customer costs and constraints, while ensuring safety and reliability. In general, National Grid views ESS as offering a wide range of potential benefits for customers and for the electric power system, including enabling customers to manage their on-site energy use, providing heightened reliability, enhancing power quality, and reducing coincident and non-coincident demand on the electric power system. In addition, as allowed by the Independent System Operator-New England ("ISO-NE"), ESS can offer benefits to the grid by exporting energy when it is needed either at the distribution level or system level, to meet local or system level demand. To this end, National Grid is actively exploring potential locations and cost-effective uses for utility-owned ESS, and continuing to support the deployment of customer-owned and operated storage that can also deliver substantial benefits. In setting the statewide target, the DOER has given the EDCs the flexibility to identify the most cost-effective applications and the best locations for ESS deployment, including both front of the meter ("FTM") and behind the meter ("BTM") applications.

National Grid is pleased to submit this Energy Storage Target Annual Report ("Report") to the DOER for the year ended December 31, 2017.

II. Reporting Requirements

An Act Relative to Energy Diversity, Chapter 188 of the Acts of 2016 requires that, "Not later than January 1, 2020, each electric company entity shall submit a report to the department of energy

[1] On June 30, 2017, the DOER sent a letter to Conference Committee Members announcing the adoption of a statewide ESS target ("Letter to Conference Committee Members"). https://www.mass.gov/files/2017-07/letter-to-legislature-notice-of-energy-storage-target-adoption%206-30-17.pdf

[2] See Letter to Conference Committee Members.

resources demonstrating that it has complied with the energy storage system procurement targets and policies developed by the department…."[3] The DOER requested that the EDCs submit annual reports ahead of the statutory reporting date of January 1, 2020.[4] Initially, the DOER contemplated that the EDCs would begin reporting annually on January 1, 2018; in recognition of the time needed to collect data through year-end, the DOER subsequently extended the reporting date from January 1 to February 15 for 2018 and 2019.

National Grid, like the other EDCs, will submit an annual Report by February 15, 2018, February 15, 2019, and January 1, 2020 for the DOER to use to inform state policy on the cost-effectiveness and viability of ESS in a variety of ownership models and use cases. This is the first annual Report and covers the period January 1, 2017 through December 31, 2017.[5]

To ensure that the Commonwealth can best leverage any findings and lessons learned from this target, over the course of the three years, the DOER expects to be informed of:

- How many MWh and MW each EDC procured;
- The types of energy storage procured;
- The cost-effectiveness of the various energy storage projects undertaken;
- Wholesale market opportunities identified and monetized;
- How market barriers to the adoption of energy storage were addressed and resolved; and
- Recommendations, if any, for energy storage programs and policies going forward.[6]

After review of the submitted Reports, the DOER will determine if an additional ESS target for EDCs will benefit EDC customers.[7]

A. Data Collection

National Grid will seek to obtain 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 started to request data and information for ESS projects they do not own from customers and developers of existing ESS projects already connected to their distribution systems, and will request such data and information from customers and developers of new projects going forward. The collected data and information will be used to demonstrate measurable progress towards the achievement of the ESS procurement target and policies adopted by the DOER. These data and information include:

- Amount of ESS Procured (MWh_{ac} and MW_{ac});
- Eligible Sources of ESS Procurement (e.g., SMART program);
- ESS Specifications (e.g., technology type, manufacturer);

[3] Section 15(c) of Chapter 188 of the Acts of 2016 (An Act to Promote Energy Diversity).
[4] See Letter to Conference Committee Members.
[5] Limited data and information on ESS in Massachusetts is available for this first annual report.
[6] See Letter to Conference Committee Members.
[7] See Letter to Conference Committee Members.

- Operational Information (e.g., installation type, system configuration); and
- Applications/ Intended Use Cases (e.g., Peak Shaving/ Load Leveling).[8]

The EDCs intend to include the above-mentioned data and information on EDC-procured ESS projects in their annual reports to the DOER. (Procured projects and projects in the pipeline, as of December 31, 2017, are listed in Attachment A of this Report.) However, for non-EDC-owned projects, such data and information must be obtained from customers and developers, who currently are not required to provide such data and information under the current DG interconnection tariff. The EDCs may be unable to obtain some or all of this customer data and information and the level and type of data and information included for each such project may vary in the Reports.

B. Eligible Sources of Procurement

As a threshold matter, based on the DOER Letter to Conference Committee Members, the EDCs have jointly identified several sources of ESS that would count towards the statewide EDC procurement target. Sources that currently qualify as "procured" by EDCs 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 newly authorized large-scale energy procurements featuring 9,450,000 MWh of clean energy and 1,600 MW of offshore wind generation under Sections 83C and 83D of the Green Communities Act ("Section 83C or 83D");
- Customer-owned ESS enrolled in an EDC's 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"); and
- 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").[9]

C. Project Eligibility Criteria

In order to determine when an ESS would count toward the EDC procurement target, different criteria would apply, depending on whether the ESS is customer-owned or utility-owned.

[8] *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.

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

i. Utility-Owned ESS

ESS projects owned by the EDC are different from developer/customer-owned projects in that the EDC commits to building them once contracted. The EDCs note that as with any large project, it is possible for issues outside of the EDCs' control to arise after contracting, such as permitting challenges, which may delay or prevent the completion of a project.

Utility-owned ESS will count towards the target once: 1) the EDC has contracted for construction services for the project, such as part of an EDC-led competitive procurement; or 2) a state or federal agency has awarded grant funding for the project (e.g., U.S. Department of Energy ARRA grants).[10]

ii. Customer-Owned ESS

Customer-owned ESS qualify as eligible sources of procurement if the EDC provides in-kind assistance, assumes operational responsibility for or contributes financial support for an ESS installation; the ESS facility is enrolled in a state-agency grant program that is funded by Alternative Compliance Payments[11]; or the EDC provides an incentive payment directly that is funded by distribution customers (e.g., the storage adder under the SMART tariff).

Customer-owned ESS would count towards the target once: 1) the customer has enrolled in an EDC program (e.g., Energy Efficiency/ DR demonstration project or SMART program), or the customer has been awarded state-agency grant funding (e.g., ACES program); and 2) the customer has submitted its application to the EDC for DG interconnection.

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 ISO-NE Forward Capacity Auction and earn revenue by contributing to ISO New England's installed capacity.

[10] The EDC will not wait for the EDC-owned ESS to be installed/ commissioned before counting them towards the target. In the event a project is unable to be installed or commissioned, the EDCs will remove the project from its reported progress towards the target.

[11] See Letter to Conference Committee Members.

c. ESS may also be able to generate revenue by participating in the ancillary services market (e.g., black start and frequency regulation).

While energy arbitrage, capacity, and ancillary service revenues have the potential to be monetized for the benefit of the ESS owner, individual customers may potentially benefit from reduced system costs.

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.

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 Deferral: Strategic deployment of ESS has the potential to defer or eliminate transmission and distribution upgrades in specific locations. The potential for transmission and distribution deferrals need 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. 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 and unpredictable generation of an intermittent renewable resource 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.

E. Target Results

See Attachment A for data and information regarding EDC-procured projects and projects in the pipeline.

i. Procured Projects

As of December 31, 2017, National Grid had procured approximately 61 MWh_{ac} and 11.5 MW_{ac} of ESS. These projects include:

(1) Utility-Owned T&D ESS

Nantucket Battery Energy Storage System: National Grid is deploying a 48 MWh_{ac} utility-owned battery ESS at the Bunker Road substation on Nantucket Island in order to provide emergency back-up on the existing undersea transmission cables and defer T&D infrastructure investment for a third undersea transmission cable. This ESS, in conjunction with a new 10 MW diesel generator, is expected to supply enough energy to the island to meet recently measured peak demand levels if the larger of the two existing undersea transmission cables fails. National Grid expects that the ESS could defer investment in a third cable for up to 15-20 years by discharging the battery to supplement the cables.

(2) Utility-Owned R&D ESS

Solar Phase II & III Solar + Storage Projects: National Grid has currently procured approximately 7.1 MWh_{ac} of ESS to be paired with utility-scale solar PV generation systems through its Solar Phase II and Solar Phase III utility-owned solar R&D program.

National Grid intends to test the benefits of storing energy from solar generation and dispatching that energy at specific times. An example of this would be using the ESS to assist in solar PV output smoothing, which would help to stabilize power output from the site.

Through its Solar Phase II and Solar Phase III projects, National Grid also is exploring solutions to the challenges associated with smart inverters. Although these inverters can provide grid support functionalities (i.e.,

voltage regulation, frequency regulation, ride though), they also have the potential to create adverse impacts on the electric power system.

U.S. DOE ARRA Grant Projects: National Grid was awarded U.S. DOE ARRA funding to build two vanadium redox flow battery-based ESS for load shifting, peak shaving, and renewable system integration. National Grid, in partnership with Vionx Energy, Worcester Polytechnic Institute, and Leidos, Inc., installed a 3 MWh_{ac} ESS co-located with a 600 kW wind turbine at Holy Name High School in Worcester. The paired system will test and operate 13 specific use-case applications that will provide National Grid with valuable data in helping to optimize grid operations for renewable energy assets. In addition, National Grid, in partnership with Vionx Energy, Worcester Polytechnic Institute, and Energy Initiatives Group, LLC., has installed a 3 MWh_{ac} ESS co-located with a 1MW solar PV array in Shirley. The project was designed to help fulfill National Grid's goal to test a utility-scale project and quantify non-monetizable benefits.

ii. Project Pipeline

As of December 31, 2017, National Grid had approximately 23.1 MWh and 9.2 MW of ESS in the project pipeline.[12]

(1) Customer-Owned DOER/ MassCEC Funded Projects

ACES Projects: On December 7, 2017, six ESS projects that were sponsored and supported by National Grid were awarded ACES funding, representing total award funding of $5.1 million for 14.6 MWh of ESS capacity. The projects represent a range of customer segments and use cases, including renewable energy integration, demand charge management, peak shaving/ load leveling, T&D asset deferral, and microgrids.

Peak Demand Reduction Grant Projects: On June 14, 2017, two ESS projects that were sponsored and supported by National Grid were awarded grants under the Peak Demand Reduction Program, representing a total of $2.5 million and 8.5 MWh of energy storage capacity. Both projects seek to demonstrate business models that include geographically targeted demand reductions that may potentially contribute to EDC asset investment deferrals, and other electricity peak load reduction services.

[12] The exact amounts of energy and power of the proposed projects in AC and DC ratings could not be confirmed at the time of report submittal, but will be known as the projects move from the pipeline to the procured list.

F. Cost-Effectiveness and Viability

Information regarding cost-effectiveness and viability will not be provided in this first Report due to lack of information and experience. This information will be provided in the future as the EDCs continue to implement ESS projects.

G. Market Barriers and Solutions to the Adoption of Energy Storage

Information regarding market barriers and solutions to the adoption of ESS will not be provided in this first Report due to lack of information and experience. This information will be provided in the future as the EDCs continue to implement ESS projects.

H. Recommendations for Future Energy Storage Programs and Policies

Recommendations for future ESS programs and policies will not be provided in this first Report due to lack of information and experience. Recommendations will be provided in the future as the EDCs continue to implement ESS projects.

PROCURED PROJECTS

Project Procurement								Energy Storage												Generation					
Common Project Name	Source of Procurement	Other - Source	Program Status	Interconnection Status	Customer Type	City/Town	Year Procured	Technology Type	Other - Technology	Manufacturer	Energy kWh (DC)	Capacity kW (DC)	Energy kWh (AC)	Capacity kW (AC)	Installation Type	Application/ Intended Use #1	Application/ Intended Use #2	Application/ Intended Use #3	Other - Application/ Intended Use	Storage Co-Located with DG/ Generation?	System Configuration Type	DG/ Generation Type	Capacity kW (DC)	Capacity kW (AC)	Comments
Vionx Energy - Holy Name High School	Utility-Owned Storage - R&D		Contracted	Interconnected	Utility-Owned Distribution	Worcester	2015	Flow Battery	Vanadium Redox	Vionx Energy	3,180	530	3,000	500	FTM	Renewable Energy Integration (e.g., Ramping, Smoothing)	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)	Wholesale Market (i.e., Energy, Capacity, Ancillary Services)		Yes	AC Coupled	Wind Turbine		600	
Vionx Energy - Groton Rd, Shirley	Utility-Owned Storage - R&D		Contracted	ISA Issued	Utility-Owned Distribution	Shirley	2017	Flow Battery	Vanadium Redox	Vionx Energy	3,180	530	3,000	500	FTM	Renewable Energy Shifting	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)	Wholesale Market (i.e., Energy, Capacity, Ancillary Services)		Yes	AC Coupled	Solar PV	991	1,000	
Solar phase II - Patterson Rd, Shirley	Utility-Owned Storage - R&D		Contracted	First Payment Made	Utility-Owned Distribution	Shirley	2017	Lithium Ion		Tesla			1,000	500	FTM	Renewable Energy Integration (e.g., Ramping, Smoothing)	Peak Shaving/ Load Leveling	Power Quality (e.g., Voltage/VAR Support)		Yes	AC Coupled	Solar PV	530	500	
Solar phase III - NEDC	Utility-Owned Storage - R&D		Contracted	Application Submitted	Utility-Owned Distribution	Northbridge	2017	Lithium Ion		Power Electronics/ Princeton Power			2,000	1,750	FTM	Renewable Energy Shifting	Power Quality (e.g., Voltage/VAR Support)	Reliability and Resiliency		Yes	AC Coupled	Solar PV	3,600	3,220	
Solar phase III - Stafford St, Leicester	Utility-Owned Storage - R&D		Contracted	Application Submitted	Utility-Owned Distribution	Leicester	2017	Lithium Ion		NEC	1,020		990	560	FTM	Renewable Energy Shifting	Power Quality (e.g., Voltage/VAR Support)	Reliability and Resiliency		Yes	AC Coupled	Solar PV	1,361	1,475	
Solar phase III - Horne Homestead Rd, Charlton	Utility-Owned Storage - R&D		Contracted	ISA Issued	Utility-Owned Distribution	Charlton	2017	Lithium Ion		NEC	2,040		1,980	1,120	FTM	Renewable Energy Shifting	Power Quality (e.g., Voltage/VAR Support)	Reliability and Resiliency		Yes	AC Coupled	Solar PV	1,978	2,000	
Solar phase III - Cedar Rd, Attleboro	Utility-Owned Storage - R&D		Contracted	Application Submitted	Utility-Owned Distribution	Attleboro	2017	Lithium Ion		NEC	1,020		990	560	FTM	Renewable Energy Shifting	Power Quality (e.g., Voltage/VAR Support)	Reliability and Resiliency		Yes	AC Coupled	Solar PV	2,518	2,399	
Nantucket BESS - Bunker Road	Utility-Owned Storage - T&D		Contracted		Utility-Owned Transmission	Nantucket	2017	Lithium Ion		Tesla			48,000	6,000	FTM	Reliability and Resiliency	T&D Asset Deferral			Yes	AC Coupled	Diesel/Grid supplied		10,000	
TOTAL MWh and MW:													60,960	11,490											

PIPELINE PROJECTS

Energy Storage Projects in Pipeline

Project Procurement								Energy Storage												Generation					
Common Project Name	Program Type	Other - Program Type	Program Status	Interconnection Status	Customer Type	City/Town	Year Procured	Technology Type	Other - Technology Type	Manufacturer	Energy kWh (DC)	Capacity kW (DC)	Energy kWh (AC)	Capacity kW (AC)	Installation Type	Application/ Intended Use #1	Application/ Intended Use #2	Application/ Intended Use #3	Other - Application/ Intended Use	Storage Co-Located with DG/ Generation?	System Configuration Type	DG/ Generation Type	Capacity kW (DC)	Capacity kW (AC)	Comments
ACES - Brockton Walmart and Leicester Walmart	MA - DOER/ MassCEC Funded Projects		Awarded		Commercial	Brockton and Leicester		Lithium Ion		Lockheed Martin			1,000	500	BTM	Renewable Energy Integration (e.g., Ramping, Smoothing)	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)	Peak Shaving/ Load Leveling		Yes		Solar PV			
ACES - Tesla Nantucket Residential	MA - DOER/ MassCEC Funded Projects		Awarded		Residential	Nantucket		Lithium Ion		Tesla			6,750	2,500	BTM	T&D Asset Deferral	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)	Reliability and Resiliency							
ACES - UMass/ Marlborough Memorial Hospital	MA - DOER/ MassCEC Funded Projects		Awarded		Commercial	Marlborough		Flow Battery	Zinc Iron	ViZn Energy Systems	800	200			BTM	Microgrid	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)	Peak Shaving/ Load Leveling		Yes		CHP + Solar PV			
ACES - Wynn Boston Harbor Resort	MA - DOER/ MassCEC Funded Projects		Awarded		Commercial	Everett		Lithium Ion		Tesla			4,200	1,044	BTM	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)	Wholesale Market (i.e., Energy, Capacity, Ancillary Services)			Yes		CHP + Solar PV			
ACES - Sunrun/ National Grid Ventures	MA - DOER/ MassCEC Funded Projects		Awarded		Residential	Various Towns Across MA		Lithium Ion		Sunrun/ LG Chem			1,860	1,000	BTM	Renewable Energy Integration (e.g., Ramping, Smoothing)	Reliability and Resiliency	Customer Bill Savings (e.g., Demand Charge Management, TOU Arbitrage)		Yes		Solar PV			
DOER Peak Demand Reduction Grant - Tesla Residential	MA - DOER/ MassCEC Funded Projects		Awarded		Residential	Various Towns Across MA		Lithium Ion		Tesla			2,430	900	BTM	Peak Shaving/ Load Leveling				Yes		Solar PV			
DOER Peak Demand Reduction Grant - Genbright Residential	MA - DOER/ MassCEC Funded Projects		Awarded		Residential	Nantucket		Thermal Storage		Ice Energy			6,020	3,010	BTM	Peak Shaving/ Load Leveling	T&D Asset Deferral								
TOTAL MWh and MW:											800	200	22,260	8,954											