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November 6, 2019

VIA FEDERAL EXPRESS & ELECTRONIC MAIL (EnergyEfficiency@bpu.nj.gov)

Honorable Aida Camacho-Welch, Secretary of the Board
Board of Public Utilities
44 S. Clinton Ave., 9th Floor
P.O. Box 350
Trenton, NJ 08625-0350

Re: Energy Efficiency October 30, 2019 Stakeholder Meeting – Programs

Dear Secretary Camacho-Welch:

On October 30, 2019 New Jersey Board of Public Utilities Staff held a stakeholder meeting ("October 30 Meeting") regarding the New Jersey energy efficiency transition. The October 15, 2019 Notice ("October 15 Notice") of that meeting provided for the submission of written comments concerning New Jersey's next generation of energy efficiency and peak demand reduction programs by November 6, 2019. These comments are being submitted on behalf of South Jersey Gas Company ("SJG") and Elizabethtown Gas Company ("ETG") (collectively, the "Companies") to provide input on this topic.

The October 15 Notice invited input from panelists on a series of questions designed to facilitate conversation on energy efficiency programs at the October 30 meeting. The October 15 Notice further invited written comments on these same questions, which the Companies hereby respond to as follows:

1. ***Which New Jersey programs are considered the most successful? How do you define "success"?***

To achieve the greatest success, New Jersey energy efficiency programs should consist of a diverse set of programs that reach a broad range of customers. It will be particularly important to reach the traditionally underserved classes, including low to moderate income customers, as well as seniors and renters. It will also be important to target large energy users such commercial and industrial customers with programs that address their particular energy efficiency needs. Entry level programs such as energy audits and efficient products offer opportunities to reach a wide number of customers, while educating them about their energy efficiency options and ways to optimize their consumption reduction. Please also see the response to Question No. 5 for a related discussion on equitable access.

2. ***What programs will achieve the most energy and/or cost savings?***

Energy efficiency programs that are managed by the utilities are the programs that are likely to achieve the most energy and cost savings. Established customer relationships, expertise in the delivery of successful energy efficiency programs and access to customer data make the utilities uniquely positioned to administer programs that can achieve the most energy and/or cost savings. Utility management of energy efficiency programs is consistent with the approach taken by energy efficiency leaders. Benchmarking demonstrates that seven of the top 10 states in American Council for an Energy-Efficient Economy's (ACEEE) 2019 State Energy Efficiency Scorecard ranking run energy efficiency programs through their electric and gas utilities. The remaining three states use either a combination of state and utility programs where there is coordination (NY), or an independent non-profit (VT, OR). Accordingly, New Jersey's efforts to implement the Clean Energy Act should include recognition of the opportunity to leverage the strengths of the utility-run programs to facilitate the most energy and cost savings.

3. ***How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?***

Consistency and flexibility can be achieved through coordination and collaboration of obligated stakeholders, as appropriate. The New Jersey utilities have a long standing history of working collaboratively on past initiatives, including Comfort Partners and other efforts, and such continued collaboration will allow for a sharing of best practices concerning program design and implementation. At the same time, such coordination should not undermine the need for flexibility in program selection, design, and implementation practices to allow for the optimization of savings and the cost-effective achievement of individual targets.

4. ***What market barriers are prevalent in specific New Jersey programs?***

SJG and ETG generally agree with the market barriers identified as prevalent in New Jersey by Rutgers at the October 30 Meeting, including imperfect information, financial constraints, misplaced incentives, externalities, technology availability/imperfect competition, and customer preference. SJG and ETG also agree with the market barriers identified by Brian Bovio, a heating, plumbing, cooling and insulation contractor, including program changes and timing of payment. A further market barrier experienced by the Companies includes the health and safety challenges associated with low to moderate income programs. Dangerous conditions at the premises associated with these programs often present health and safety issues that prevent project completion and the delivery of benefits to relatively underserved customer classes. Solutions to overcome these barriers will help to facilitate customer participation and program success.

5. ***How do we ensure equitable access?***

Equitable access can be achieved through a diversified portfolio of programs that give all customer classes the opportunity to participate and realize energy savings. Of particular importance is the need to include programs that support participation by traditionally underserved classes, including low to moderate income residential customers, along with residential programs that focus on renters and seniors. For commercial and industrial customers, there is an opportunity to expand efforts to serve commercial customers by industry segment and leverage insights from national efforts, including the Consortium for Energy Efficiency and Department of Energy Better Buildings Network. The considerable experience of the utilities with providing programs will enable them to leverage their knowledge to target or maximize participation across customer segments through both program design and implementation.

Thank you again for the opportunity to provide these comments. We look forward to continued collaboration with all stakeholders.

Respectfully yours,

Deborah M. Franco

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Re: October 30, 2019 Energy Efficiency Stakeholder Meeting — Programs

Introduction

The Energy Efficiency Alliance of New Jersey ("EEA-NJ") is a trade association dedicated to expanding the market for energy efficiency in the Garden State. Together with its sister organization, the Keystone Energy Efficiency Alliance ("KEEA"), EEA-NJ has more than 60 business members who provide energy efficiency products and services across the state, and support an industry that accounts for more than 30,000 New Jersey jobs. Our membership is large and diverse, with experience designing and implementing a variety of demand side management solutions and energy efficiency programs across the globe. Simply stated, our members understand what works and what does not when it comes to successful demand side reduction programs.

EEA-NJ appreciates the opportunity to engage with the New Jersey Board of Public Utilities ("BPU") on how to best implement programs that will reach the energy efficiency and peak demand reduction portions of the Clean Energy Act ("CEA"). With these comments and the individual comments of our member companies and partners, EEA-NJ hopes to provide the BPU with the information required to create a framework for a thriving energy efficiency industry in New Jersey.

Clean Energy Act and Implementation

The Clean Energy Act directs both the BPU and New Jersey's electric and gas utilities to act to reduce energy usage in the Garden State. Specifically, the CEA spells out that each electric utility will be required to achieve a 2% reduction in energy usage per year, while each natural gas utility must achieve a .75% reduction per year.[1] As part of this process, the BPU is required to conduct and complete a study to determine the energy savings targets for full economic, cost-effective reductions and the time frame for achieving these reduction with comments and suggestions from interested parties.[2] In addition to the comments outlined below, EEA-NJ is eager to see specific plans for this process to get underway and would like to encourage the BPU and utilities to propose such programs or implementation plans in order to better inform this discussion going forward.

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[1] Clean Energy Act, PL 2018, c. 017, a3723, 3(a).
[2] Clean Energy Act, 3(b)

Questions from Stakeholder Meeting Agenda

1. **Which New Jersey programs are considered the most successful? How do you define "success"?**

EEA- NJ and its members believes that a successful program will:

Follow clear goals created by the BPU that will achieve New Jersey's Clean Energy Act and Energy Master Plan goals while allowing for flexibility in types of programs. New Jersey has passed groundbreaking legislation in the Clean Energy Act and chartered a new path towards a cleaner energy future through the Energy Master Plan. To achieve what is required in these legislative mandates, the BPU must outline clear goals for energy efficiency programs consistent with both the EMP and CEA that are informed by independent energy efficiency potential studies, such as the Optimal energy analysis, and stakeholders that can provide real world knowledge on the market potential. Additionally, the BPU should establish minimum reporting, measurement, and evaluation guidelines to ensure consistency and transparency across programs.

Establish customer engagement and marketing as a priority of any program. EEA-NJ has noted in the past that customer engagement and education has been a particularly weak spot for New Jersey programs. Without acknowledging this weak spot and addressing it by making it a priority there is a significant chance that New Jersey could miss this opportunity for statewide innovation and change in the energy efficiency sector. Therefore, new programs must place awareness building, marketing, and engagement as a priority to correct this.

Utilize a Societal Cost Test or similar test that values the environmental and other beneficial impacts of energy efficiency investments to determine cost effectiveness. In addition to utility system benefits, there are a number of Non-Energy Benefits ("NEBs") or Non-utility benefits that should be quantified and included in considering the cost and benefits of programs. Such tests can encompass impacts on low-income customers, fuel impacts, water impacts, environmental impacts, public health impacts, economic development, and energy security, among others. The National Standard Practice Manual ("NSPM") provides significant detail on how to treat each category of impact and cost, as well as the sub-categories that comprise them.[3]

Easy to participate in for customers, utilities, and third parties in the industry. The process for various actors to apply for and/or participate in programs must be clear and accessible. To do so, the BPU can work with other regulatory authorities in the state to set up uniform minimum standards that allow for predictability in the market, especially for industries that work with different utilities across the state. The BPU can ensure that easy to follow application processes are established with responsive support and reasonable timeframes for participants, can outline clear incentives and penalties for participants, and ensure transparency in payment and contracting processes for programs implemented by both utilities and third parties. Finally, the BPU through oversight should assure that all programs which offer rebates to consumers and

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[3] *See* National Efficiency Screening Project, National Standards Practice Manual for Assessing Cost-Effectiveness of Energy Efficiency Resources, Edition 1 Spring 2017, available at https://nationalefficiencyscreening.org/wp-content/uploads/2017/05/NSPM_May-2017_final.pdf

businesses are easy to access and participate in once programs are up and running (i.e. no delays in approval, financing, or decision making).

2. **What programs will achieve the most energy and/or cost savings?**

To determine what programs will achieve the most energy and/or cost savings, the BPU must first determine what it considers to be savings. EEA-NJ encourages the BPU to take a broad view of the benefits of energy efficiency programs, as doing so will result in programs that deliver the most long-term value for New Jersey.

Costs and benefits metrics should include societal cost metrics or similar costs test. EEA-NJ believes the CEA requires the BPU to utilize a Societal Cost Test or similar test that values the environmental and public health impacts of energy efficiency investments. EEA-NJ recommends the BPU look to the NSPM for guidance on how to develop jurisdictional cost-effectiveness tests of utility customer-funded energy efficiency programs.[4] The NSPM provides a multi-step process — The Resource Value Framework— that can be used to establish a comprehensive primary cost-effectiveness test for a jurisdiction.[5] The Framework will encompass a " jurisdiction's applicable policy goals, assigns value to all relevant impacts (costs and benefits) related to those goals, and embodies a set of universal principles representing sound economic and regulatory practices." [6]

Investing in market transformation strategies and prioritizing advertising to encourage participation. To address some market barriers, energy efficiency programs and technologies must infiltrate the market so they are visible and available to all customers statewide at competitive rates. Such a priority can also drive down costs for implementers of programs by aiding in customer outreach and education. To minimize implementation and marketing costs, the state can aid in setting up and growing the energy efficiency marketplace through statewide initiatives such as creating uniform state appliance standards that advance better, more efficient technologies and will result in these technologies competing in the market. Additionally, the state can engage in workforce development and consumer education. These policies will support the energy efficiency marketplace and provide for its growth.

Deploying programs at scale by each utility with regulatory oversight and reporting requirements. Administrative costs are at their greatest during program design and ramp up and utilities are best poised in New Jersey to fill this role. Once efficiency programs are administered, the portion of spending allocated to administration drops. The cost of program administration continues to decline as lessons are learned and implementers tune their offerings. Moreover, the costs of program oversight are minimized when utilities, and/or third-party implementers have to meet reasonable reporting requirements that are evaluated by a third party. Yet, utility's ability to run these programs must be contingent on BPU and third party oversight, which would continue through the life of the program.

[4] More information available at: https://nationalefficiencyscreening.org/the-national-standard-practice-manual-for-energy-efficiency/.
[5] *See* National Efficiency Screening Project, Overview: National Standard Practice Manual, April 2019, availble at https://nationalefficiencyscreening.org/wp-content/uploads/2019/07/NSPM-3-pg-overview-7.31.19.pdf.
[6] *See* National Efficiency Screening Project, Overview: National Standard Practice Manual, April 2019, availble at https://nationalefficiencyscreening.org/wp-content/uploads/2019/07/NSPM-3-pg-overview-7.31.19.pdf.

Ensuring long-term flexibility in implementation with a reliable budget. The BPU should allow for flexibility in programs across the state and within utility service territories provided that they achieve goals and objectives outlined by the BPU. Flexibility can be achieved through allowing programs to run costs and benefits tests through portfolio level assessments instead of measure level. Also, providing at least a 5-year minimum program budget life and planning horizon for implementers ensures stability for small businesses that work in the energy efficiency markets and allows them the opportunity to respond to changes in the market. For more details see EEA-NJ's response to question 3.

Saving money for ratepayers through optimal ease of use, customer service, and maximizing market utilization. This can be facilitated through performance-based program designs that allows implementers to use successful models for customer engagement and adapt to a quickly changing market. Following these three principles: (1) simplicity in design and delivery of incentives to the market; (2) flexibility in implementation by utilities and/or third-party implementers; (3) leveraging private capital that can supplement ratepayer capital.

3. **How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?**

To achieve a balance between consistency versus flexibility in programs, the BPU can establish minimum standards and goals, but allow for flexibility in design and implementation.

To create consistency in minimum standards and goals, the role of the BPU should be establish goals, incentives, and penalties that drive energy efficiency programs to achieve targets laid out in the Clean Energy Act and Energy Master Plan, which will enable utilities and third-party implementers to identify the right programs and implement them within their respective territories and fields of work.

These goals should be sure to not stifle participation, turnaround times, and the ability to tailor or modify a program once implemented, but instead clearly define industry standards and programs' performance goals, incentives, and penalties. These standards should be established from reasonably available data; free from external influence; easily interpreted; and easily verified. Additionally, the BPU should be sure that incentives are flexible to allow program implementers to respond, modify, or shift strategies as implementation occurs. Finally, the BPU should collaborate with other state agencies to put in place regulations that can provide for consistency across all sectors, such as updating baseline codes and standards for buildings, appliances, and other sectors.

To allow for flexibility in program implementation and goals, program administration will have to be structured so that implementers can respond and adapt to current and future market conditions across the state. This can be done through establishing a performance instead of compliance based regulatory structure with the BPU overseeing programs as a regulator and utilities or third parties acting as administrators. Flexibility is valuable in an emerging market, such as the energy efficiency one, because initial market assessments have limitations and companies need to be able to modify programs based on market conditions, real world experience, barriers, and other risks, all of which do not become apparent until implementation is underway. In this role, the BPU should ensure that benefits and costs analyses are done at the portfolio level instead of measure level, guarantee programs at least a 5-year minimum budget life and planning horizon, and allow for funding to shift between more and less successful programs over time.

Conducting benefits and costs analysis at the portfolio level instead of the measure level will allow for the most effective program implementation as measure level is not a cost-effective approach for participants. A measure level analysis requires incremental assessment and inhibits programs by getting too bogged down in the details and limiting ways to approach a project. A portfolio level analysis will allow for bigger picture innovation and savings with more working parts and ultimately better results. Additionally, it will give the participant the ability to adjust with market conditions.

Programs should have at least a 5-year minimum program budget life and planning horizon. This will ensure program stability, allow for costs and benefits to be more accurately measured, improve implementation, and allow for adjustments prior to determining the success or failure of a program. Such a policy will allow determination of what is achievable in a more cohesive and thought-out manner. Further, it creates confidence and stability in the marketplace so that participants can make longer term commitments to meeting program standards.

4. **What market barriers are prevalent in specific New Jersey programs?**

EEA-NJ members have identified the following market barrier issues within current New Jersey programs. While we do not identify specific programs, we believe that this list covers the most prevalent issues across all programs:

- ➢ Unreasonable time frames for programs, such as application and incentive processes, that take months and need to be done quicker to incentivize participation.
- ➢ Rebates should be more understandable and accessible.
- ➢ Lack of customer awareness for current programs.

5. **How do we ensure equitable access?**

Statewide specialized programs for underserved communities and hard to reach sectors of the market such as low and moderate income, multifamily housing, and small businesses. These programs need to include specialized incentives to engage energy efficiency businesses in this sector as well as marketing and education resources to ensure these communities are aware of and engaged in these programs.

Transparency in government and utility implementation of programs and incentives to insure the relationships between regulators, utilities, and businesses participating in the programs are clear and all parties are on equal footing.

Uniform minimum standards across the state to make it easy to access and participate in programs. The BPU can ensure that program implementers establish easy to follow application processes with responsive support and reasonable timeframes for participants; clearly outline incentives and penalties for implementers and participants; and ensure transparent payment and contracting processes for programs implemented by both utilities and third parties.

Conclusion

EEA-NJ thanks the BPU for this opportunity to comment on the important topic of programs. By using the recommendations provided in these comments, EEA-NJ believes that the BPU, utilities, and stakeholders can create programs that will make the Garden State a leader in energy efficiency. EEA-NJ looks forward to continued opportunities for stakeholder input as New Jersey designs and implements the Clean Energy Act.

Sincerely,

Erin Cosgrove, esq.
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Energy Efficiency Alliance of New Jersey

November 6, 2019

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RE: Energy Efficiency Transition: Program

Dear Secretary Camacho-Welch,

Thank you for the opportunity to comment on the Energy Efficiency Transition process focused on Programs. Environmental Defense Fund appreciates the Board of Public Utilities (BPU) attention to this important issue as New Jersey transitions to a low carbon future.

Strategy 4 of the Draft Energy Master Plan to "Reduce Energy Use and Emissions from the Building Sector" calls for the building sector to be largely electrified by 2050. The Integrated Energy Plan[1] confirms that building electrification is a critical component of the least-cost pathway to meet New Jersey's climate and clean energy goals and the importance of beginning to switch equipment at the end of its useful life now.

The state's energy efficiency program can serve as an early catalyst to building electrification through the design of appropriate programs and incentives that will address market barriers to electrifying existing buildings, such as high upfront costs, low fossil fuel prices and consumer education. New Jersey can benefit from learnings from other states that have developed electrification programs as part of their energy efficiency offerings like the New England states and New York.[2] The program design should also hasten to recognize the unique opportunities for cost-effective building electrification that new construction may offer; as we stated in our September 13, 2019 Draft EMP Comments, "All relevant agencies should immediately study the

[1] New Jersey Integrated Energy Plan Public Webinar November, 1, 2019
https://www.youtube.com/watch?v=8kj9zVR4vWQ&feature=youtu.be
[2] https://neep.org/sites/default/files/Strategic%20Electrification%20Regional%20Assessment.pdf Pg. 31

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cost effectiveness of requiring that all construction/buildings that are to or will be newly constructed in the future be reliant on electricity for all of their ongoing energy needs."

Additionally, the BPU should recognize the critical need, in light of the urgent decarbonization challenge that the State now recognizes and that the Draft EMP addresses (including the role that electrification is expected to play in this endeavor), of assessing legacy efficiency policies and programs for their goodness of fit with current policy priorities. To that end, the BPU should initiate a stakeholder process to explore existing energy efficiency policies and programs to determine how they promote or impede electrification and explore other potential electrification program models.

Respectfully submitted,

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RE: October 30, 2019 Energy Efficiency Stakeholder Meeting on "Programs"
Comments of Atlantic City Electric Company

Dear Secretary Camacho-Welch:

On behalf of Atlantic City Electric Company ("ACE" or "the Company"), please accept these comments in response to questions included in the agenda for the October 30, 2019 Energy Efficiency Stakeholder Meeting (the "Meeting"), distributed by the Board of Public Utilities' ("BPU" or the "Board") Office of Clean Energy ("OCE") on October 24, 2019. The Meeting was the second in a series of topic-specific stakeholder meetings related to the Energy Efficiency ("EE") Transition, pursuant to the Clean Energy Act (P.L.2018, c.17) ("the Act").

The Company appreciates the opportunity to participate in the stakeholder meetings and provide additional comments on the identified topics. The Meeting convened industry experts and other stakeholders to provide input on New Jersey's next generation of EE and peak demand reduction programs. Panelists were invited to comment on the following questions:

1. Which New Jersey programs are considered the most successful? How do you define "success"?
2. What programs will achieve the most energy and/or cost savings?
3. How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?
4. What market barriers are prevalent in specific New Jersey programs?
5. How do we ensure equitable access?

ACE's parent company, Pepco Holdings, is recognized as a national leader in EE and demand response for its robust portfolios of programs in Maryland, as well as emerging portfolios in Delaware and New Jersey. Notably, the American Council for an Energy Efficient Economy ("ACEEE") ranks Maryland seventh in the nation for EE overall, and specifically recognizes Maryland for its utility programs, highlighting the outstanding and diverse portfolio that the Exelon Utilities—Pepco, Delmarva Power and Baltimore Gas and Electric—offer to Maryland residents.

Pepco Holdings has been recognized for its excellence in delivering effective EE programs, having received a number of awards, including the ENERGY STAR Partner of the Year Sustained Excellence Award, the Peak Load Management Alliance Program Pacesetter Award, and the Star of Dynamic Efficiency Award from the Alliance to Save Energy. Leveraging these best practices will aid ACE in meeting the two percent energy savings goal defined in the Act.

ACE's responses below to the questions posed in the agenda are informed by this broader perspective, but are tailored to New Jersey's specific goals and priorities. ACE is fully committed to achieving the goals established in the Act as it relates to EE and other priorities, and submits these comments to advance the EE discussion. ACE looks forward to taking part in additional stakeholder meetings on this subject and anticipates future opportunities to provide its perspectives on implementing EE programs in New Jersey.

1. **Which New Jersey programs are considered the most successful? How do you define "success"?**

Program success can be analyzed through several different lenses, depending on state policy goals, program administrator goals, the needs and priorities of the customer base, the efficiency potential in each sector, and financial goals. The Act established a framework to measure the overall success of New Jersey's EE initiatives, requiring each electric public utility to develop EE programs to "achieve annual reductions in the use of electricity of two percent of the average annual usage in the prior three years within five years of implementation of its electric energy efficiency program." In light of the Act's landmark energy reduction goals, successful programs will be scalable and effective at engaging customers in adopting EE measures. Achieving the Act's goals will likely require programs that target customers with high savings potential (through deep retrofits), as well as mass market programs that address EE lighting installations and customer behavioral changes. In short, success will require an "all of the above" approach.

In defining success for utilities, it is important to consider the programs that utilities are currently able to offer. As the market potential study commissioned by BPU shows, approximately 90 percent of the maximum achievable electric potential for residential customers are covered by OCE programs. These programs provide incentives or services for space heating, water heating, cooling, appliances, and refrigeration. For commercial customers, approximately 93 percent of the maximum achievable electric potential is offered through OCE programs, which generally focus on building retrofits and other efficiencies. As such, there is presently little opportunity for an electric utility to develop non-duplicative programs that reach the State's energy-saving targets.

Even if a utility adds to State-administered energy savings with utility-administered energy savings, the combined savings will not meet the stated two percent goal. Thus, the definition of success for utility programs should reflect existing limitations that serve as barriers to scaling programs and the ability to meet the State's goals.

Success in EE programs is often measured by achieving the greatest energy savings at the lowest cost. However, to ensure customer equity, it is imperative that ACE designs a program portfolio so that all customers will have access to energy-saving programs. Designing a portfolio solely on the basis of total energy savings or cost-effectiveness can bias the portfolio toward commercial and industrial ("C&I") customers and can limit program access to those who may need it most, *e.g.*, income-eligible customers (for whom programs are often not cost-effective). Approximately 26 percent of ACE customers are low- to moderate-income, who generally spend a higher portion of their income on energy costs. Designing and offering income-eligible programs for these customers increases energy affordability, decreases dependence on State and social services, offers non-energy benefits such as health and safety measures, and supports the State's energy savings goals.

2. What programs will achieve the most energy and/or cost savings?

The highest performing programs are usually C&I programs, which can target a diversity of energy-intensive end uses, benefit from economies of scale, and lower customer acquisition costs, compared to residential programs. Other high performing programs include upstream and midstream programs, which work with manufacturers and retailers to discount the cost of energy efficient consumer products without requiring additional customer action (such as the completion of a rebate form). These programs are popular for energy efficient light bulbs, but have expanded to include other end uses, such as appliances and HVAC equipment.

Table 1 presents the highest saving programs offered by our affiliate, Delmarva Power, as part of the EmPOWER MD initiative in Maryland, and includes the cost per kilowatt hour ("kWh") saved. We include this data to highlight the general trend of C&I and upstream programs as being significant contributors to portfolio savings at an average of half the cost of residential programs, and to show that portfolios should be customized and balanced to best meet the needs of the customer base. For instance, there are some programs in Maryland, like Family Farms and Schools, that do not provide a lot of energy savings, but reach an important customer category. Overall, Delmarva Power places a strong emphasis on residential customer participation, and its realized energy savings are more or less equally split between residential and C&I programs. The cost-effectiveness of the upstream lighting, behavior program, and Quick Home Energy Check Up help offset the higher cost of the more intensive programs.

Table 1. FY2018 Delmarva Power Program Results in Maryland

Sector	Program Name	Gross Savings (MWh)[1]	Program Spend	$/kWh
Commercial & Industrial	Prescriptive	18,577	$4,190,496	$ 0.226
Residential	Lighting	17,869	$1,669,387	$ 0.093
Residential	Behavior Based	14,873	$553,771	$ 0.037
Commercial & Industrial	Midstream Products	8,475	$1,242,280	$ 0.147
Commercial & Industrial	Small Business	4,041	$3,371,677	$ 0.834
Residential	Quick Home Energy Checkup	2,709	$1,297,302	$ 0.479
Commercial & Industrial	Custom	2,153	$1,491,427	$ 0.693
Commercial & Industrial	Retrocommissioning	2,069	$401,649	$ 0.194
Residential	Home Performance with ENERGY STAR	825	$1,110,415	$ 1.346
Residential	Appliance Recycling	805	$358,618	$ 0.445
Residential	Appliance Rebates	661	$722,670	$ 1.093
Residential	HVAC	610	$821,399	$ 1.347
Residential	New Construction	489	$398,746	$ 0.815
Residential	Schools	167	$75,743	$ 0.454
Residential	Family Farms	106	$317,274	$ 2.993

Ranked by cost-effectiveness, C&I programs generally outperform residential programs. This is to be expected, because: (1) C&I customers use more energy and therefore there are greater savings opportunities per customer; and (2) the primary cost drivers of EE programs (excluding rebates and incentives) are marketing, customer acquisition, and administration, and these costs are higher when attempting to reach greater numbers of customers. High cost-effectiveness among the C&I programs leave room for other programs to expand with new measures that may not be cost-effective themselves, but would nonetheless produce energy savings. Residential programs sometimes struggle to be cost-effective given the higher transaction costs and lower per customer savings. As explained further in ACE's response to Question 5 below, ACE recommends accounting for non-energy benefits ("NEBs") in the Societal Cost Test ("SCT") in order to include as many program options as possible to meet the State's policy goals.

While C&I programs can improve the economics and savings achievements of a portfolio, ACE views programs targeting the low- to moderate-income customer segment, such as the existing Low-Income Program, as an essential part of the EE portfolio, as stated above. Some states, such as Rhode Island, Colorado, and Vermont, have developed "adders" in the SCT to account for hard-

[1] At the generator; not net savings which account for line losses.

to-quantify benefits, such as health, comfort, and economic development, and as a result, put low-income programs on more equal footing. Adders for low-income programs typically range from 15 to 25 percent.

3. How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?

To reach energy saving goals, both flexibility and consistency are important, although the desire for consistency should yield in appropriate instances to allow for flexibility. The most effective programs are those that iterate and evolve in response to changing market conditions and the specific needs and interests of the customer base, which may differ by service territory. This could include changes in incentive levels or marketing strategies, and shifting budgets between programs as needed. Developing approval processes that provide flexibility at the outset, within certain parameters such as budget impacts, will allow utilities to remain agile and minimize administrative burden and lag time.

Additionally, flexibility in program requirements and design may allow utilities to leverage new customer data that becomes available through Advanced Metering Infrastructure ("AMI"). Such data will allow utilities to more effectively target customers with marketing messages that are likely to resonate with them, and to introduce advanced technologies that rely on AMI for full realization of benefits. Further, an important element of flexibility is measuring cost-effectiveness at the portfolio level. This preserves the flexibility to offer less economic but more targeted programs that still benefit customers, while ensuring the portfolio as a whole has benefits that outweigh its costs.

The value of consistency is primarily on the vendor or provider side, recognizing that there are transaction costs associated with understanding the specific requirements and benefits of programs offered by different utilities. There may be opportunities to promote consistency in program requirements and application processes without compromising the flexibility to customize programs based on the unique characteristics of a given utility service territory. For example, BPU could establish minimum program requirements to ensure that vendors have a common set of basic requirements for participating in utility programs. A centralized website could serve as a clearinghouse for contractors, vendors, and service providers for details on each utility's programs, similar to the EmPOWER MD website in Maryland. This kind of common branding can provide a unifying element and framework, while preserving flexibility within utility programs.

4. What market barriers are prevalent in specific New Jersey programs?

Panelists at the October 30, 2019 Meeting identified several market barriers impacting New Jersey EE programs, including financial and budgetary constraints, unavailability of certain technologies, customer preferences, uncertainty about future electricity prices, and the "split incentive" (where benefits do not accrue to the party who makes the investment). Other market barriers include lack of awareness or confusion about what is offered and how to access programs, insufficient incentive levels for some programs, burdensome program applications and requirements, and lack of vendor awareness or engagement. Another specific barrier raised by contractors is the timeframe for completing administrative processes, such as issuing rebate payments.

These market barriers prevent the Clean Energy Programs from obtaining maximum energy savings. Some of these barriers are administrative in nature, *i.e.*, financial and budgetary constraints, that cannot be resolved by a public program administrator. Other barriers, however, like application requirements and administrative processes, can be readily addressed by a utility administrator, which has the systems and resources in place to manage those processes.

5. How do we ensure equitable access?

To ensure equitable access to programs, utilities can use a variety of customer-centric communication platforms to engage customers in energy saving programs. For instance, Pepco and Delmarva Power include energy saving messages on their bills and online account tools. Pepco and Delmarva Power also propose EE programs as a customer solution when alerting customers of high bills. Call center representatives direct customers to energy-saving programs when assisting customers with other concerns. These Exelon Utilities use their position as the trusted energy provider to help customers navigate a variety of energy-saving solutions. These utilities also "meet their customers where they are" by participating in community events and summits, and also collaborate with social service groups like Food Banks and congregations.

Because ACE also communicates with customers through many of these channels and via its mobile app, it ensures that all customers have an opportunity to participate, regardless of housing status, income level, primary language, or geographic location within the service territory. To promote wide access to programs, it is useful to include a variety of end uses and measures that are relevant at different purchasing decision points. For example, new home programs work with builders to encourage energy efficient construction practices and installation of high efficiency appliances and equipment (measures that are more cost-effective than retrofitting post-construction). To serve lower-income customers, weatherization and other direct install programs retrofit existing single and multi-family homes to improve efficiency, safety, and comfort.

As discussed above, to maximize program opportunities, ACE recommends that cost-effectiveness metrics be applied at the portfolio level. A way to ensure cost-effectiveness and quantify the full market value of energy efficiency programs is to value the benefits of energy efficiency by including NEBs in the cost-effectiveness calculation. "NEBs" are non-energy benefits that result from energy efficiency programs, such as water savings, greenhouse gas emissions reductions, and improved comfort, productivity, health, convenience, and aesthetics.

ACE supports inclusion of NEBs as part of cost-effectiveness considerations and recommends that all environmental, health, and safety NEBs that can be quantified to a reasonable extent should be included in the calculation. EmPOWER MD, for example, includes NEBs within its Total Resource Cost ("TRC") test calculation. The NEBs that are calculated include water and wastewater savings, deferred replacement costs, deferred operation and maintenance ("O&M") costs, benefits associated with comfort for insulation installs, and arrearage for limited-income programs.

Using a slightly different approach, the District of Columbia Sustainability Energy Utility ("DCSEU") uses a five percent proxy adder to account for NEBs that result from energy efficiency programs but are difficult to quantify and monetize with meaningful precision. In New Jersey, NEBs could be included as a proxy through a percent adder or a methodology could be developed to estimate a fixed value per kWh. NEBs that cannot be quantified or are not included in the calculation of the cost-effectiveness value can be documented qualitatively to nonetheless demonstrate additional benefits. These qualitative observations may be considered in cases where the calculated cost-effectiveness is just short of a minimum standard or where multiple proposals are being compared.

Offering a diversity of program opportunities, preparing marketing materials in multiple languages and across multiple channels, such as online advertising, bill inserts, and bus advertisements, can raise program awareness across the community. Partnerships with community-based organizations serving hard-to-reach customers can also help bring people into EE programs. Additionally, each program should be designed to overcome known barriers to participation whenever feasible.

***

ACE appreciates the opportunity to work with the Board, Board Staff, and other interested parties to help shape an energy efficiency program that is set up for success and appropriately balances flexibility in program design and consistency in program requirements and processes. We thank you for your consideration of these comments, and the Company welcomes the opportunity to provide further input on this subject in the future.

Respectfully submitted,

Andrew J. McNally

Andrew J. McNally

October 2019

Dear Members of the Board,

My name is John Gilson. I am Assistant Vice President of Operations for CarePoint Health. We operate three hospitals in Hudson County – all critically dependent on safe and reliable electric and gas to maintain operations. I am writing to you today to share with you why I agree with the proposed Energy Plan and why the utilities are positioned to lead the implementation to a cleaner and more energy efficient future, specifically as they have eliminated key barriers for us and enabled an increase in successful operations.

As you may be aware, hospitals are considered a large user of both electric and natural gas. Because of the need for a reliable source of our energy, the infrastructure of our power systems within our hospitals must always stay updated and as energy efficient as possible. We are always investigating ways to reduce our energy consumption and appropriate cost-saving measures. These measures allow us to maintain efficient operation and ensure the focus remains on quality patient care.

Through previous programs offered by PSE&G we have been involved in energy saving projects at two of our hospitals. These programs have been very successful and considerably reduced our energy "footprint." I believe the previous programs were a natural partnership between hospitals and the utility company and because of my experience working with PSE&G to help our hospitals become more energy efficient I am confident in the utility role in managing energy efficiency programs. The participants of programs during previous energy efficiency programs are still saving dollars across the state, including our hospital allowing us to invest that much needed capital where it was needed the most – patient care.

Our participation in utility efficiency programs helped us install an energy efficient boiler, change motors and lighting throughout the facility and install a building management system for the HVAC system that serves the entire hospital. These projects were run efficiently and managed carefully by our utility, and the upgrades would not have been possible at the time if it were not for the energy efficiency program.

Based on our previous experience with energy efficiency, the reduction in market barriers as a result of the utility managed programs, and ongoing desire to be increasingly efficient- I, on behalf of CarePoint Health, fully support the proposed Energy Master Plan proposal and encourage the board to implement immediately with the utility as the shepherd to oversee and manage the roll out of these programs.

Thank you for your time and consideration,

John Gilson
AVP Operations
CarePoint Health
10 Exchange Place
Jersey City, NJ 07302
973-296-5089

BEFORE THE STATE OF NEW HAMPSHIRE
PUBLIC UTILITIES COMMISSION

Docket No. DE 17-189

Liberty Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities
Request for Approval of Battery Storage Pilot

DIRECT TESTIMONY

OF

JUSTIN R. BARNES

May 2, 2018

Table of Contents

Attachments

I. INTRODUCTION AND QUALIFICATIONS

Q. Please state your full name, business address, and position.

A. My name is Justin Robert Barnes and my business address is 401 Harrison Oaks Blvd., Suite 100, Cary, North Carolina, 27513. My current position is Director of Research with EQ Research LLC ("EQ Research").

Q. Please describe your educational and occupational background.

A. I obtained a Bachelor of Science in Geography from the University of Oklahoma in Norman in 2003 and a Master of Science in Environmental Policy from Michigan Technological University in 2006. Beginning in 2007 I was employed at the North Carolina Solar Center at N.C. State University ("NCSU"). I worked at NCSU through mid-2013, during which time I worked primarily on the *Database of State Incentives for Renewables and Efficiency ("DSIRE")* project and the U.S. Department of Energy ("DOE") Solar America Communities project.[1] I began at EQ Research as a Senior Policy Analyst in 2013 and became the Director of Research in 2016.

In my current position I coordinate EQ Research's various research projects for clients, provide subject matter oversight of EQ Research's electric industry regulatory and general rate case tracking services, and perform customized research and analysis as necessary to fulfill client requests. Most of my work focuses on the customer-sited solar and energy storage sector and how the

[1] The North Carolina Solar Center has since been renamed the North Carolina Clean Energy Technology Center.

evolving state and federal legislative, regulatory, and ratemaking landscape affects the industry.

I have testified before the Public Service Commission of South Carolina, the Oklahoma Corporation Commission, the Colorado Public Utilities Commission, the Utah Public Service Commission, the Public Utility Commission of Texas, and the North Carolina Utilities Commission as an expert in distributed generation ("DG") policy, rate design, and cost of service. My *curriculum vitae* is attached as Attachment JRB-1.

Q. Have you previously submitted testimony before the New Hampshire Public Utilities Commission ("Commission")?

A. No.

Q. What specific expertise do you have that qualifies you as an expert in this proceeding?

A. I possess a detailed understanding of how regulators in other states have evaluated programs and proposals for utility ownership of customer-sited distributed energy resources ("DERs") and regulators' efforts to realize the benefits of customer-sited energy storage. This includes the benefits and drawbacks of different approaches, how they are weighed, and the overall strategies being employed. I believe that this information can provide valuable insights to the Commission.

Q. On whose behalf are you testifying?

A. I am testifying on behalf of Sunrun Inc. and ReVision Energy, Inc.

Q. What is the purpose of your testimony?

A. The purpose of my testimony is to suggest improvements to Liberty Utilities' ("Liberty or "the Company") proposal for establishing a residential energy storage pilot program (the "Storage Pilot Program"). The modifications I suggest are based on insights that can be gained from experiences in other states, which I place in the context of New Hampshire law governing utility ownership of DERs and the specifics of Liberty's Storage Pilot Program.[2] I also compare Liberty's proposed Storage Pilot Program based on utility-owned assets to an alternative model that allows customers to furnish and control battery storage systems enrolled in the program. My recommendations for an alternative design are intended to make the program:

1. More competitively neutral;
2. More replicable and scalable;
3. More cost-effective; and
4. More transparent and certain from a costs and benefits standpoint.

To be clear, on a conceptual level, I support the underlying objective of the program: using customer-sited DERs as system resources to produce benefits for all ratepayers. In this respect I applaud Liberty's efforts to explore the opportunities that DERs present. While my testimony discusses flaws present in the Company's proposed design and analysis, in my opinion the Company's design *might* still produce net benefits. The alternative design I propose addresses those flaws and uncertainties so as to result in a program that is *more likely* to

[2] As defined in NH Stat. 374-G.

produce *greater benefits*. Furthermore, if customers adopt DERs of their own volition in the future, this alternative design provides avenues for these DERs to be utilized to produce system benefits.

Q. Please summarize your recommendations to the Commission.

A. I recommend that the Commission allow Liberty to establish a Storage Pilot Program, but direct Liberty to modify the program to allow customers to furnish their own equipment under an alternative program design. I describe this alternative design in detail in my testimony and in an appended conceptual program design document (Attachment JRB-2). Should Liberty be permitted to own a portion of the energy storage systems that participate in the program, the amount of utility ownership should be limited to 25% of total program size (if applicable), however that is denominated (e.g., number of customers, energy storage capacity).

As a secondary recommendation, if the Commission elects to approve a Storage Pilot Program based on 100% utility-owned assets, Liberty should be directed to:

1. Reduce the size by at least 75% to make it more consistent with the character of a "pilot" program.
2. Employ a traditional competitive request for proposals ("RFP") process to select one or more providers, of either hardware or service solutions.
3. In parallel, develop an equivalent program of at least three times the size that allows customers to furnish their own device. The parameters for this program should follow my alternative program design.

My primary recommendations are meant to be considered together as a whole. My secondary recommendations could each be adopted independently, but they would most effectively support competitive neutrality, scalability, and cost-effectiveness if they were pursued together.

II. EXPERIENCES FROM OTHER STATES AND THEIR RELEVANCE TO LIBERTY'S ENERGY STORAGE PILOT PROGRAM

Q. Why are experiences in other states relevant to the Commission's consideration of Liberty's Energy Storage Pilot Program?

A. Pilot programs of this type, involving either or both utility-owned customer-sited assets and the tests of how customer-sited energy storage can provide value to participating customers, utilities, and other ratepayers are not uncommon. These programs or policies all have their own unique context, but there are a number of themes that can be distilled from regulatory evaluations and progress to date. While I hesitate to call these themes "best practices", as I explain below there are common elements between these themes and the parameters set for utility DER ownership in New Hampshire.

Q. Has utility ownership of customer-sited DERs, including energy storage, been permitted by regulators in other states?

A. Yes, though typically with limits. Most often regulators have not had any express statutory guidance on the matter so their determinations reflect the merits of a given proposal in the context of larger policy objectives.

Q. What common themes have you identified in state regulatory consideration of utility-owned customer-sited DERs?

A. Regulators have often expressed concerns about the cost-effectiveness of utility-ownership relative to non-utility ownership and potential impacts on the competitive market for the same product or service. Consequently, where approved the programs have been small relative to the overall market, designed to test the utility ownership model with minimal risk, serve a need not met by the competitive market (e.g., services for low-income customers), expand competition through providing more diverse options for customers, and avoid creating a monopoly service where one is not necessary.

Q. Can you provide any examples of regulatory decisions illustrating the characteristics you describe above?

A. Yes. To date, programs established by Arizona Public Service ("APS") and Tucson Electric Power ("TEP") are the most prominent examples of utility-owned residential DERs. In 2014, APS was authorized to establish a 10 MW, $28.5 million residential solar program[3] and TEP was permitted to establish a 3.5 MW, 600 customer, $10 million residential solar program.[4] In both instances, the Arizona Corporation Commission ("ACC") discussed the characteristics I describe above. For instance, for both programs, the ACC noted that its decisions were not a determination of prudency or cost recovery. Furthermore, in the TEP

[3] ACC. Docket No. E-01345A-14-0250. Decision No. 74878. December 23, 2014. ("APS Decision").
[4] ACC. Docket No. E-01933A-14-0248. Decision No. 74884. December 31, 2014. ("TEP Decision")

case, the ACC reasoned that the program size of 600 customers and $10 million in capital investment was tiny compared to the utility's 400,000 customer base and $2.2 billion rate base.[5] In the APS case, the ACC noted that the pilot would address the needs of underserved customers and required the utility to conduct a competitive RFP for solar providers through an independently monitored process.[6] The ACC later declined to approve a subsequent request from TEP to expand its program to serve an additional 1,000 customers, reasoning that the "inconvenience" of allowing the program to become fully subscribed without a successor was "outweighed by ensuring that nonparticipating ratepayers are not paying more than is necessary for the addition of renewable resources."[7]

Separately, the New York Public Service Commission ("NYPSC") has espoused similar principles in defining the conditions for utility ownership of DERs in its Reforming the Energy Vision ("REV") effort. The NYPSC first established that generally "utility ownership of DER will not be allowed unless markets have had an opportunity to provide a service and have failed to do so in a cost-effective manner."[8] It then described exceptions to this general rule as follows:[9]

1. Procurement of DERs has been solicited to meet a system need, and a utility has demonstrated that competitive alternatives proposed by non-utility parties are clearly inadequate or more costly than a traditional utility infrastructure alternative;

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[5] TEP Decision. p. 18.
[6] APS Decision. pp. 5-6.
[7] ACC. Docket No. E-01933A-15-0239. Decision No. 75815. November 21, 2016. p. 34.
[8] NYPSC. Docket No. 14-M-0101. *Order Adopting a Regulatory Policy Framework and Implementation Plan*. February 26, 2015. p. 70.
[9] Id.

2. A project consists of energy storage integrated into distribution system architecture [referring to systems on utility property];
3. A project will enable low- or moderate-income residential customers to benefit from DERs where markets are not likely to satisfy the need; or
4. A project is being sponsored for demonstration purposes.

Of significance with respect to exception (4) is that the NYPSC observed "partnerships with utilities and third parties can accelerate market understanding and the development of sustainable business models."[10] In other words, demonstration projects are intended to support the scaling of DERs through early stage utility and third-party partnerships. Demonstration projects in aggregate are limited to the greater of 0.5% of a utility's revenue requirement or $10 million.[11]

Q. Is it common for utility ownership of DERs to extend to non-wires alternative ("NWA") projects?

A. No. The general idea behind NWA projects is that DERs may be a more cost-effective solution than traditional utility investments to meet some system needs. It follows from this premise that in some cases more cost-effective competitive solutions are possible for needs that have traditionally been met by monopoly providers. Implicit within the NWA construct is that utilities and non-utilities are *competing*, within their respective areas of core competency (i.e., DERs or distribution investments), to provide the most cost-effective solution.

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[10] Id.
[11] Id. p. 116.

Competitive NWA solicitations are the vehicle by which this competition to provide the most cost-effective solution is realized. While some utility solutions may not be wires-based (e.g., a battery at a substation), the NWA concept is not defined by the resource inasmuch as it is defined by the introduction of competition into the process. Substituting one utility investment for another as a "NWA" without consideration of competing solutions, including consideration of the core competencies of providers offering solutions is inconsistent with the purpose of NWAs.

Q. What common themes have you identified in state regulatory consideration of energy storage deployment programs or policies?

A. There is a general recognition that maximizing the benefits energy storage can provide requires the "stacking" of value streams at the customer, distribution, and bulk system or wholesale level. This requires coordination of the operation and control of storage devices so that they can be used to provide multiple services (i.e., "multi-use applications" or "MUAs") without creating conflicts between the provision of one service and another. Customer-sited energy storage is considered to have the most *potential* value because it allows benefits to be created within all three domains.

There is also a general objective of developing participation models that unlock access to private capital. There are at least two virtues to supporting private investment. First, enabling private investment allows energy storage or DER deployment to be scaled, since private capital offers an essentially unlimited well to draw from. Second, private investment under models where revenues are based on performance insulates ratepayers from risk. In practice, this involves demonstrating and validating performance from both a technical and economic (i.e., revenue) perspective. Both elements are critical for creating investor confidence.

It is also worth noting that there is frequently a more holistic focus on the services that can be provided by DERs more generally, as opposed to confining efforts to energy storage specifically. That is, in the same way that a group of DERs located at different customer sites can complement one another to form a larger aggregate resource, at the individual customer level multiple DERs can complement each other as well.

Q. Can you cite any examples of these characteristics?

A. Yes. As I've described above, New York's designation of demonstration projects is oriented in this fashion. Utilities in New York have proposed several projects along these lines. For instance, Consolidated Edison ("ConEd") in New York has pursued several storage demonstration projects intended to test different deployment models and use cases, all of which target wholesale market integration and test benefits sharing mechanisms. Among these are a residential behind-the-meter ("BTM") solar-paired storage "virtual power plant",[12] a mobile

[12] NYPSC. Docket No. 14-M-0101. ConEd Clean Virtual Power Plant REV Demonstration Project. July 1, 2015, Approved via an August 3, 2015 PSC Letter.

grid-scale storage model referred to as "Storage on Demand"[13], and a commercial in-front-of-the-meter project utilizing a site leasing model.[14]

California has also been in the forefront on efforts of this type. For instance, in January 2018 the California Public Utilities Commission adopted a Decision establishing a rule-based framework for energy storage MUAs.[15] Likewise, Hawaii is in the initial stages of developing an aggregator-based demand response ("DR") model for DERs to provide capacity (via time of use rates), fast frequency response, and reserves through a standardized tariff-based regime. The initial demonstration version of this effort was authorized in January 2018.[16]

Q. Are efforts to support the concept of "value-stacking" present outside of the specific examples you describe above?

A. Yes. At the state level there are numerous other efforts that have not yet reached the stage of defining rules or implementing formal programs. Those include more narrow demonstration projects, such as a locally targeted DER deployment program in Connecticut. In this program, United Illuminating ("UI") will employ a targeted marketing campaign in partnership with the Connecticut Green Bank to reduce substation loading through the installation of storage-ready solar systems at customer residences. Participants would receive an incentive of $0.05/kWh for

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[13] NYPSC. Docket No. 14-M-0101. Coned Storage on Demand REV Demonstration Project. February 27, 2017. Approved via a May 18, 2017 PSC Notice.
[14] NYPSC. Docket No. 14-M-0101. Coned Commercial Energy Storage REV Demonstration Project. January 20, 2017. Approved via a May 18, 2017 PSC Notice.
[15] California Public Utilities Commission. Docket No. 15-03-011. D.18-01-003. January 17, 2018.
[16] Hawaii Public Utilities Commission. Docket No. 2015-0412. Order No. 35238. January 25, 2018.

metered generation during summer peak hours for seven years.[17] Other states, including but not limited to Massachusetts, Maryland, the District of Columbia, and Rhode Island, are pursuing broad "grid transformation" where energy storage and DER enablement are prominent among the many objectives.

Apart from this, the Federal Energy Regulatory Commission ("FERC") has recently addressed the concept of value-stacking in Order No. 841 directing regional transmission organizations ("RTOs") and independent systems operators ("ISOs") to adopt market reforms that facilitate energy storage participation in bulk power markets. The FERC is also in the process of developing further rules encompassing DER integration and DER aggregations in RTO and ISO wholesale markets.[18] Efforts on the part of individual RTOs and ISOs are likewise underway, such as the California Independent System Operator's long-running Energy Storage and Distributed Energy Resources initiative,[19] the PJM's DER Subcommittee,[20] and the New York Independent System Operator's DER Roadmap initiative.[21]

Q. Are these themes consistent with New Hampshire law governing utility ownership of DERs?

A. I believe they are. Section 374-G:1 of the New Hampshire statutes defines the objective of utility investment in DERs as follows:

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[17] Connecticut Public Utility Regulatory Authority. Docket No. 17-06-03. Decision dated January 24, 2018.
[18] FERC. Docket No. RM18-9.
[19] This initiative is now in its 3rd phase. See: http://www.caiso.com/informed/Pages/StakeholderProcesses/EnergyStorage_DistributedEnergyResources.aspx.
[20] A successor to prior special meetings that began in 2016. See: http://www.pjm.com/committees-and-groups/subcommittees/ders.aspx.
[21] See: http://www.nyiso.com/public/markets_operations/market_data/demand_response/index.jsp.

> Distributed energy resources can increase overall energy efficiency and provide energy security and diversity by eliminating, displacing, or better managing traditional fossil fuel energy deliveries from the centralized bulk power grid, in keeping with the objectives of RSA 362-F:1. It is therefore in the public interest to *stimulate investment in distributed energy resources in New Hampshire in diverse ways*, including by encouraging New Hampshire electric public utilities to invest in renewable and clean distributed energy resources *at the lowest reasonable cost to taxpayers* benefiting the transmission and distribution system under state regulatory oversight. [Emphasis added]

Section 374-G:5(II) elaborates on how the Commission should evaluate utility applications, directing the Commission to, among other things, consider and weigh:

1. "The effect on competition within the region's electricity markets and the state's energy services market." (Subsection f)
2. The costs and benefits to the utility's customers, including but not limited to a demonstration that the company has exercised competitive processes to reasonably minimize costs of the project to ratepayers and to maximize private investment in the project." (Subsection g)

Thus, as in other states, utility ownership of DERs is permitted in New Hampshire, but with an express "lowest reasonable cost" qualifier, and with an express objective of stimulating investments "in diverse ways". Furthermore, as in other states, in New Hampshire the Commission is expected to exercise its judgment on whether a project is in the public interest, including consideration of the effects it would have on competition, overall costs and benefits, and the extent to which private investment is maximized. All of these characteristics are similar to those present in other states. The chief differences are that in New Hampshire the question of whether utility ownership of customer-sited DERs is permitted is moot, and direct statutory guidance exists with respect to the evaluation parameters. Those parameters though, are not dissimilar from what other regulators have arrived at independently in their own evaluations.

Q. What do you conclude from your evaluation of New Hampshire law and regulatory proceedings involving similar proposals in other states?

A. The characteristics of evaluations and experiences in other states have value in the context of Liberty's application. The primary foci in those states have been:

1. Preserving and/or enhancing competition and the options available to customers.
2. Validating models that enable greater storage and/or DER deployment through the mobilization of private capital.

These themes are consistent with provisions of New Hampshire law emphasizing an objective of supporting DER investments "in diverse ways", maximizing private investment, and consideration of the effects that utility-owned DER applications would have on competition in the state's energy service market.

III. LIBERTY'S APPLICATION AND ANALYSIS

Q. Please briefly summarize Liberty's proposed Storage Pilot Program.

A. Liberty proposes to install 5 megawatts ("MW") of BTM energy storage systems in the homes of up to 1,000 residential customers.[22] The battery storage systems

[22] The total number of customers may be less than this if participants elect to install multiple batteries.

are to be owned by the Company and included in its rate base. Participating customers will make an up-front payment of $1,000 or monthly payments of $10 for 10 years, and in return will be permitted to use the battery for back-up generation and time-of-use ("TOU") rate management under a new rate option available exclusively to pilot customers. Liberty will control the charge and discharge of the batteries generally, and dispatch them during expected peak periods to reduce ISO-NE transmission charges.

The program is effectively broken into two tranches. The first tranche targets the installation of roughly 300 batteries to support an NWA pilot in a local area. This tranche limits participation to customers served by the specific circuits that are part of the NWA pilot. The second tranche comprises the remaining 700 batteries and would be open to residential customers throughout the Company's service territory.

Q. Did the Company consider other arrangements beyond full utility ownership and control of the participating systems?

A. No.[23]

Q. What objectives does the Company identify for the Storage Pilot Program?

A. Company Witness Tebbetts lists the following questions that the program seeks to answer:[24]

- What are the behavioral changes of customers taking service under the TOU

[23] Attachment JRB-4, Liberty response to Office of the Consumer Advocate ("OCA") Data Requests, Set 1, IR 1-37; Attachment JRB-5, Liberty response to Sunrun Technical Session Data Requests, Set 1, IR 1-5.
[24] Supplemental Direct Testimony of Heather Tebbetts ("Tebbetts Supplemental Direct"). p. 14.

pricing?

- What types of behaviors changed, such as doing chores later in the day or weekend that require the use of the batteries to avoid utilizing power from the grid?
- If the customer's behavior did not change, why not?

- How accurate were the predicted peaks from ISO-NE versus actual peak periods?
- How are the batteries affecting the distribution system, either positively or negatively?
- Has customer satisfaction with reliability increased?
- Do the benefits of battery installations at customer locations with on-site generation differ from those without on-site generation? If so, in what ways?

Q. Has the Company performed a cost-benefit analysis of the program, and if so, what are the results?

A. The Company has produced three different cost-benefit analyses. Initially, Liberty filed a cost-benefit evaluation showing a potential monetary savings to ratepayers of roughly $1.8 million over 15 years, and a net present value ("NPV") of $65,000.[25] However, the Company later submitted a revised analysis, among other things incorporating a degradation factor for the batteries, showing monetary savings of only roughly $254,000 and an NPV of roughly ($1.1 million). The

[25] Tebbetts Supplemental Direct. Attachment A, p. 2

circuit upgrade associated with the NWA project shows an NPV of roughly ($620,000) in the revised analysis. [26]

Subsequent to the issuance of the revised cost-benefit analysis, Liberty provided a further revision incorporating its assessment of the program under a Total Resource Cost ("TRC") cost-effectiveness protocol. Most significantly, this version incorporated two additional benefit categories, avoided capacity costs and participant customer savings, producing an NPV of $2.96 million.[27]

Q. Are you confident that the Company's cost-benefit analysis is accurate?

A. No. I have identified several flaws that cause me to question both the results of the analysis and the level of rigor applied by Liberty in performing it. The specific problems that I have identified are as follows:

1. It is inappropriate to count customer bill savings as a system benefit in the TRC, and in fact, some portion of the customer savings benefits may be more properly classified as costs.
2. The Company made numerous errors in its estimates of customer bill savings, which lead to a dramatic overstatement of participant customer benefits.
3. The Company's inclusion of the benefits of avoided capacity costs is premature, since it has not articulated how those potential benefits will be realized.

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[26] Tebbetts Supplemental Direct. Revised Attachment A, p. 2
[27] Attachment JRB-6, Liberty response to Staff Technical Session Data Requests, Set 3, IR 3-1.1, Tab "TRC Model 2."

Q. Why is it inappropriate to count participant bill savings as a TRC benefit category?

A. Participant bill savings are simply not a component of the TRC in common practice.[28] The TRC assesses savings for *all customers* (i.e., participants and non-participants) so counting participant savings as a separate category would double count benefits. In other words, the TRC represents a combination of the Participant Cost Test assessing benefits for participants, and the Ratepayer Impact Measure Test assessing a program from the perspective of non-participants.

Q. What errors have you identified in Liberty's estimates of participant bill savings?

A. The Company's analysis presents a comparison between a customer on the standard residential rate (Rate D) and that same customer with an energy storage system that charges during off-peak hours and discharges during critical peak hours under its proposed TOU rate. The results of the calculations are monthly bill estimates under both scenarios. The difference between the two monthly bills is customer bill savings after the monthly battery cost is subtracted. I have identified the following errors in the Company's estimates:

1. The derivation of non-battery customer bills includes energy to charge the battery. The total monthly use calculations for battery customers (except for the low use group, where the mistake is symmetrical) are adjusted to

[28] See, e.g.: Regulatory Assistance Project. *Energy Efficiency Cost-Effectiveness Screening: How to Properly Account for 'Other Program Impacts' and Environmental Compliance Costs*. November 2012. Available at: http://www.synapse-energy.com/sites/default/files/SynapseReport.2012-11.RAP_.EE-Cost-Effectiveness-Screening.12-014.pdf.

subtract charging energy, since it nets to zero (apart from efficiency losses) when discharge energy reduces critical peak use. This mistake makes the total monthly use underlying the calculations for non-battery customer higher than for battery customers, inflating the monthly bill estimate and the savings estimate.

2. Liberty failed to model weekend and holiday days as fully off-peak days. In total, weekends and holidays amount to 114 days per year during which critical peak savings cannot be achieved because all hours are off-peak.
3. The Company misplaced a decimal point in the Stranded Cost portion of the non-battery customer bill estimate, increasing it from the correct rate of 0.049 cents/kWh to 0.49 cents/kWh. The correct (lower) number was used for the battery customer, inflating the savings estimates by making the non-battery customer's bill higher than it should be.
4. A similar error was made in the System Benefits Charge component, listing it as 0.354 cents/kWh for the battery customer (an incorrect rate under the current tariff) and using the correct rate of 0.457 cents/kWh for the non-battery customer. This also increases the non-battery customer's bill beyond what it should actually be.
5. The Company failed to incorporate efficiency losses resulting from charge and discharge of the battery.

Q. How does this affect participant bill savings?

A. My estimates of customer savings after correcting for these errors show dramatically lower savings, as illustrated in Table 1 below depicting net monthly savings under a one battery per customer scenario. Liberty's estimates are provided in the top row followed by the results of my own calculations.

Table 1: Comparison of Participant Savings Estimates

Savings Estimates	Customer Group			
	Low (1)	Med-Low (2)	Med-High (3)	High (4)
Net Monthly Savings (Liberty)	$3.13	$31.20	$59.72	$109.75
TOU-Only Savings	$2.20	$6.47	$12.84	$23.92
Battery Savings	$6.64	$14.67	$23.25	$39.32
Battery Cost	$10.00	$10.00	$10.00	$10.00
Total Net Monthly Savings	($1.17)	$11.14	$26.09	$53.24
Total Net Battery Savings	($3.36)	$4.67	$13.25	$29.32
Difference in Total Net Savings From Liberty Estimate	($4.30)	($20.06)	($33.63)	($56.51)

Q. Please explain the distinction you have made between TOU-only savings and battery savings.

A. Based on the Company's load research data, Liberty's TOU rate will produce bill savings for all customer groups without the use of a battery and without requiring any change in customer load patterns. I refer to this savings as TOU-only savings, which I arrived at by modeling the customer group profiles against the TOU rate without use of a battery. The battery savings are the savings actually associated with the use of the battery to shift load from critical peak times to off-peak times.

Q. Why does the TOU rate produce bill savings without requiring any load shifting by customers via any means?

A. I believe it stems from the fact that Liberty did not account for weekends and holidays as off-peak periods when developing the rate design.

Q. What portion of customer savings may be more properly classified as a program cost?

A. There are two components. First, since TOU savings accrue without accompanying cost savings, the TOU rate itself represents a subsidy or incentive cost. Second, while the Company has not modeled this aspect, when the Company dispatches the battery to reduce transmission charges, the customer is to be compensated for any exports that occur.[29] That compensation could be considered a program cost of achieving the transmission cost savings. Over the life of the program it could easily amount to several hundred thousand dollars. Total battery savings themselves might be considered a program cost since the TOU rate functions as an incentive for load shifting. That cost would be balanced by the avoided cost benefits of that load shifting in the TRC protocol.

Q. Please explain why you characterize the Company's inclusion of avoided capacity costs as a program benefit as "premature".

A. In contrast to energy efficiency measures that produce capacity savings via automatic load reductions, energy storage systems must be dispatched specifically to avoid capacity costs in order to produce capacity cost savings. Certainly, customer use of the battery during critical peak periods and utility dispatch plans could produce capacity savings, but it remains to be seen how much savings would accrue. Liberty assumes that the full battery capacity is used to produce capacity savings, but does not indicate that the batteries will be dispatched for this purpose, or the mechanics of how savings will be realized via ISO-NE capacity

[29] Tebbetts Direct. p. 17, lines 11-15.

charge settlement processes. In other words, capacity cost savings are achievable with battery storage, but it cannot just be assumed that they will be generated, much less in a certain amount, without direct attention and planning. This objective could be integrated into the program, or realized outside of the program by third parties, provided those third-parties can own and operate the batteries.

Q. Given the results of the updated cost-benefit analysis, how does the Company justify continuing to pursue the program?

A. At the time the first revised cost-benefit analysis showing a negative NPV was served, Company Witness Tebbetts stated "The pilot, while showing a lower net present value than the upgrade alone, will provide qualitative and quantitative benefits to customers with reduction [sic] to transmission costs and the ability to retrieve data to inform future decisions for grid modernization and possibly net metering tariffs."[30]

Q. What are your conclusions about the reliability of the Company's cost-benefit analyses?

A. I cannot consider them to be reliable given the number of materially significant errors, uncertainties, and inconsistencies I have discovered. This is not to say that a residential energy storage program targeting similar objectives is incapable of producing net benefits, or even that Liberty's design would not produce net benefits. However, as I describe later in my testimony, the alternative program design I propose offers a higher degree of certainty of achieving net benefits.

[30] Tebbetts Technical Statement accompanying Revised Attachment A. April 6, 2018. p. 3

IV. FLAWS IN LIBERTY'S STORAGE PILOT PROGRAM DESIGN

Q. Please summarize your concerns with the design of the Storage Pilot Program.

A. I have two major criticisms. First, the program is not designed to identify or test the effectiveness of different potential solutions to the objectives of reducing transmission costs and deferring distribution investments. Rather than attempting to identify optimal or lower cost solutions, Liberty simply selected the "solution" (i.e., utility-ownership and control) that is the most financially beneficial to itself. This type of approach flies in the face of an evolving electricity system landscape that views consumers as a resource and potential solution to system needs. In other words, it simply perpetuates and reinforces the business-as-usual model of utility command and control rather than customer empowerment.

Furthermore, the program would prevent, or at a minimum delay for years to come, the development of a competitive residential energy storage market in Liberty's service territory and the customer empowerment that would stem from that. For any customer interested in energy storage, participating in Liberty's program would be the most viable option. There are several factors that contribute to this outcome, as follows:

1. At present, the competitive market for residential energy storage is nascent in New Hampshire and the proposed Pilot program is extraordinarily large relative to the Company's residential customer base.

2. The Company's TOU rate offer as part of this program is designed in a way that makes it more attractive to prospective energy storage customers than the only other TOU rate option available to other customers.
3. The design is highly rigid and narrow, resting on full utility control of the energy storage systems and a limited scope of services, as opposed to creating a platform suitable for the competitive provision of those same or future, additional, services.

Another important consideration is that Liberty's program design conflates many different demonstration elements, adding complexity that may not be necessary to demonstrate customer value and net benefits from residential storage. A TOU rate could be utilized effectively to incentivize daily load shifting when the battery is not dispatched for peak shaving. However, this might best be added as an element to further enhance a fundamentally sound program rather than an integral part of the program itself.

Q. Please explain why the current state of New Hampshire's market for energy storage is important when considering how Liberty's proposed program would affect the development of a competitive market.

A. Consumer adoption of DERs tends to be a gradual process that begins slowly and accelerates over time. In the early stages of a DER market there are a relatively small number of potential customers that may be actively interested in installing DERs for a variety of reasons, such as unfamiliarity with the technology or underwhelming economics. Those who do invest under these circumstances are often referred to as "early adopters". They serve as the foundation for service providers to grow their businesses over time. Without access to these customers, competing providers will be unable to gain a foothold and a competitive market will not emerge.

Q. How does the size of Liberty's Energy Storage Pilot frustrate the development of a competitive market for residential energy storage?

A. Liberty proposes a program that could enroll up to 1,000 residential customers. This represents roughly 2.8% of the total number of residential customers in its service territory. By comparison, as of January 2018 Liberty had only 396 residential solar net metering customers in total, and from January 2017 to January 2018 this number increased by only 57 customers. The utility did not report having any customers with on-site energy storage. Furthermore, the scale of Liberty's program exceeds reported numbers of residential energy storage deployment even in the service territories of much larger utilities in more advanced DER markets, such as Pacific Gas and Electric (640 residential storage customers) and Southern California Edison (703 residential storage customers).[31]

Based on these statistics, it is clear that Liberty's program would almost certainly dominate the residential energy storage market for years to come, preventing other providers from being able to sell and finance residential energy storage.

[31] EIA Form 861M. https://www.eia.gov/electricity/data/eia861m/.

Q. How does Liberty's Program compare to existing utility-owned DER programs?

A. In terms of absolute size it is comparable to the largest programs approved to date, such as those established in Arizona, but an absolute size comparison disguises the potential effects on competition. For instance, the TEP residential solar program (600 customers) equates to only 0.16% of that utility's residential customers. Moreover, it was established at a time when a competitive residential rooftop solar market had already developed, as at the time it was approved TEP already had more than 9,000 residential solar customers.[32] In fact, in discussing the program, ACC staff noted that competitive effects would likely be minimal noting that the utility had recently received more than 500 new solar interconnection requests during a single month.[33] APS's residential solar program (10 MW) is of a similar scale relative to the competitive market since APS has roughly three times as many residential customers as TEP.

Similarly, Liberty refers repeatedly to a similar Green Mountain Power ("GMP") program as a model for its own program. While GMP's program is sized at 10 MW according to Liberty, GMP has roughly 221,000 residential customers.[34] Thus when scaled based on the total number of residential customers, Liberty's program is three times the size of GMP's. Moreover, GMP has recently petitioned

[32] EIA Form 861. Net Metering (2015). https://www.eia.gov/electricity/data/eia861/.
[33] TEP Decision. p. 8.
[34] EIA Form 861M. https://www.eia.gov/electricity/data/eia861m/.

the Vermont Public Service Board ("VTPSB") for permission to establish a Bring Your Own Device ("BYOD") pilot program that allows non-utility ownership.[35]

Thus Liberty's "pilot" is far larger than other utility-owned DER programs on a general per customer basis, as well as in relation to the size of existing competitive market. It resembles a major capital investment project rather than a "pilot".

Q. How did Liberty arrive that the 5 MW/1,000 battery size for its proposed program?

A. The Company states that 1.5 MW is necessary to meet the need identified for the NWA project, and the incremental 3.5 MW was added to allow customers outside of the NWA area to participate. It further stated that a total of 5 MW would be large enough to provide a "noticeable monetary savings in transmission costs."[36]

Q. Is this justification sufficient to outweigh the detrimental competitive market impacts you have previously described?

A. No. First, the use of utility-owned assets for an NWA project runs contrary to the idea of NWAs in the first place. Typically, an NWA project is a vehicle for cost-effective competitive DER solutions to supplant the need for utility investment, not a means for utilities to simply substitute one type of investment for another without considering alternatives that may be more cost-effective. Second, the scale of monetary savings is irrelevant unless the program size has been optimized

[35] Attachment JRB-3, GMP Letter to the Vermont Public Service Board, "Green Mountain Power – Bring Your Own Device "BYOD" Innovative Pilot" dated February 23, 2018.
[36] Attachment JRB-7, Liberty Responses to Staff Data Requests, Set 1, IR 1-1.

to maximize those savings. In this case, Liberty's transmission cost savings estimates have a 1:1 relationship to the amount of capacity deployed so a larger program is no more cost-effective than a smaller one.

Q. Please explain how Liberty's TOU rate proposal creates inequities between utility-owned and non-utility owned residential storage.

A. The proposed pilot TOU rate has a rate spread totaling roughly 19 cents/kWh between the off-peak rate and critical peak rate. That rate spread is one measure of the customer benefits of load shifting using a storage device (i.e., charging off-peak and discharging on-peak). By comparison, Schedule D-10, the only other available residential TOU rate, has a total rate spread of roughly 10.3 cents/kWh. The disparity in potential load-shifting benefits would steer prospective residential storage customers towards the Company's program, and away from any offers from competing service providers. In other words, it grants Liberty a monopoly on the storage value proposition for customers since a customer can only achieve this enhanced value by contracting with the Company. It is anti-competitive on the most fundamental level.

Moreover, it is inequitable since customers that do not do business with Liberty (i.e., non-storage customers) would not have access to the rate, which as I have shown previously, appears to be less costly generally for participating customers.

Q. Please elaborate on what you consider to be unnecessarily rigid about the Storage Pilot Program and how that relates to establishing a viable competitive energy storage market.

A. As I have previously discussed, value-stacking and private investment are critical for scaling energy storage deployment. This demands the development of a flexible, solutions- and service-based framework where any party can receive compensation for the services they provide. Those services could include energy arbitrage via TOU-based energy rates offered by competitive retailers, and direct participation in the ISO-NE Forward Capacity Market ("FCM") or ancillary services markets. The rigid charge-discharge framework and full utility control of the battery would prevent value-stacking since it does not allow providers to adjust cycling to meet the requirements associated with providing these other services. Furthermore, Liberty intends to rely exclusively on Tesla's proprietary GridLogic software and battery platform. This reliance calls into question how other DERs that can provide the same service(s) could be integrated into Liberty's system now or in the future.

As proposed, the Storage Pilot Program *limits* the potential value that can be extracted from energy storage resources, rather than creating a foundation that can be built upon. At best, this is short-sighted. The alternative program design I propose solves for these issues by requiring allowing non-utility ownership and control, subject to performance requirements for the service being provided (i.e., transmission cost savings). All other value-stacking opportunities would remain available to the extent that providing them does not conflict with these performance requirements.

Q. Do the Company's stated objectives for the program require it to use utility-owned assets?

A. No. In fact, in my opinion several of the stated objectives make little sense as justification for the program.

Q. Please elaborate on which of the Company's stated objectives "make little sense" and why this is the case.

A. My criticisms fall within two areas, whether the program is necessary to meet an objective, and whether the testing would produce useful results, as follows:

<u>Validating Peak Forecasts</u>: Liberty could validate its ability predict system peaks without the program at all. For that purpose, the Company might test its algorithm against data from past years, or attempt to do so on a forward-looking basis.

<u>Studying Consumer TOU Responses</u>: The study of customer behavioral responses to TOU rate designs does not require a customer to have on-site battery storage, utility-owned or otherwise. Furthermore, any conclusions that could be reached would likely be highly unreliable because most customers will not have on-site energy storage in the near future. It does not require a great leap in logic to expect that customers with on-site storage may rely on it for load-shifting purposes, rather than make the

behavioral changes that other customers would need to make. This is especially likely because Liberty's load research data shows that a single battery system is more than sufficient to offset average critical peak period energy use for all but the highest use customers.[37] In any case, a pilot TOU rate and/or comparison to customer behavior under the Company's existing D-10 rate would be sufficient for this purpose.

Studying Distribution Impacts: The value of this study would be diminished by the rigid, narrow program design. It would fail to capture how storage would be operated in a regime where operators seek to optimize dispatch to access different parts of the value stack, and would therefore fail to accurately represent how energy storage systems are expected to be operated in the future.

Q. How would you modify the design of the Storage Pilot Program and the objectives to make it a more valuable test bed?

A. Liberty's proposed program has an NWA tranche and general market tranche. Both tranches should be modified to make them solution-oriented, performance-based, and competitive. In other words, the utility should define the objective and then seek the most appropriate tool or tools for meeting that objective. Those needs can be distribution system support, wholesale market charge reduction, or both. The key is that the need drives the solution and not the other way around.

[37] Attachment JRB-8, Liberty response to Staff Technical Session Data Requests, Set 3, IR 3-1.1, Tab "Customer Bill Calc Backup TRC 2" (listing hourly average demands for customer groups).

I will describe the specifics of an alternative model that permits non-utility owned storage to be enrolled in the following section. With respect to objectives, I recommend that if the Commission permits any utility ownership of storage assets, one of the chief objectives should be to develop data on how utility ownership compares to non-utility ownership. That could include measurements of relative cost-effectiveness, operational performance, and customer satisfaction. With the exception of customer behavioral responses to the TOU rate, which would require significant modification in order to return useful data, all of the Company's testing objectives could be pursued in this fashion. However, the results would be far more robust and valuable to both Liberty and the Commission under a comparative framework.

V. ALTERNATIVE PROGRAM DESIGN MODEL

Q. Please summarize the principal characteristics of an alternative design for the Storage Pilot Program.

A. My proposed design is based in part on GMP's recent BYOD program proposal. However, it has elements similar to some other programs that utilize an aggregator type structure with long-term pay for performance contracts, such the numerous NWA solicitations that have been issued in New York. The alternative program would have the characteristics listed below, and Attachment JRB-2 contains a concept program design.

1. Participants are permitted to use non-utility owned energy storage assets to participate in the program, access value on the same terms as utility-

owned assets, and be eligible for the same customer tariffs (such as TOU) offered to customers with utility-owned assets.

2. Direct control of the DER remains with the system owner or another party they designate for this purpose, such as an aggregator entity.
3. Customers with solar-paired energy storage are able to participate without limits or any additional conditions beyond those that would otherwise apply.
4. Payments for program participation may be distributed directly to an aggregator entity, either at the election of an individual participating customer or through a direct services agreement between the utility and the aggregator (e.g., for a specific amount of capacity).
5. Payment rates are established under a standardized minimum fixed rate system for the duration of participation, subject to performance rules consistent with the use case, punitive measures for non-performance, and potential enhanced payments for performance.
6. Program benefits and risks are shared in a systematic, equitable manner between participants and non-participants.
7. Any utility-owned storage assets are limited to no more than 25% of the total size of the program (if applicable), however that is denominated (e.g., number of customers, total capacity).
8. Customers may opt-out of the program at any time via coordination with any aggregator that they have designated as the system operator.

Q. Why did you choose the GMP BYOD program as a base model?

A. The BYOD model and its predecessors are among the most innovative, flexible, and forward-thinking DER utilization programs that I am aware of. The BYOD version in particular is well-suited for supporting the growth of a competitive energy storage market while balancing the risks and benefits to participants and non-participants.

Q. Please describe the advantages that your proposed design has over Liberty's Storage Pilot Program proposal.

A. There are several advantages. First, my proposed design is consistent with developing a competitive market for residential energy storage in Liberty's service territory through the creation of a level playing field for all potential providers. Second, the design is flexible enough to allow any operator to pursue additional revenue streams not encumbered by the participation payment, such as those that may be available in the ISO-NE wholesale market. This additional revenue could permit owner-operators to offer more attractive pricing to prospective customers while also providing system-wide benefits. Third, the performance-based design would reduce risks to both participant and non-participant customers. Finally, the design allows for a much clearer and transparent evaluation of program costs and benefits relative to what Liberty has proposed.

Q. Please describe how the payment for performance design would operate.

A. Non-performance that is not remedied within a cure period, such as 30 days, would result in a payment reduction. Procedures for removal from the program could be considered for repeated non-performance. However, since permanent removal from the program could sacrifice years' worth of savings for non-participating ratepayers, removals should be temporary pending the resolution of the source of non-performance. Re-enrollments could allow the available capacity of a participating system to be modified to a new amount if necessary.

Q. How would customers participating through aggregators be affected by non-performance issues?

A. Since customers participating through aggregators would assign the participation payment to the aggregator, the aggregator – not the customer – would be at risk for non-performance.

Q. Should utility-owned assets be subject to the same performance requirements as non-utility assets?

A. Yes. It is important that utility-owned assets be held to the same standard as non-utility assets, subject to punitive measures for non-performance. However, any customer that enrolls using a utility-owned or controlled asset should be held harmless against poor performance. In this way both participants and non-participants would be protected from the impacts of poor performance by utility-owned assets, as they are for non-utility-owned assets.

Q. Would this still retain an incentive for Liberty to support adoption of energy storage systems?

A. Yes. Liberty would capture the same portion of participation payments as an aggregator or independent participant, generating revenue for itself. The playing field would be entirely level and like other storage owners; Liberty would "share" in the cost savings produced by the program. I describe this sharing mechanism later in my testimony.

Q. How would energy storage systems be dispatched?

A. Presumably any utility-owned assets would be directly controlled by Liberty. Other customers would have the option to control the system themselves or designate a third-party to do so, either Liberty or an aggregator. For systems not directly controlled by the utility, the operator would receive a notice in advance of the event that allows sufficient time to fully charge the battery. Given how straightforward Liberty's proposed use cases currently are, this notice could be as simple as coordinated communication directly with aggregators. Alternatively, Liberty could select any number of scalable DER management system ("DERMS") platforms that function as a flexible, long-term provider-agnostic solution, or otherwise use open communication protocols. The program could also employ a multi-level notice system, where a day-ahead preliminary notice informs the operator that an event is likely to be called the following day, which is later confirmed by a final notice. Non-utility operators would then dispatch the system in line with these instructions.

Q. How should the amount of participation payments be determined?

A. At a high level, the payments should be based on net benefits, such as the projected reduction in transmission charges described in the Company's application minus program costs (e.g., metering). When calculating benefits, it may also be appropriate to assume that for various reasons (e.g., forecast error), the storage assets may not be 100% effective at reducing costs. For instance, GMP's initial similar pilot assumed that utility-owned systems would be 75% effective at reducing regional network service ("RNS") charges.[38] The pending BYOD filing assumes that the systems will be effective at reducing 8 out of 12 monthly peaks.[39] The benefits calculation is then translated into a fixed minimum participation payment based on the power made available to the utility.

In order to ensure that non-participating ratepayers experience some of the benefits of the program, a benefits sharing ratio should be established such that a portion of projected benefits are not paid out to participants and are instead retained by other ratepayers. I initially recommend that 90% of the net benefits be distributed to participants in order to create a strong enrollment incentive. If actual cost reduction benefits exceed the amount on which the minimum participation payment is based, those "excess" benefits can be shared between participants, non-participants, and Liberty.

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[38] GMP Innovative Pilot Filing. December 2, 2015. Available at: https://greenmountainpower.com/wp-content/uploads/2017/01/Hudson-12.02.2015-Tesla-Pilot-Filing.pdf
[39] Attachment JRB-3, GMP Letter to the Vermont Public Service Board, "Green Mountain Power – Bring Your Own Device "BYOD" Innovative Pilot" dated February 23, 2018.

Q. It seems like the design you propose is still vulnerable to forecast errors that could lower the effectiveness. How could that issue be mitigated?

A. It is correct that program success will hinge on accurate forecasting and notice. The participation payment structure I have described addresses this concern in part by calculating payments under an assumption of less than 100% effectiveness. That provides a margin for forecast error.

Another part of mitigating this issue is fostering an environment that rewards Liberty for generating accurate forecasts and notices. Liberty should already have an ingrained incentive to do so, but it could be appropriate to provide an additional performance incentive that rewards the Company for excellent forecasting. This could be formulated as a benefits sharing arrangement between Liberty and non-participating customers where Liberty is granted a specified percentage (e.g., 33%) of the actual cost savings above the assumed net benefits amount if it achieves a specified forecast success rate.

For example, assume that the expected effectiveness rate is reductions in 9 of 12 monthly peaks (i.e., 75%) and the expected annual net benefits are $500,000. If Liberty correctly predicts 10 out of 12 monthly peaks and the actual savings are $550,000, Liberty is entitled to 33% of the difference, or $16,500. As I have described above, the remainder is split between participating and non-participating customers in equal shares, effectively splitting the excess equally among all parties.

Q. Why do you recommend a ten-year structure for program payments?

A. Ten years is generally cited as the useful life of lithium-ion based battery storage systems. A fixed or minimum characteristic is necessary to support financing, which is important because battery storage systems have high up-front costs. A fixed rate payment is functionally similar to how costs would be incurred if a system was owned by Liberty and included in its rate base.

Q. Would a minimum rate create risks to non-participating ratepayers, for instance, if transmission cost savings are lower than expected?

A. It would, though the design I propose contains several elements that mitigate non-participant risk. First, an assumption of less than 100% effectiveness and the sharing ratio provides a margin for error in cost projections, creating an insulating effect. This actually makes the risk to non-participants lower than would be the case under Liberty's design since under the Company's revised cost-benefit analysis, monetary savings over 15 years are essentially a breakeven for customers. Non-participant risk would also be lowered further by the pay for performance design I propose, which is not present in Liberty's application. Finally, non-participating customers could also retain a portion of the upside if cost savings turned out to be higher than expected. This is an appropriate balance of risk in my opinion.

Q. How can the BYOD design be more cost-effective than a utility-owned model?

A. Utility-owned assets create a fixed revenue requirement based on the utility's costs of deploying the resources, and in Liberty's proposal there would be no adjustment for performance. The BYOD design creates some "soft" revenue requirement (i.e., contracted payments to customers), but adjusts it downward if systems fail to perform and savings are not achieved. Furthermore, BYOD costs are manageable through the determination of performance payment levels and benefits sharing. Thus, the BYOD model can be designed at the outset to produce a high likelihood of net benefits, in effect ensuring that the resources that are deployed and receive payments are in fact cost-effective.

Q. Why is the BYOD design more transparent than what Liberty has proposed?

A. As I have previously described, Liberty's proposal is a mix of a direct subsidy to participants via the sharing of battery costs and additional compensation through the TOU rate. Some potential program costs, such as the amount of export compensation, are uncertain, while benefits depend on how well the batteries actually perform. Collectively, this makes it challenging to parse program costs, benefits, and risks because components become mixed together in ways that are not easy to separate.

In contrast, the BYOD design clearly segregates the program costs (i.e., compensation for customers or the aggregator) from benefits (i.e., system savings) in a manner that adjusts costs in line with savings (i.e., via pay for performance).

A properly designed TOU rate accompanying the BYOD design could produce additional participant savings aligned with reductions in system costs. In fact, the program design does not necessarily require a customer to take service under a TOU rate, since the benefits are distributed exclusively via participation payments.

Q. Please describe how you arrived at a 25% limitation for utility-owned assets within the program.

A. In most DER markets, a 25% share would represent significant share for a single provider. If the idea is to foster competition and cost-effectiveness, sufficient volume must be available to be spread among multiple competitive providers. On a relative utility size basis, Liberty's share would be roughly equivalent the size of the comparable GMP program the Company cites.

Q. Could your program design support the use of participant systems to produce benefits beyond transmission cost savings?

A. Yes. The design is compatible with other use cases, such as achieving savings on ISO-NE FCM charges. In fact, GMP's battery programs target FCM savings in addition to transmission cost savings. Any services not encumbered by the tariff could be pursued outside of the program at the election of the system owner, generating additional value.

Q. Could your program design also support NWA projects?

A. Yes. There are at least two options for adapting this general design for NWA services. Under one option, similar to Liberty's proposal, installations could be targeted towards a specific identified location at the outset as an open offer.

Participants (or aggregators) located in those local areas would receive an enhanced payment based on the incremental deferral benefits. That incremental amount would align system benefits with customer benefits, and compensate them for the greater restrictions placed on their own use of the battery. This is similar to the pilot recently adopted in Connecticut in UI's service territory that I described previously.

Alternatively, the NWA portion could use a direct solicitation to competitive providers and result in the selection of one or more providers to secure the capacity necessary to serve need. This could result in innovative approaches that Liberty may not have considered. The provider or providers selected would then be responsible for enrolling customers and capacity up to their contracted commitment level within the requisite time frame. This model is typical of how NWA opportunities are addressed in states such as California and New York, where solicitations define system characteristics, needs, and performance requirements in granular detail and leave it up to providers to develop resource portfolios and cost proposals for meeting those needs.[40]

Under either model, the payment would still take the form of a contracted, predictable revenue stream with standards for performance and punitive measures for non-performance.

[40] See, e.g., http://jointutilitiesofny.org/utility-specific-pages/nwa-opportunities/.

Q. Should a similar program be deployed to serve the non-residential sector?

A. I see no reason that a non-residential program could not or should not be developed. I have focused on the residential sector here simply because the Company's proposal is confined to the residential sector. If a similar program was implemented for non-residential customers some changes may be required to address the characteristics of that market. I recommend that a non-residential sector program only be established separate from the residential program to avoid the possibility that larger non-residential storage systems could impact the availability for residential customers.

VI. SUMMARY AND CONCLUSIONS

Q. Please summarize your thoughts on Liberty's proposed Storage Pilot Program.

A. I support the concept embodied in the program: using customer-sited DERs to produce system benefits and savings. As a concept, this objective is both worthwhile and forward-thinking. However, in my opinion the program as proposed suffers from some significant flaws that limit its potential to support the development of a vibrant, competitive energy storage market and reliably deliver energy storage benefits to customers. Central to these flaws are its rigid design and exclusive use of Liberty-owned and controlled storage assets. The program requires modifications in order the make it competitively neutral, scalable and replicable, more cost-effective, and transparent from the standpoint of costs and benefits.

Q. Please summarize your recommendations to the Commission

A. I recommend that the Commission permit Liberty to establish a residential energy storage program, but direct it to modify the program to establish an alternative design that allows customers to furnish and control battery storage systems enrolled in the program. The alternative design I recommend is based on a Bring Your Own Device or BYOD model being pioneered by GMP in Vermont. I also recommend that if Liberty is permitted to own any portion of the energy storage systems that participate in the program, the amount of utility ownership be limited to 25% of total program size (if applicable), however that is denominated (e.g., number of customers, energy storage capacity).

In the alternative, if the Commission elects to approve a Storage Pilot Program based on 100% utility-owned assets, Liberty should be directed to:

1. Reduce the size by at least 75% to make it more consistent with the character of a "pilot" program.
2. Employ a traditional competitive RFP process to select one or more providers.
3. In parallel, develop an equivalent program of at least three times the size that allows customers to furnish their own device. The parameters for this program should follow my alternative program design.

Q. Does this conclude your testimony?

A. Yes.

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Bachelor of Science, Geography, December 2003
Area of concentration in Physical Geography.

RELEVANT EXPERIENCE

Director of Research, July 2015 – present
Senior Analyst & Research Manager, March 2013 – July 2015
EQ Research, LLC and Keyes, Fox & Wiedman, LLP Cary, North Carolina

- Oversee state legislative, regulatory policy, and general rate case tracking service that covers policies such as net metering, interconnection standards, rate design, renewables portfolio standards, state energy planning, state and utility incentives, tax incentives, and permitting.
- Responsible for service design, formulating improvements based on client needs, and ultimate delivery of reports to clients. Expanded service to cover energy storage.
- Oversee and perform policy research and quantitative or qualitative analysis to fulfill client requests, and for internal and published reports, focused primarily on state solar market drivers such as net metering, rate design, incentives, and renewable portfolio standards.
- Provide expert witness testimony on issues related to overall DG policy, rate design, cost of service, and DG costs and benefits.

Senior Policy Analyst, January 2012 – May 2013;
Policy Analyst*,* September 2007 – December 2011
North Carolina Solar Center, N.C. State University Raleigh, North Carolina

- Responsible for researching and maintaining information for the Database of State Incentives for Renewables and Efficiency (DSIRE), the most comprehensive public source of renewables and energy efficiency incentives and policy data in the United States.
- Managed state-level regulatory tracking for private wind and solar companies.
- Coordinated the organization's participation in the SunShot Solar Outreach Partnership, a U.S. Department of Energy project to provide outreach and technical assistance for local governments to develop and transform local solar markets.
- Developed and presented educational workshops, reports, administered grant contracts and associated deliverables, provided support for the SunShot Initiative, and worked with diverse group of project partners on this effort.
- Responsible for maintaining the renewable portfolio standard dataset for the National Renewable Energy Laboratory for use in its electricity modeling and forecasting analysis.
- Authored the *DSIRE RPS Data Updates*, a monthly newsletter providing up-to-date data and historic compliance information on state RPS policies.
- Responded to information requests and provided technical assistance to the general public, government officials, media, and the energy industry on a wide range of subjects, including federal tax incentives, state property taxes, net metering, state renewable portfolios standard policies, and renewable energy credits.

- Extensive experience researching, understanding, and disseminating information on complex issues associated with utility regulation, policy best practices, and emerging issues.

SELECTED ARTICLES and PUBLICATIONS

- EQ Research and Synapse Energy Economics for Delaware Riverkeeper Network. *Envisioning Pennsylvania's Energy Future*. 2016.
- Barnes, J., R. Haynes. *The Great Guessing Game: How Much Net Metering Capacity is Left?*. September 2015. Published by EQ Research, LLC.
- Barnes, J., Kapla, K. *Solar Power Purchase Agreements (PPAs): A Toolkit for Local Governments*. July 2015. For the Interstate Renewable Energy Council, Inc. under the U.S. DOE SunShot Solar Outreach Partnership.
- Barnes, J., C. Barnes. *2013 RPS Legislation: Gauging the Impacts*. December 2013. Article in Solar Today.
- Barnes, J., C. Laurent, J. Uppal, C. Barnes, A. Heinemann. *Property Taxes and Solar PV: Policy, Practices, and Issues*. July 2013. For the U.S. DOE SunShot Solar Outreach Partnership.
- Kooles, K, J. Barnes. *Austin, Texas: What is the Value of Solar; Solar in Small Communities: Gaston County, North Carolina*; and *Solar in Small Communities: Columbia, Missouri*. 2013. Case Studies for the U.S. DOE SunShot Solar Outreach Partnership.
- Barnes, J., C. Barnes. *The Report of My Death Was An Exaggeration: Renewables Portfolio Standards Live On*. 2013. For Keyes, Fox & Wiedman.
- Barnes, J. *Why Tradable SRECs are Ruining Distributed Solar*. 2012. Guest Post in Greentech Media Solar.
- Barnes, J., multiple co-authors. *State Solar Incentives and Policy Trends*. Annually for five years, 2008-2012. For the Interstate Renewable Energy Council, Inc.
- Barnes, J. *Solar for Everyone?* 2012. Article in Solar Power World On-line.
- Barnes, J., L. Varnado. *Why Bother? Capturing the Value of Net Metering in Competitive Choice Markets*. 2011. American Solar Energy Society Conference Proceedings.
- Barnes, J. *SREC Markets: The Murky Side of Solar*. 2011. Article in State and Local Energy Report.
- Barnes, J., L. Varnado. *The Intersection of Net Metering and Retail Choice: an overview of policy, practice, and issues*. 2010. For the Interstate Renewable Energy Council, Inc.

TESTIMONY

- North Carolina Utilities Commission, Docket No. E-7 Sub 1146. January 2018.
- North Carolina Utilities Commission, Docket No. E-2 Sub 1142. October 2017.
- Public Utility Commission of Texas, Control No. 46831. June 2017.
- Utah Public Service Commission, Docket No. 14-035-114. June 2017.
- Colorado Public Utilities Commission, Proceeding No. 16A-0055E. May 2016.
- Public Utility Commission of Texas, Control No. 44941. December 2015.
- Oklahoma Corporation Commission, Cause No. PUD 201500271. November 2015.
- South Carolina Public Service Commission, Docket No. 2015-54-E. May 2015.
- South Carolina Public Service Commission, Docket No. 2015-53-E. April 2015.
- South Carolina Public Service Commission, Docket No. 2015-55-E. April 2015.
- South Carolina Public Service Commission, Docket No. 2014-246-E. December 2014.

AWARDS, HONORS & AFFILIATIONS

- Solar Power World Magazine, Editorial Advisory Board Member (October 2011 – March 2013)
- Michigan Tech Finalist for the Midwest Association of Graduate Schools Distinguished Master's Thesis Awards (2007)
- Sustainable Futures Institute Graduate Scholar Michigan Tech University (2005-2006)

Concept Bring Your Own Device ("BYOD") Program Design

Program Overview

Customers participating in the BYOD Pilot (the "Pilot") will install a compatible battery system. Once installed, they will follow enrollment instructions to enter into the Pilot, individually or through an aggregator. The enrollment will include a verification process that confirms the device can be utilized in the program platform. Once integration into the platform is confirmed, the participating customer or a designated aggregator will begin receiving participation payments in exchange for allowing the utility or the customer's chosen aggregator, if applicable, shared access to their device to generate value for all customers. For customers not participating through an aggregator, the participation payment could be provided as a bill credit.[1] For customers that enroll with an aggregator, the participation payment will convey as a direct cash payment to the aggregator.

The battery system needs to be available to charge and discharge in accordance with utility instructions, so that the output can be used for peak shaving and other grid services. The battery system can be utilized for other purposes by the customer, including backup power for the customer's premises, to the extent that those uses will not conflict with its use to serve the objectives of the Pilot. During and beyond this Pilot, the utility will collaborate with participating aggregators to explore options that allow customers to participate on different levels and essentially 'pay for performance' when they do provide other outcomes that benefit all customers and the utility system.

Participation Agreements

To be part of this Pilot, customers will sign an agreement allowing shared access to their device to be used by a third party, including the utility or third-party aggregators, for grid services such as peak reduction and other ancillary services. Among the terms that will be identified in the agreement are:

- A "Peak Event" is defined as a period of time in which a utility or aggregator will make adjustments to the device such as charging or discharging a battery at a specific rate.
- The anticipated number and duration of Peak Events in times per month and hours per Peak Event.

[1] The utility may function as an aggregator and operator at the election of the customer. Nothing compels a customer to choose the utility or another third-party as the operator.

- The utility will send “Peak Event” notifications to customers and participating aggregators.
- Customers may be sent notification of a Peak Event from the utility or via their chosen aggregator, via a smart phone app or other electronic method provided by the aggregator or developer, at least 4 hours in advance.
- The utility or a customer’s chosen aggregator will ensure that batteries are available to perform backup power for the customer as quickly after the peak event as possible.
- The utility or a customer’s chosen aggregator will also make adjustments when possible to avoid completely discharging a battery for the purpose of achieving grid benefits during or prior to a pending weather event that could create outages.
- The utility, in coordination with participating aggregators, will continually explore other opportunities to generate value for all customers through mechanisms, such as ancillary market revenues, energy arbitrage, etc., and if feasible, will amend the Pilot to include mechanisms for providing compensation for those benefits.

The participation payment amount will be effective for the duration of the agreement with the utility. The agreement term will be 10 years. Customers will have the option to opt-out of the Pilot at any time and discontinue shared access to their device. Opt-outs must be coordinated with the aggregator, if applicable, and the participation credit or payment, as applicable will also terminate at the time a customer opts-out. Customers are allowed to opt back in, but may be assessed a reconnection fee to do so and can only opt back in once annually. The 10-year term will continue from the date of the original activation.

Participation Payments

The agreement between the utility, the customer, and the aggregator, if applicable, will yield a monthly participation payment to the customer, or to the aggregator if the customer has chosen an aggregator, based on assumed value for each kW of storage capacity contractually available to the utility for the minimum duration determined to be necessary to meet program objectives, at the full capacity rating.

Participation payment amounts will be determined through analysis of forecasted cost savings and a sharing ratio between payment recipients and non-participant customers. This will involve an estimation of total potential cost savings, which will be adjusted for the possibility that systems may not prove to be 100% effective at reducing costs. A sharing ratio will be applied to this value to assign a portion of the expected cost savings to participants and non-participants. The product of the the adjusted cost savings and the sharing ratio will determine the participation payment amount for battery capacity made available to the program.

For example, if total potential cost savings of $10 million are forecast for a given amount of storage capacity (e.g., 5 MW), and it is assumed that participating systems will be 75% effective, the total sharable benefits are $7.5 million. If the benefits sharing ratio is 90% to participants and 10% to non-participants, the payment pool will be $6.75 million. This amount is then divided by the amount of storage capacity to determine the participation amount. In this instance, the amount would be divided by 10 years and 5 MW, leading to a participation payment of $200/kW-year or $16.67/kW-month.[2]

Participation payments will be subject to the following conditions:

- The utility may omit or reduce the participating customer's or aggregator's monthly payment if the contracted energy storage is not available due to:
    1. Lack of capacity to deliver at contracted output for the applicable duration;
       or
    2. Lack of communication with the device during a peak event.
- The monthly participation payment amount is effective for a period of 10 years or until the customer opts out or the contract is terminated.
- For customers receiving the bill credit directly from the utility, the monthly credit can be used to offset all charges on the bill.
- A fee may be charged to each customer or aggregator for utility-provided services required for participation in the program to the extent these costs are not recovered through other means.

Performance Rewards

Additional performance awards may be made to participants, including aggregators, and the utility where realized cost savings exceed the amount on which participation payments are based, evaluated on an annual basis. These payments are to be shared at equal percentages between participants, non-participants, and if applicable, the utility.

A utility will be eligible for performance payments if it achieves a peak forecast accuracy higher than the assumed rate underlying the calculation of participation payments. For instance, if the participation payments are based on a successful peak forecast rate of 9 of 12 months, a utility may receive a performance incentive if: (a) its forecasts cause cost reductions during 10 or more months, and (b) actual cost savings produce an excess of

[2] These monetary amounts are for illustrative purposes only.

savings that can be distributed. In this case, the utility will receive 33.3% of the excess savings.

If excess savings accrue during a year where a utility exceeded the forecast accuracy benchmark, the remaining excess savings will be split among participants and non-participants at 33.3% for each. If excess savings occur during a year where the utility fails to exceed the forecast accuracy benchmark (e.g., future system costs were underestimated), the excess savings would be shared at a 50/50 ratio between participants and non-participants.

Customer Obligations

1. The customer is required to maintain the internet connection with the battery storage system at all times. In the event connectivity with the battery system is lost, the customer and, if applicable, the aggregator, will be notified and will have 30 days to remedy. If not resolved in this time frame, the customer will be removed from the Pilot and no longer receive the credit. If the issue is resolved at a future date, the customer may opt back in with a $15 reconnection fee. The monthly credit or payment, as applicable, will resume.
2. If a customer is a net-metered customer, the credits generated from the battery storage system will be tracked separately from any solar credits generated. All rules and expiration requirements for solar credits will still apply.
3. For customers receiving the credit directly from the utility, monthly credits will be allowed to accrue, and are able to be used to pay all charges on the utility bill.
4. The utility will measure performance of the system during the peak events. If the battery system fails to perform within 10% of the contracted capacity, the customer or aggregator will have 30 days to resolve the issue. Upon resolution, the customer or aggregator will request the utility to test and verify that performance has been restored. If not resolved within 30 days, the customer may be removed from the Pilot with the agreement voided and the monthly credit, or payment, as applicable, ceased, or the monthly credit or payment amount, as applicable, may be lowered to reflect the new available power and capacity.
5. The utility may only remove a customer from the Pilot for repeated issues of connectivity or non-performance of the system, after opportunity to cure.

Aggregator Obligation

For participating Aggregators, the following provisions will apply.

1. Aggregators will identify new customers and support BYOD customers by deploying energy storage to participating customers, ensuring customers fully understand the provisions of the BYOD program, ensuring customers are able to maintain their participation in the program, ensuring customers understand optimal usage of their energy storage system, and identifying additional value streams for customers.
2. Through a contractual mechanism with the utility, aggregators will receive payments from the utility associated with the 10-year stream of value of the battery capacity they have enrolled.
3. The aggregator is responsible for ensuring that issues such as device connectivity are resolved quickly and effectively, and replacing with new battery capacity any batteries that exit the program.
4. Aggregator contracts with customers will detail how payments from the utility will be shared with the customer, such as through upfront discounts on storage deployment or an ongoing share of revenue.
5. If and when the utility identifies additional value streams, such as distribution investment deferral, renewables hosting capacity expansion, or grid reliability, the aggregator will assist the utility in realizing this value by, for example:
    a. Targeting deployment to high-value locations for elevated contracted value;
    b. Supporting battery discharge optimization, as needed, to stack value;
    c. Co-optimizing more complex battery discharge with future customers needs, such as EV charging or complex tariffs.

Measurement & Verification

Measurement and verification is a key component of this Pilot to test the assumptions made regarding benefits to the grid and savings to all customers – both those participating in the Pilot and those not participating. To that end, the utility will report the available capacity for grid services, monitor which resources and aggregators are sent dispatch signals, and importantly, provide the total capacity and energy of the DERs for each peak event that is called. The energy platform will provide performance information for each system, which will assist in determining that the systems remain in compliance with their requirements. The utility will use this data to determine the overall effectiveness of the Pilot to reducing peak demands.

The utility will also send out a brief survey to each customer and aggregator 6 months into their agreement to gain feedback from Pilot participants. The utility will look to learn if customers and aggregators are satisfied with their involvement in the Pilot, the notification process, and value of the monthly credit or payment, as applicable.

CRAIG FERREIRA
Innovation Development

Direct Dial Number: (802) 747.6818
Craig.Ferreira@greenmountainpower.com

Electronic and Hand Delivery

February 23, 2018

Mrs. Judith C. Whitney, Clerk
Vermont Public Utility Commission
112 State Street
Montpelier, VT 05620-2701

Re: Green Mountain Power – Bring Your Own Device "BYOD" Innovative Pilot

Dear Mrs. Whitney:

Please accept this as Green Mountain Power's ("GMP") notice of the Bring Your Own Device ("BYOD") Pilot (the "Pilot"). Green Mountain Power plans to start offering customers the opportunity to participate in the Pilot after March 10, 2018.

Executive Summary

Green Mountain Power is focused on a new energy future, that is home-, business-, and community-based and leverages the latest innovations in grid modernization to drive down costs and provide value for all customers. Battery storage is a meaningful part of that energy future. The BYOD Pilot opens GMP's distributed energy resource ("DER") platform to customers who purchase and install compatible batteries in their home or business. Customers will have the opportunity to earn a GMP bill credit by allowing GMP shared access to the battery to maximize its value for all GMP customers by reducing costs at "peak" times, and exploring the ability to charge and discharge systems to achieve other forms of wholesale power market value. The BYOD pilot allows customers to find new ways to obtain backup power in a cost-competitive way, while participating in GMP's grid transformation efforts with their own storage solution and receiving credits for doing so, while also helping to drive down costs for all GMP customers.

Current or likely to be compatible battery systems include the following[1]:

1. Sonnen Battery

[1] The official list of currently approved battery systems will be located on GMP's website.

2. Sunverge Battery
3. Solar Edge StorEdge Compatible Battery Systems
4. PowerWall 2.0

This is the current range of mainstream battery storage market offerings, and thus integrate with GMP's software. We are open to exploring the integration of other battery technologies upon request.

Customers participating in the Pilot will install a compatible battery system. Once installed, they will follow enrollment instructions to enter into the Pilot. The enrollment will include a verification process that enables their device to be utilized within the GMP energy platform[2]. Once integration into the GMP energy platform is confirmed, the participating customer will begin receiving a credit on their electric bill in exchange for allowing GMP shared access to their device to generate value to all GMP customers. This means the battery system needs to be available to charge and discharge in accordance with GMP instructions, so that the output can be used for peak shaving and other grid services. The battery system cannot be utilized for any other controls by the customer, other than providing backup power for the customer's premises. As we look beyond this pilot, we plan to explore options that allow customers to participate on different levels and essentially 'pay for performance' when they do provide outcomes that benefit all customers and the GMP system.

To be part of this pilot and GMP's energy platform, customers will sign an agreement allowing shared access to their device to be used for grid services such as peak reduction and other ancillary services. Some of the details that will be identified in the agreement are:

- A "Peak Event" is defined as a period of time in which GMP will make adjustments to the device such as charging or discharging a battery at a specific rate.
- Peak Events are anticipated to occur an average of 5 to 8 times per month for an average of 3 to 6 hours at a time.
- Customers will be sent notification of a Peak Event, via a smart phone app or other electronic method, at least 4 hours in advance.
- GMP will ensure that batteries are available to perform backup power for the customer as quickly after the peak event as possible.
- GMP will also make adjustments when possible to avoid completely discharging a battery for the purpose of achieving grid benefits during or prior to a pending weather event that could create outages. While we cannot guarantee that the participating customer's battery system will be charged to a minimum level at all times, we will work to minimize these impacts to make sure the customer has back up power.

[2] The platform is a system that enables GMP to monitor and control the output of many distributed devices such as battery storage systems, for the benefit of GMP's system and customers as a whole.

- GMP will continually explore other value opportunities to generate value for all customers through mechanisms, such as ancillary market revenues, energy arbitrage, etc., and if feasible, we will amend this pilot to include a feature to share those benefits.

The participating customer's bill credit amount will be effective for the duration of the agreement with GMP. The agreement term will not exceed 10 years. Customers will have the option to opt-out of the Pilot at any time and discontinue GMP shared access to their device. The GMP bill credit will also terminate at this time. Customers are allowed to opt back into the Pilot, but will be assessed a $15 reconnection fee on their next GMP bill and can only opt back in once annually. The 10-year term will continue from the date of the original activation.

Value of Energy Storage Systems

Energy Storage

The agreement between GMP and the customer will yield a monthly bill credit[3] based on assumed value for each kW of storage capacity contractually available to GMP for a minimum duration of 3 hours at the full capacity rating. The minimum offer amount must be 2kW or greater with the maximum aggregate offer being 10kW behind an individual meter. If batteries are paired to get a full 10kW/30kWH the bill credit would be two times the 5kW bill credit rate.

Duration (Hours)	Power (kW) Available to GMP	Energy (kWh) Available to GMP	Monthly Bill Credit*
3	2-2.9	6-8.7	$14.50
	3-3.9	9-11.7	$22.00
	4-4.9	12-14.7	$29.00
	5-5.9	15-17.7	$36.00

* Bill credit based on an assumption that GMP will be able to use participating battery systems to reduce 8 out of 12 monthly Vermont peaks per year for RNS transmission savings, and assumes that the systems will be 75% effective at reducing the annual ISO-NE peak that determines GMP's Forward Capacity Market obligations.

- GMP reserves the right to omit or reduce the participating customer's monthly bill credit if the contracted energy storage is not available due to:
  1. Lack of capacity to deliver a 3-hour discharge at full output; or
  2. Lack of communication with the device during a peak event.
- The monthly bill credit amount is locked in for a period of 10 years or until the customer opts out or the contract is terminated.
- The monthly bill credit can be used to offset all chargers on the bill, including those not covered by solar, i.e. 'non-bypassable'.
- An integration and communication fee of $2.50 per month will be added to each bill to cover the costs of the ongoing communications and software platform fee.

[3] Participating customers receive 70% of the estimated value that the battery system will provide to GMP, with remaining 30% of value flowing to non-participating customers through reduced retail rates.

Customer Obligation

1. The customer is required to maintain the internet connection with the battery storage system at all times. In the event GMP loses connectivity with the battery system, the customer will be notified and will have 30 days to remedy. If not resolved in this time frame, the customer will be removed from the Pilot and no longer receive the bill credit. If the issue is resolved at a future date, the customer may opt back in with a $15 reconnection fee. The monthly bill credit will be resumed in the amount specified at the initial activation.
2. If a customer is a net-metered customer, the credits generated from the battery storage system will be tracked separately from any solar credits generated. All rules and expiration requirements for solar credits will still apply.
3. Monthly bill credits will be allowed to accrue, and are able to be used to pay all charges on the GMP bill. At any time, but no more frequent than once annually, if a customer has excess bill credits, they are able to request an Energy Transformation Rebate in the amount of the excess bill credit with proof of purchase any product that meets the requirements of the Renewable Energy Standard under Tier 3, such as:
    i. Smart Thermostat
    ii. Heat Pump
    iii. Heat Pump Water Heater
    iv. Qualified Electric Vehicle
4. GMP will measure performance of the system during the peak events. If the battery system fails to perform within 10% of the contracted capacity, the customer will have 30 days to resolve the issue. Upon resolution, the customer will request GMP to test and verify performance has been restored. If not resolved within 30 days, the customer may be removed from the Pilot with the agreement voided and the bill credit ceased, or the monthly bill credit amount may be lowered to reflect the new available power and capacity.
5. GMP may remove a customer from the Pilot for any reason, including, but not limited to repeat issues with connectivity or performance of the system as that is how value is delivered to all customers.

Measurement & Verification

Measurement and verification is a key component of this Pilot to test the assumptions made regarding benefits to the grid and savings to all GMP customers – both those participating in the Pilot and those not participating. To that end, GMP's Energy Platform will report the available capacity for grid services, monitor which resources are sent dispatch signals, and most importantly, provide the total capacity and energy of the DERs for each peak event that is called. The energy platform will provide us with the performance information for each system, which will determine the systems are remaining in compliance with their requirements. GMP will be using data provided by Virtual Peaker to determine the overall effectiveness of the Pilot to reducing GMP peak demands.

GMP will also send out a brief survey to each customer 6 months into their agreement to gain feedback from Pilot participants. GMP will look to learn if customers are satisfied with their involvement in the Pilot, the notification process, and value of the monthly bill credit.

Timing & Scope

Beginning in March the BYOD Pilot will be available to all residential customers and small commercial customers not currently on a Time-Of-Use retail electric rate. The initial Pilot will last for 18 months and will be available to a maximum of up to 2MW/6MWh of battery storage systems.

To reach 2MW/6MWh, GMP is expecting a mix of system sizes will be installed by participating customers. Currently, the most commonly sized system is around 9kWh, and other common sizes range from 6kWh to 15kWh. With this in mind, GMP anticipates the breakdown of 2MW/6MWh will be close to the following:

Battery kW Size	Quantity Installed
2	50
3	550
4	45
5	15

The Pilot Advances State Energy Goals

The BYOD offering will help advance state energy goals. First, the promotion and use of energy storage provides a clean alternative backup power solution for customers that would otherwise rely on a fossil-fuel generator, or not have a backup power source. Second, energy storage can be a tool to manage the grid with the development of distributed energy resources called for under Act 56, the Vermont Renewable Energy Standard ("RES") enacted in 2015. Specifically, dispatch control of energy storage can be used to help smooth grid impacts caused by a high penetration of distributed solar energy, potentially avoiding more expensive, traditional grid upgrades[4]. Additionally, these resources are anticipated to provide a small amount of value towards the Tier 3 targets under the RES. Finally, these DERs represent innovative, dispatchable resources that can be used during peak periods to help reduce GMP's power supply costs, lowering costs for customers.

Summary of Projected Costs & Revenues

There is an ongoing software cost to enable this Pilot that is partially offset by the monthly communication fee. This Pilot will provide value to non-participating customers through power supply cost reductions. Based on GMP Power Supply projections, GMP assumes

[4] The BYOD Pilot will begin by primarily focusing on peak shaving, however GMP will continue to work and build the framework to utilize batteries for this purpose.

a levelized per kW value of approximately $10.30 per month. Participating customers will receive 70% of this value, while the remaining 30% will benefit all GMP customers. GMP expects a mix of battery sizes to be deployed by participating customers. Table 1 shows the expected benefits to all GMP customers based on an anticipated mix of battery size deployments.

Year	1	2	3	4	5	6	7	8	9	10
Revenue										
Communication & Integration Fees	$19,800	$19,800	$19,800	$19,800	$19,800	$19,800	$19,800	$19,800	$19,800	$19,800
Power Supply Benefit	$150,521	$251,251	$316,532	$325,119	$334,653	$350,465	$372,873	$397,496	$423,057	$449,713
Total Revenue	**$170,321**	**$271,051**	**$336,332**	**$344,919**	**$354,453**	**$370,265**	**$392,673**	**$417,296**	**$442,857**	**$469,513**
Costs										
GMP Grid Platform	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)	(30,000)
Battery Bill Credit	($176,040)	($176,040)	($176,040)	($176,040)	($176,040)	($176,040)	($176,040)	($176,040)	($176,040)	($176,040)
Total Costs	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**	**($206,040)**
Net Benefit to GMP Customers	**($36,080)**	**$65,667**	**$131,608**	**$140,282**	**$149,912**	**$165,884**	**$188,518**	**$213,390**	**$239,209**	**$266,134**

Table 1

Efficiency Vermont Non-Conflict and Collaboration Certification

By this filing, GMP certifies that the BYOD Pilot does not conflict with work being performed by Efficiency Vermont. GMP has discussed the scope and objectives of this pilot with Efficiency Vermont and Efficiency Vermont is supportive of this pilot.

Status Updates

GMP proposes to provide status updates to the Commission regarding the BYOD Pilot's progress on a six-month basis until the Pilot expires in 18 months. In the event GMP decides to terminate the Pilot prior to the passage of 18 months, we will provide prompt notice to the Commission and the Department.

If you should have any questions, please contact me at 802-747-6818.

Sincerely,

Craig Ferreira

cc: Stephanie Hoffman, Vermont Department of Public Service
Karen Glitman, Efficiency Vermont
Barry Murphy, Vermont Department of Public Service

Liberty Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities

DE 17-189

Petition to Approve Battery Storage Pilot Program

OCA Data Requests - Set 1

Date Request Received: 2/16/18
Request No. OCA 1-37

Date of Response: 3/9/18
Respondent: Heather Tebbetts

REQUEST:
Did the Company consider any other ownership schemes (i.e., joint ownership between customer and utility)? If not, why not? If yes, why this paradigm?

RESPONSE:

No other ownership arrangements were considered. The objective is to make the pilot simple for customers to understand and for the Company to administer.

Liberty Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities

DE 17-189

Petition to Approve Battery Storage Pilot Program

Sunrun Inc. Technical Session Data Requests - Set 1

Date Request Received: 3/16/18 | Date of Response: 3/23/18
Request No. Sunrun Tech 1-5 | Respondent: Heather Tebbetts

REQUEST:

Liberty's response to OCA 1-37 states that Liberty did not consider any other ownership schemes and that the proposed Pilot will achieve the objective of making the Pilot simple for customers to understand for the Company to administer.

a. Please describe how Liberty arrived at this determination if Liberty did not compare the proposed Pilot with any other ownership schemes.

b. Please provide a timeline from when Liberty began developing the proposed Pilot up to when Liberty filed the Petition. Please include milestone dates, such as the issuance of the RFP.

RESPONSE:

a. The Company arrived at this determination based on the goals of the pilot. Allowing the possibility of different ownership schemes would introduce complexity to the pilot, thus making customer understanding and Company administration more difficult.

b. The Company began developing the proposed pilot in September 2017. The only milestone date was the filing date of November 30, 2017. Regarding the selection of Alectra as well as the battery manufacturer, please refer to the direct and supplemental testimony of Witness Tebbetts, as well as the data responses to OCA 1-31, OCA 1-35, and Staff 1-15.

Liberty Utilities (Granite State Electric) d/b/a Liberty Utilities
Total Resource Cost Model
Option 2 - Cellular Based Metering

		-1	-2	-3	-4	-5	-6	-7	-8	-9	-10	-11	-12	-13	-14	-15	
1	Year	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	
2	Units Installed	1,000	0	0	0	0	0	0	0	0	0	0	0	0	0	0	
3	#Units with Upfront Contribution	100															
4	#Units with Monthly Contribution	900	900	900	900	900	900	900	900	900	900						
	Benefits																**Total**
5	Regional Network System (RNS) Charges	$640,000	$645,050	$644,517	$631,433	$612,490	$594,115	$576,292	$559,003	$542,233	$525,966	$505,210	$484,455	$463,699	$442,944	$422,188	**$8,289,594**
6	Local Network System (LNS) Charges	$126,284	$131,082	$130,851	$128,171	$124,323	$120,615	$116,991	$113,480	$110,082	$106,767	$102,554	$98,340	$94,127	$89,913	$85,700	**$1,679,280**
7	Distribution Circuit Upgrades (Rev Req)	$0	$96,101	$92,889	$89,797	$86,815	$83,934	$81,148	$78,450	$75,831	$73,226	$70,622	$68,017	$65,412	$62,807	$60,202	**$1,085,251**
8	Avoided Costs	$264,706	$189,721	$149,437	$139,138	$191,379	$228,996	$275,207	$327,946	$363,058	$375,271	$384,445	$354,235	$330,844	$337,063	$308,705	**$4,220,151**
9	Customer Savings	$218,862	$309,296	$300,017	$291,016	$282,286	$273,817	$265,603	$257,635	$249,906	$242,409	$232,843	$223,277	$213,711	$204,145	$194,579	**$3,759,402**
10	Customer Contribution	$208,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$108,000	$0	$0	$0	$0	$0	**$1,180,000**
11	Total Benefits	$1,457,851	$1,479,250	$1,425,711	$1,387,555	$1,405,293	$1,409,478	$1,423,242	$1,444,514	$1,449,109	$1,431,639	$1,295,673	$1,228,323	$1,167,793	$1,136,872	$1,071,375	**$20,213,677**
	Costs																
12	Revenue Requirement - Batteries	($1,522,041)	($1,396,114)	($1,287,404)	($1,190,992)	($1,103,335)	($1,015,704)	($928,047)	($851,385)	($785,693)	($720,000)	$0	$0	$0	$0	$0	**($10,800,715)**
13	Revenue Requirement - Cell Based Meters	($43,873)	($42,023)	($40,220)	($38,461)	($36,743)	($35,062)	($33,415)	($31,801)	($30,191)	($28,582)	($26,973)	($25,364)	($23,755)	($22,145)	($20,536)	**($479,144)**
14	Monthly Cellular Reading Cost	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	($36,000)	**($540,000)**
15	Cogsdale Programming Costs	($92,290)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($92,290)**
16	Meter MV-90 Programming Costs	($80,000)	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	$0	**($80,000)**
17	Total Costs	($1,774,204)	($1,474,137)	($1,363,624)	($1,265,453)	($1,176,078)	($1,086,765)	($997,463)	($919,186)	($851,884)	($784,582)	($62,973)	($61,364)	($59,755)	($58,145)	($56,536)	($11,992,149)
18	Net Benefit to All Customers	($316,352)	$5,113	$62,087	$122,102	$229,214	$322,712	$425,779	$525,328	$597,225	$647,056	$1,232,700	$1,166,959	$1,108,039	$1,078,727	$1,014,839	**$8,221,528**
	Net Present Value Calculation																
19	Required Rate of Return	9.40%															
20	Net Present Value	$2,965,867															

1 Year of installation
2 Total units in pilot
3 Based on Green Mountain Power's experience of 10% paying upfront
4 (2) - (3)
5 Calculation as described in testimony; Includes 3% degradation per year
6 Calculation as described in testimony
7 Page 7
8 Calculated using the most recent Avoided Energy Supply Components in New England: 2018 Report
9 Savings Calc TRC 2
10 Customer contribution of $1000 upfront (100) plus $10 per month (900)
11 Sum of lines 5-8
12 Page 3
13 Page 5
14 Verizon monthly cell data charges
15 Estimated programming costs associated with billing TOU rates
16 Estimated programming costs associated with reading cellular meters
17 Sum of lines 10-14
18 Sum of lines 9+15
19 Page 3
20 Net Present Value calculation of net benefits

Liberty Utilities (Granite State Electric) Corp. d/b/a Liberty Utilities

DE 17-189

Petition to Approve Battery Storage Pilot Program

Staff Data Requests - Set 1

Date Request Received: 2/16/18
Request No. Staff 1-1

Date of Response: 3/9/18
Respondent: Heather Tebbetts

REQUEST:

Refer to the pre-filed Direct Testimony of Heather M. Tebbetts, page 7, lines 9-11, and please explain why the size of the pilot program is proposed to be five MW and 1,000 batteries? Were larger or smaller pilot program sizes evaluated? If so, then please provide copies of all such evaluations and studies, and all supporting documentation and related workpapers in live Excel format with all formulae intact. If not, then please explain why no such evaluations were conducted.

RESPONSE:

The Company considered Green Mountain Power's program in which it proposed 10 MW of storage, or 2,000 batteries, but that amount was determined to be too large for a pilot program. After internal discussion and looking at the non-wires alternative ("NWA") possibilities in Lebanon, as described in my testimony, 1.5 MW for the NWA wasn't large enough, since customers outside of the targeted circuits may want to participate. Participation of customers outside the NWA targeted area will provide additional value and data through being able to study the behavior and usage changes of customers in non-targeted areas. In determining the proposed size of the pilot program, the Company also considered the annual level of transmission costs, and decided on up to 5 MW of storage, which will be enough to provide a noticeable monetary savings in transmission costs, thus providing benefit for all customers.

Low use

	hourly usage	battery charge
00:00 - 00:59	0.25	0.31
0100 - 0159	0.22	0.32
0200 - 0259	0.20	0.35
0300 - 0359	0.21	0.40
0400 - 0459	0.25	0.39
0500 - 0559	0.27	
0600 - 0659	0.30	
0700 - 0759	0.30	
0800 - 0859	0.30	
0900 - 0959	0.32	
1000 - 1059	0.33	
1100 - 1159	0.33	
1200 - 1259	0.32	
1300 - 1359	0.31	
1400 - 1459	0.31	
1500 - 1559	0.32	
1600 - 1659	0.35	
1700 - 1759	0.40	
1800 - 1859	0.39	
1900 - 1959	0.40	
2000 - 2059	0.41	
2100 - 2159	0.41	
2200 - 2259	0.36	
2300 - 2359	0.29	
battery offset	0	

Bill Calculation

	battery	battery
Customer Charge	$14.57	$14.57
Distribution		
Critical Peak	$ 0.13304	$ -
On Peak	$ 0.03727	$ 2.13
Off Peak	$ 0.00940	$ 1.59
Transmission		
Critical Peak	$ 0.07209	$ -
On Peak	$ 0.02019	$ 1.15
Off Peak	$ 0.00509	$ 0.86
Stranded Costs	$ 0.00049	$ 0.14
ECT	$ 0.00055	$ 0.15
SBC	$ 0.00354	$ 0.99
Energy Service	$ 0.08931	$ 24.95
		$46.54

	no battery	
Customer Charge	$14.57	$14.57
Distribution		
1st 250 kWh	0.04070	$ 10.17
Excess	0.052841	$ 1.55
Transmission	0.02011	$ 5.62
Stranded Costs	0.0049	$ 1.37
ECT	0.00055	$ 0.15
SBC	0.00457	$ 1.28
Energy Service	0.08931	$ 24.95
total		$ 59.67

	monthly	
no battery	$ 59.67	
battery	$46.54	
difference	$ 13.13	2 batteries
		monthly
monthly charge	$10	$20
new savings	$ 3.13	$ (6.87)

usage

	Day	Month	Battery Offset
Total	9	279	226
Critical Peak	2	53	-
On Peak	2	57	57
Off Peak	6	169	169

Medium Low Use

	hourly usage	battery charge
00:00 - 00:59	0.51	0.67
0100 - 0159	0.46	0.67
0200 - 0259	0.43	0.77
0300 - 0359	0.43	0.90
0400 - 0459	0.43	0.96
0500 - 0559	0.45	
0600 - 0659	0.54	
0700 - 0759	0.57	
0800 - 0859	0.61	
0900 - 0959	0.62	
1000 - 1059	0.66	
1100 - 1159	0.69	
1200 - 1259	0.70	
1300 - 1359	0.69	
1400 - 1459	0.67	
1500 - 1559	0.67	
1600 - 1659	0.77	
1700 - 1759	0.90	
1800 - 1859	0.96	
1900 - 1959	0.93	
2000 - 2059	0.88	
2100 - 2159	0.80	
2200 - 2259	0.10	
2300 - 2359	0.59	
battery offset	0	

Bill Calculation

	battery	battery
Customer Charge	$14.57	$ 14.57
Distribution		
Critical Peak	$ 0.13304	$ -
On Peak	$ 0.03727	$ 4.44
Off Peak	$ 0.00940	$ 3.13
Transmission		
Critical Peak	$ 0.07209	$ -
On Peak	$ 0.02019	$ 2.40
Off Peak	$ 0.00509	$ 1.69
Stranded Costs	$ 0.00049	$ 0.22
ECT	$ 0.00055	$ 0.25
SBC	$ 0.00354	$ 1.60
Energy Service	$ 0.08931	$ 40.33
		$ 68.62

	no battery	
Customer Charge	$14.57	$14.57
Distribution		
1st 250 kWh	0.04070	$ 10.17
Excess	0.052841	$ 16.94
Transmission	0.02011	$ 11.47
Stranded Costs	0.0049	$ 2.80
ECT	0.00055	$ 0.31
SBC	0.00457	$ 2.61
Energy Service	0.08931	$ 50.95
total		$ 109.83

	monthly	
no battery	$ 109.83	
battery	$ 68.62	
difference	$ 41.20	2 batteries
		monthly
monthly charge	$10	$20
new savings	$ 31.20	$ 21.20

usage

	Day	Month	Battery Offset
Total	19	571	452
Critical Peak	4	119	-
On Peak	4	119	119
Off Peak	11	333	333

Medium High Use

	hourly usage	battery charge
00:00 - 00:59	0.88	1.05
0100 - 0159	0.80	1.09
0200 - 0259	0.74	1.24
0300 - 0359	0.72	1.41
0400 - 0459	0.76	1.44
0500 - 0559	0.82	
0600 - 0659	0.96	
0700 - 0759	0.91	
0800 - 0859	0.94	
0900 - 0959	0.98	
1000 - 1059	0.96	
1100 - 1159	0.98	
1200 - 1259	1.01	
1300 - 1359	1.03	
1400 - 1459	1.05	
1500 - 1559	1.09	
1600 - 1659	1.24	
1700 - 1759	1.41	
1800 - 1859	1.44	
1900 - 1959	1.43	
2000 - 2059	1.42	
2100 - 2159	1.36	
2200 - 2259	1.21	
2300 - 2359	1.02	
battery offset	0	

Bill Calculation

	battery	battery
Customer Charge	$14.57	$ 14.57
Distribution		
Critical Peak	$ 0.13304	$ -
On Peak	$ 0.03727	$ 6.59
Off Peak	$ 0.00940	$ 5.42
Transmission		
Critical Peak	$ 0.07209	$ -
On Peak	$ 0.02019	$ 3.57
Off Peak	$ 0.00509	$ 2.94
Stranded Costs	$ 0.00049	$ 0.37
ECT	$ 0.00055	$ 0.41
SBC	$ 0.00354	$ 2.67
Energy Service	$ 0.08931	$ 67.33
		$ 103.88

		no battery
Customer Charge	$14.57	$14.57
Distribution		
1st 250 kWh	0.04070	$ 10.17
Excess	0.052841	$ 36.50
Transmission	0.02011	$ 18.92
Stranded Costs	0.0049	$ 4.61
ECT	0.00055	$ 0.52
SBC	0.00457	$ 4.30
Energy Service	0.08931	$ 84.01
	total	$ 173.60

	monthly	
no battery	$ 173.60	
battery	$ 103.88	
difference	$ 69.72	2 batteries
		monthly
monthly charge	$10	$20
new savings	$ 59.72	$ 49.72

usage	Day	Month	Battery Offset
Total	31	941	754
Critical Peak	6	187	-
On Peak	6	177	177
Off Peak	19	577	577

High Use

	hourly usage	battery charge
00:00 - 00:59	1.37	1.85
0100 - 0159	1.27	1.94
0200 - 0259	1.21	2.10
0300 - 0359	1.21	2.29
0400 - 0459	1.27	2.39
0500 - 0559	1.45	
0600 - 0659	1.81	
0700 - 0759	1.87	
0800 - 0859	1.86	
0900 - 0959	1.83	
1000 - 1059	1.87	
1100 - 1159	1.85	
1200 - 1259	1.83	
1300 - 1359	1.81	
1400 - 1459	1.85	
1500 - 1559	1.94	
1600 - 1659	2.10	
1700 - 1759	2.29	
1800 - 1859	2.39	
1900 - 1959	2.29	
2000 - 2059	2.19	
2100 - 2159	2.09	
2200 - 2259	1.80	
2300 - 2359	1.54	
battery offset	0	

Bill Calculation

	battery	battery
Customer Charge	$14.57	$ 14.57
Distribution		
Critical Peak	$ 0.13304	$ -
On Peak	$ 0.03727	$ 12.35
Off Peak	$ 0.00940	$ 9.00
Transmission		
Critical Peak	$ 0.07209	$ -
On Peak	$ 0.02019	$ 6.69
Off Peak	$ 0.00509	$ 4.88
Stranded Costs	$ 0.00049	$ 0.63
ECT	$ 0.00055	$ 0.71
SBC	$ 0.00354	$ 4.56
Energy Service	$ 0.08931	$ 115.16
		$ 168.56

		no battery
Customer Charge	$14.57	$14.57
Distribution		
1st 250 kWh	0.04070	$ 10.17
Excess	0.052841	$ 71.68
Transmission	0.02011	$ 32.31
Stranded Costs	0.0049	$ 7.87
ECT	0.00055	$ 0.88
SBC	0.00457	$ 7.34
Energy Service	0.08931	$ 143.48
	total	$ 288.31

	monthly	
no battery	$ 288.31	
battery	$ 168.56	
difference	$ 119.75	2 batteries
		monthly
monthly charge	$10	$20
new savings	$ 109.75	$ 99.75

usage	Day	Month	Battery Offset
Total	54	1,607	1,289
Critical Peak	11	317	-
On Peak	11	331	331
Off Peak	32	958	958

SAINT PETER'S UNIVERSITY HOSPITAL
Treating you better...for life.

Date 11/5/19

Dear Secretary Camacho-Welch:

My name is Andrew Schoeber and I serve as the Director of Engineering & Project Management for St. Peter's Hospital.

The first Saint Peter's Hospital opened in New Brunswick in 1872, fast forward 147 years and I am proud to say we have come a long way. But in over a century, it is not just medical advancements that we are proud of, it is our commitment to maintaining the most efficient and forward-thinking intuition possible, while delivering quality care to all patients.

To be the best, we have to work with the best- and PSE&G has a history of success and has delivered millions of dollars of savings for St. Peter's in their various programs and initiatives.

Saint Peter's has observed first-hand how PSE&G is uniquely positioned to overcome market barriers in order to deliver energy efficiency programs at scale. Investment grade audit support coupled with the engineering and construction expertise are key competencies of the utility and critical drivers of program success. In addition, on-bill repayment offered by PSE&G makes programs more affordable.

For example, in 2012 the PSE&G Hospital Efficiency Program helped pay for more than $4.8 million in energy efficiency improvements at Saint Peter's University Hospital. This project saved St Peter's $502,000 annually in energy costs. In 2015, Saint Peter's Healthcare System and PSE&G cut the ribbon on a five-station electric vehicle (EV) charging system at the Hospital. The system was built through a PSE&G pilot program that is designed to help spur the adoption of electric vehicles in the utility's electric service territory.

The extension of the Hospital Efficiency program continues to pay dividends for us. St Peter's total savings from PSE&G programs totals $7.2 million and savings from the energy efficiency improvements are roughly $709,000 annually. The benefits of this cannot simply be quantified in savings, but also in our ability to reinvest in patient comfort and safety and in-patient care technology.

It is with great pride and pleasure that I share these successes with you, as they are not just a testament to the progress of St. Peter's but also of PSE&G's commitment to clean energy and positioning the State to be a leader in efficiency. On behalf of St Peter's, I encourage the Board of Public Utilities to support programs like PSE&G's Hospital Efficiency program, due to its ability to help customers like us overcome barriers to participation. The program's offer of upfront capital, as well as the expertise for the audit, engineering, and construction phases of the work were key to our ability to participate.

Thank you for your time and consideration of this statement
Sincerely,
Andrew Schober

Energy Storage: The New Efficiency

HOW STATES CAN USE ENERGY EFFICIENCY FUNDS TO SUPPORT BATTERY STORAGE AND FLATTEN COSTLY DEMAND PEAKS

Todd Olinsky-Paul | Clean Energy Group | April 2019

ABOUT THIS REPORT

This report, which describes how states can use energy efficiency funds to provide incentives for energy storage, is a publication of Clean Energy Group (CEG), with appendices containing several white papers prepared by the Applied Economics Clinic under contract to CEG. This report explains the steps Massachusetts took to become the first state to integrate energy storage technologies into its energy efficiency plan, including actions to 1) expand the goals and definition of energy efficiency to include peak demand reduction, and 2) show that customer-sited battery storage can pass the required cost-effectiveness test. The report summarizes the economics of battery cost/benefit calculations, examines key elements of incentive design, and shows how battery storage would have been found to be even more cost-effective had the non-energy benefits of batteries been included in the calculations. The report also introduces seven non-energy benefits of batteries, and for the first time, assigns values to them. Finally, the report provides recommendations to other states for how to incentivize energy storage within their own energy efficiency plans. Four appendices provide detailed economics analysis, along with recommendations to Massachusetts on improving its demand reduction incentive program in future iterations of the energy efficiency plan.

The report and accompanying analyses were generously supported by grants from the Barr Foundation and Merck Family Fund. It is available online at *www.cleanegroup.org/ceg-resources/resource/energy-storage-the-new-efficiency*.

ACKNOWLEDGMENTS

Clean Energy Group wishes to express its sincere thanks to Barr Foundation and the Merck Family Fund for their generous support of this work; to Liz Stanton and staff of the Applied Economics Clinic, who produced the economic analyses that serve as the basis for many findings of this report; and to the following organizations with whom CEG collaborated to advocate for Massachusetts battery storage incentives: Northeast Clean Energy Council, Acadia Center, Conservation Law Foundation, and Local Initiatives Support Corporation (LISC) Boston. Thanks also to Liz Stanton of the Applied Economics Clinic, Rachel Gold of the American Council for an Energy-Efficient Economy (ACEEE), and Jamie Dickerson of the New England Clean Energy Council (NECEC), for their review comments. Todd Olinsky-Paul wishes to thank Lewis Milford, Maria Blais Costello, Meghan Monahan, and Samantha Donalds of Clean Energy Group for their invaluable contributions.

DISCLAIMER

TABLE OF CONTENTS

HOW TO READ THIS REPORT

This report comprises two parts, which may appeal to different audiences.

The main body of this report explains how a groundbreaking new energy efficiency policy came about in Massachusetts; summarizes original economic analyses that supported this policy change; identifies key barriers and issues confronting states in this making this policy change; and makes recommendations for policy and program development in other states. This portion of the report is intended for a general audience and should be of interest to state policymakers and regulators.

Following the main body of the report are three appendices that contain the original white papers prepared for Clean Energy Group by economist Liz Stanton and the staff of the Applied Economics Clinic. These white papers 1) present an independent cost/benefit analysis of customer-sited battery storage, 2) review the economic underpinnings of the new Massachusetts performance-based incentive for battery storage within the efficiency plan, and 3) present new analysis valuing seven non-energy benefits of battery storage. They are intended for readers who wish to delve more deeply into the economics of battery storage and should be of interest to economists and regulators.

The AEC white paper presented here as Appendix 1 was published in July 2018. The two additional white papers from AEC, presented here as Appendix 2 and Appendix 3, are being published and released simultaneously with this report.

A fourth appendix contains recommendations, prepared by Clean Energy Group, for improving the Massachusetts Energy Efficiency Plan, as it pertains to battery storage.

Executive Summary

INTRODUCTION

Energy storage is perhaps the most revolutionary new energy technology since the electric grid was invented over a century ago. It can transport electricity over time, as well as distance; it can act as a generator or as a load; it can integrate renewables into the grid or enable customers to disconnect from the grid entirely.

But states have yet to figure out how to move storage aggressively into various market segments with dedicated incentive programs. Typically, states have supported new clean energy technologies, such as wind and solar, through public benefit funds or utility incentives, which bring down the up-front capital costs and jump-start markets. So far, only a few states have developed incentives that would support energy storage. But that is beginning to change.

This report shows how a new energy storage incentive has been created through the innovative use of state energy efficiency funds. With technical support from Clean Energy Group (CEG), a national nonprofit advocacy organization, Massachusetts, a national leader in energy efficiency, has incorporated energy storage as an active demand reduction measure in its 2019-2021 Three-Year Energy Efficiency Plan.[1] This groundbreaking action was supported with original economic analysis by the Applied Economics Clinic (AEC), under contract to CEG.[2]

This report explains how, for the first time, distributed energy storage has been included in a state energy efficiency plan, and what the implications are for states and the storage industry. It covers the following topics:

- How behind-the-meter battery storage provides efficiencies, both for the customer and for the energy system.
- Why and how Massachusetts included storage in its energy efficiency plan.[3]
- Why this is important to move storage into many markets, including low-income markets where early stage technologies might not otherwise penetrate until years from now.
- Why expanding energy efficiency to include demand reduction measures like energy storage is in keeping with the historical evolution of such funds, to bring new technologies into their programs over time.
- What actions are necessary to enable more states to incorporate storage into their efficiency plans, and to use efficiency funds to jumpstart battery storage markets in those states.
- How to value both energy and non-energy benefits of battery storage, and why this is important if storage is to be incorporated into state policy and programs.

This report shows how a new energy storage incentive has been created through the innovative use of state energy efficiency funds.

KEY FINDINGS

Distributed battery storage can deliver valuable energy efficiencies, both behind the meter and on the grid. This report presents economic analysis showing that peak demand reduction, an emerging energy service for which battery storage is well suited, provides cost savings to both storage customers and the energy system as a whole. Peak demand reduction, or peak shifting, is a valuable efficiency that cannot be effectively achieved with traditional, passive efficiency measures, but it can be cost-effectively achieved with battery storage. As more renewables come onto the electric grid, the ability to shift peak loads becomes more important and valuable.

States can open energy efficiency programs to battery storage with one simple step. As shown in Massachusetts, states can redefine energy efficiency to include the peak demand reduction concept. Electricity demand peaks are costly, leading to huge inefficiencies across the energy system. While some states have demand reduction programs, these are not typically as well funded as are energy efficiency programs. Bringing demand programs under the umbrella of energy efficiency makes more resources available to support battery storage deployment and allows consumption-reduction and demand-reduction measures to be installed together, to achieve optimal results.

Battery storage can pass required cost-effectiveness screens, justifying the investment of public dollars. As shown in the CEG/AEC July 2018 report (Appendix 1), battery storage passes the Total Resource Cost (TRC) test in Massachusetts, meaning it returns savings to consumers that are greater than its cost. This is the threshold requirement for efficiency measures to be eligible for incentives under the Massachusetts Energy Efficiency Plan. Since most state rebate and incentive programs include cost-effectiveness screens, it is important that states develop methods to fairly and thoroughly evaluate the costs and benefits of battery storage.

Battery storage offers more than just energy benefits—and its non-energy benefits are both valuable and important. As shown in the CEG/AEC report on the non-energy benefits of storage (Appendix 3), battery storage offers many non-energy benefits, including resiliency, reduced outages, increased property values, job creation, and reduced land use. The non-energy benefits of storage must be assigned an economic value, or by default they will be valued at zero in cost/benefit analyses. In this report, we present economic analysis showing the value of seven non-energy benefits of battery storage.

Numerous program design issues should be addressed when states contemplate creating battery storage incentives. These include: Incentive design, Financing, Low-income provisions, Defining peak, Duration of discharge, Measuring benefits, Ownership issues, Stacking incentives, and Transparency.

More work is needed to continue to refine and expand the value of battery storage, including the identification and valuation of more non-energy benefits. Establishing a more accurate benefit-cost ratio (BCR) for distributed battery storage will support its inclusion in state energy efficiency programs and other incentive programs (such as rebates) that require measures to pass a cost-effectiveness screen. If this is not done, storage will continue to be at a disadvantage relative to other technologies, and it may not qualify for state incentive programs.

State energy efficiency programs represent an important potential source of incentive funding for distributed battery storage. Most states have energy efficiency programs, and these programs collectively represent an investment of nearly $9 billion in public funds annually. Qualifying energy storage as an efficiency measure in these state programs would make storage eligible for vastly greater incentive support than it currently enjoys in any state—even early adopter states like California, Massachusetts and New York. Bringing new technologies like storage into state energy efficiency programs is in keeping with the history of these programs and is cited as a best practice in EPA guides.[4]

Battery storage offers many non-energy benefits, including resiliency, reduced outages, increased property values, job creation, and reduced land use.

RECOMMENDATIONS

In the main body of this report, we discuss policy issues and present recommendations for a national audience of state policymakers and regulators. Recommendations and discussion directed specifically toward improving the Massachusetts demand reduction program can be found in Appendix 4.

Key Recommendations

- Other states should learn from the experience of Massachusetts and incorporate demand reduction measures, including storage, into their own energy efficiency plans.
- State energy storage incentives, in general, should include three basic elements: an up-front rebate, a performance incentive, and access to financing.
- State energy storage incentives should include adders and/or carve-outs for low-income customers. These customers need the cost savings and other benefits of new clean energy technologies the most but are typically the last to gain access to them.
- Researchers should build on the economics analyses presented here. Specifically, cost/benefit analyses of storage should be conducted using not only the TRC but also other cost-effectiveness tests commonly in use among states, such as the Societal Cost Test and the Utility/PACT test.
- Non-energy benefits of storage should be identified, analyzed, and valued.

How Massachusetts brought energy storage into its efficiency plan

In January 2019, the Massachusetts Department of Public Utilities (DPU) approved the Commonwealth's new Three-Year Energy Efficiency Plan, which for the first time includes incentives that could be used for behind-the-meter energy storage. This DPU order[5] demonstrates a bold new direction for energy storage funding at the state level, while expanding the opportunities for behind-the-meter battery storage applications.

In Massachusetts, two barriers needed to be overcome before energy storage could be included in the efficiency plan:

1. **Redefining efficiency.** In order to include storage within the energy efficiency plan, Massachusetts first had to include *demand reduction*, a major application of battery storage, within the efficiency plan. This underlying expansion of the Commonwealth's efficiency efforts to include demand reduction was formalized as early as 2008 with the Massachusetts *Green Communities Act*.[6]
2. **Showing that storage is cost-effective.** In order for battery storage to qualify for the efficiency plan, it first had to be shown to be *cost-effective*. This meant that batteries had to be able to pass a Total Resource Cost (TRC) test with a benefit-cost ratio (BCR) equal to or greater than 1. This was demonstrated in the CEG/AEC July 2018 white paper, *Massachusetts Battery Storage Measures: Benefits and Costs*, in Appendix 1.

These two barriers will likely be faced by every state that seeks to incorporate energy storage into its energy efficiency plan. We discuss these two barriers, and how they can be overcome, in more detail below.

REDEFINING EFFICIENCY

The first barrier to the inclusion of energy storage in energy efficiency programs is the traditional definition of electrical efficiency as "using fewer electrons." If efficiency is defined solely in terms of reduced electricity consumption, efforts to include battery storage as an efficiency measure will face high barriers due to the round-trip losses associated with battery cycling. Therefore, any effort to incorporate battery storage into an efficiency program first requires that the definition of efficiency be expanded to include energy services other than reduced consumption.

Any effort to incorporate battery storage into an efficiency program first requires that the definition of efficiency be expanded to include energy services other than reduced consumption.

In Massachusetts, the inclusion of energy storage as an efficiency measure was preceded by the recognition that in addition to reducing consumption, there is also value in shifting consumption from times of high electricity demand to times of lower demand. This peak load shifting is an increasingly important application for which batteries are well suited, and which cannot be accomplished with traditional, passive efficiency measures. Massachusetts recognized the high cost of high electricity demand (peak demand) to utility customers and to the grid and, to better address the problem, brought demand reduction measures into its efficiency program, see **Figures 1** and **2** (p. 8).

Massachusetts formally associated demand reduction with energy efficiency in the *Green Communities Act of 2008*.[7] *The Green Communities Act* requires that efficiency program administrators seek ". . . all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply." Demand reduction, in this context, includes the notion of shifting demand from peak to off-peak hours.

FIGURE 1

Traditional Efficiency Reduces Net Consumption, but Does Not Shift Peaks

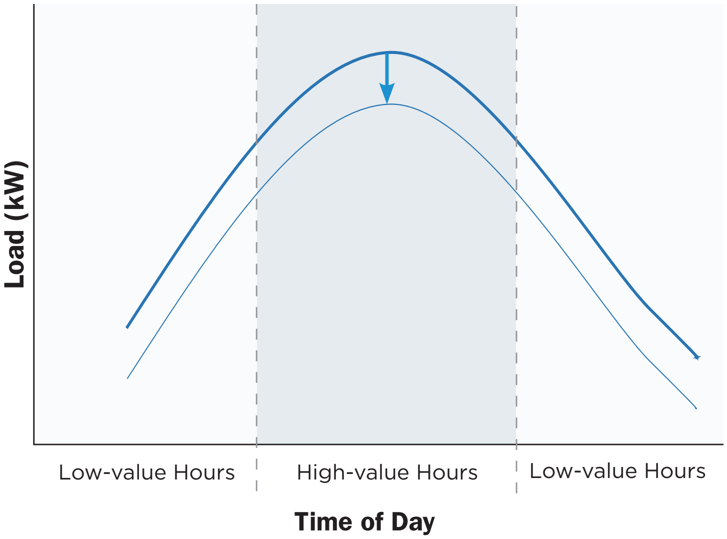
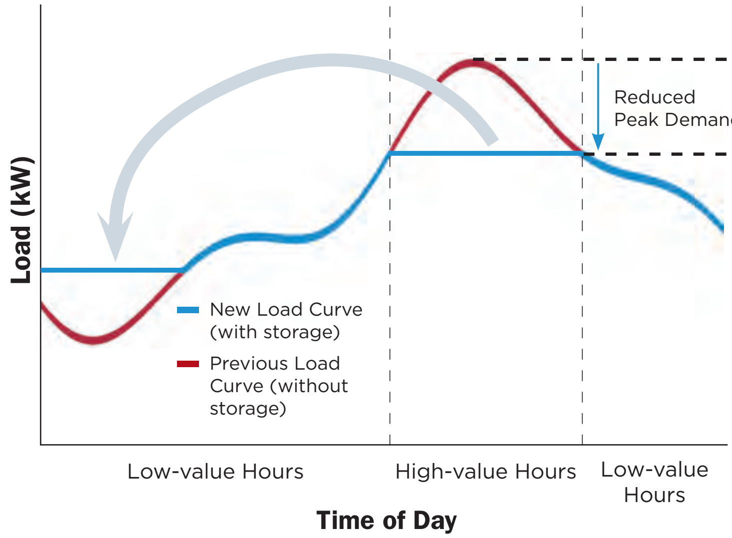


FIGURE 2

Peak Demand Reduction Shifts Peaks, but Does Not Reduce Net Consumption



Redefining efficiency—Not all load hours should be valued the same!

That this was the intent of the *Green Communities Act* was confirmed and reinforced in the *State of Charge* report, published jointly by Massachusetts Clean Energy Center (MA CEC) and Massachusetts Department of Energy Resources (MA DOER) as part of the Massachusetts Energy Storage Initiative in 2016. *State of Charge* (p. xix) notes that "Storage and other measures that shift load are firmly covered by the intent of the [Green Communities] Act" and adds, "The 2016–2018 Statewide Energy Efficiency Investment Plan ("Three Year Plan") identifies peak demand reduction as an area of particular interest in the term sheet and in the EEAC resolution supporting the Three Year Plan. . . . Energy storage, used to shift and manage load as part of peak demand reduction programs, can be deployed through this existing process." This was further reinforced by the state legislature in the 2018 "Act to Advance Clean Energy," Section 2, which specifically added active demand management technologies and called out energy storage as an allowable investment in the energy efficiency plan.

Among its many recommendations, the *State of Charge* report called for "Storage as Peak Demand Savings tool in Energy Efficiency Investment Plans" and notes on p. 162, "The [Green Communities] Act establishes the framework for developing, implementing and funding energy efficiency and demand-side management programs. The Act treats demand management (either peak load reduction or peak load shifting) the same way as energy efficiency (load reduction)."

Beyond reinforcing the legal basis for storage to be included as an efficiency measure, the *State of Charge* report also took a first step toward assessing the value of storage as a demand reduction technology. The report concluded that 40 percent of the Commonwealth's annual electricity dollars spent was attributable to just 10 percent of the top demand hours. That is, the top 10 percent demand hours in each year cost Massachusetts *nearly half* its overall electricity budget. Shifting load away from these very costly peak hours, while it does not reduce net electricity consumption, can significantly reduce costs to ratepayers and increase efficiencies across the electric system (see **Figure 3)**.

Shifting load away from these very costly peak hours, while it does not reduce net electricity consumption, can significantly reduce costs to ratepayers, and increase efficiencies across the electric system.

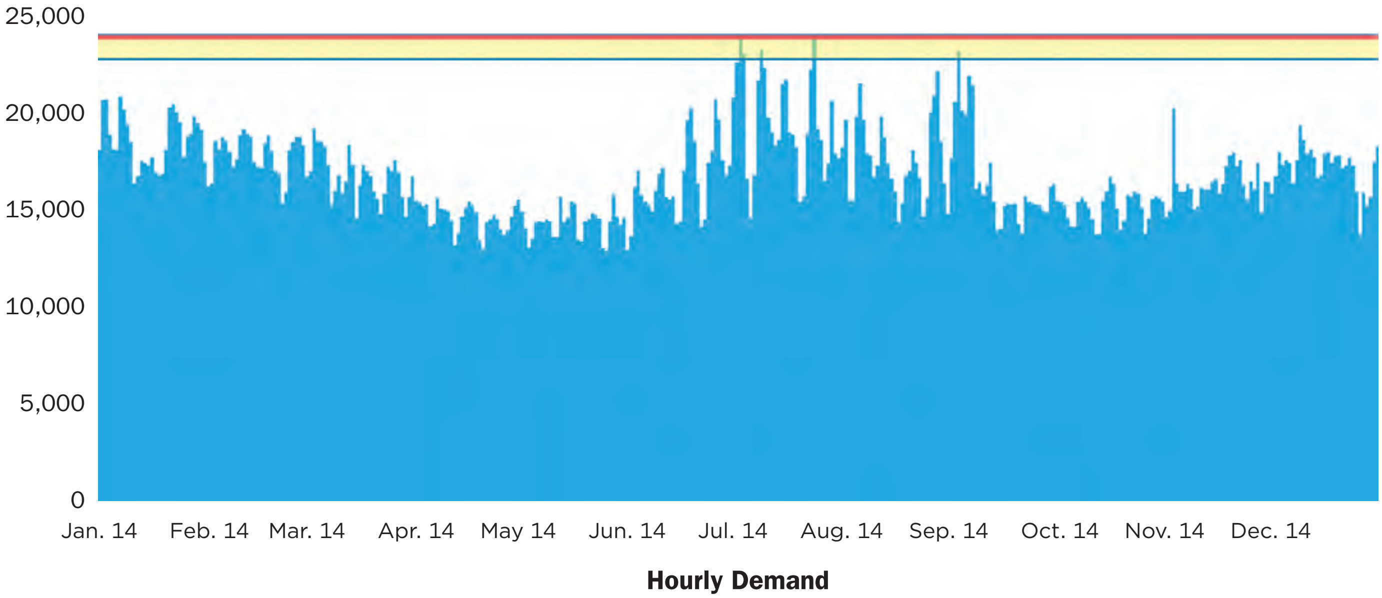
The net value of peak load reduction using behind-the-meter battery storage in Massachusetts was more specifically established in CEG's cost/benefit valuation of storage, with analysis from the Applied Economics Clinic (see Appendix 1) and, subsequently, by the Massachusetts utility program administrators' own BCRs for energy storage.

SHOWING THAT STORAGE IS COST-EFFECTIVE

Once peak demand reduction measures became eligible for inclusion in the energy efficiency plan, it remained to show that battery storage would also pass the Commonwealth's cost effectiveness test, the Total Resource Cost test (TRC).[8]

FIGURE 3

Peak-hour Demand for 2014—Whole Energy System Sized to Meet This Peak



The white area indicates inefficiencies in a system sized to meet occasional peaks.

Source: The Massachusetts *State of Charge* report

In recommending battery storage as an energy efficiency measure, the *State of Charge* report notes the importance of showing that storage can pass the TRC cost-effectiveness test. The report states,

> "In order to incorporate storage and demand reduction as full-scale programs in future Three Year Plans, the DPU must approve them as cost-effective as defined in the DPU Guidelines.... This cost effectiveness test relies on years of precedent and has been rigorously defined to support robust energy efficiency and passive demand reduction programs, but are [sic] untested for active demand response programs. It is possible that active demand reduction programs might require modification to the current cost effectiveness methodology."[9]

In 2018, CEG contracted with Liz Stanton of the Applied Economics Clinic (AEC) to produce original economic analysis[10] of distributed battery storage, using the same data and methods employed by utility program administrators in the Massachusetts energy efficiency program. AEC's initial white paper, "Massachusetts Battery Storage Measures: Benefits and Costs"[11] showed that battery storage passes the cost/benefit test required by the Commonwealth's energy efficiency program, with BCRs of 2.8 in the low-income category, and 3.4 in the commercial/industrial category. In other words, for every dollar of public money spent on battery storage, the Commonwealth would see benefits in the range of $2.80–$3.40. Therefore, according to the Massachusetts Green Communities Act,[12] battery storage should qualify for inclusion in the Massachusetts Energy Efficiency Plan.[13] These results are shown in **Table 1**. Clean Energy Group presented the findings from AEC's analysis to the DOER, the Massachusetts Energy Efficiency Advisory Council (EEAC), and the utility program administrators. These positive BCRs provided a basis for inclusion of a performance incentive that could be applied to battery storage as a demand reduction measure in the proposed new energy efficiency plan.

TABLE 1

Total Benefits and Costs by Customer Class

Parameter for 2019	Low-Income	C&I
Total Electric Benefits ($)	$36,296	$155,782
Total Resource Costs ($)	$13,163	$46,322
Benefit-Cost Ratio	**2.8**	**3.4**

Source: Applied Economics Clinic calculations

Following the release of the white paper, the utility program administrators revised their draft energy efficiency plan to include a new calculation of the cost/benefits of storage. This final plan was presented by the program administrators in October, and ultimately approved by the DPU. In this version of the energy efficiency plan, the Massachusetts utilities, using only the energy benefits of battery storage, came up with BCRs in the range of 0–6.2, as shown in **Table 2** (p. 10).

Note that the program administrators' calculated BCRs for energy storage are different depending on where storage measures are to be installed and how they are to be dispatched. For example, in **Table 2**, storage in the targeted dispatch program in the Eversource service territory is shown to have a BCR of 3.2 when installed behind a commercial/industrial

TABLE 2

Energy Benefits of Storage by Utility

BCRs	Cape Light			Eversource			National Grid			Unitil		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Residential Advanced Demand Management Program (A2e)												
Program BCRs	1.6	2.4	2.4	1.0	1.4	1.6	1.5	2.4	2.5	0.7	1.1	1.2
Direct Load Control	4.9	6.6	7.4	5.0	5.0	5.0	5.3	5.5	5.3	5.2	9.6	9.6
Behavior DR												
Storage System & Performance		3.0	3.0									
Storage Daily Dispatch				1.5	1.5	1.5	4.9	4.9	5.0			
Storage Targeted Dispatch				0.0	0.0	0.0	0.1	0.1	0.1			
EV Load Management								0.8	0.8			
Income-Eligible Advanced Demand Management Program (B1b)												
Program BCRs		2.3	2.4					2.4	2.4			
Direct Load Control												
Behavior DR												
Storage System & Performance		3.0	3.0									
Storage Daily Dispatch												
Storage Targeted Dispatch												
EV Load Management												
Commercial/Industrial Advanced Demand Management Program (C2c)												
Program BCRs	7.5	4.6	4.7	2.9	2.9	2.8	7.9	4.8	4.9	2.7	2.9	3.1
Interruptible Load	9.7	9.8	9.8	7.9	7.9	7.9	7.5	7.5	7.5	4.2	4.2	4.2
Winter Interruptible Load												
Storage System & Performance		3.0	3.0									
Storage Daily Dispatch				1.7	1.7	1.7	4.9	4.9	5.0	6.2	6.2	6.2
Storage Targeted Dispatch				3.2	3.2	3.2	0.1	0.1	0.1	0.1	0.1	0.1
Custom	8.3	8.3	8.3		2.0	2.0	1.3	1.3	1.3			

Source: AEC

This table shows the BCRs of behind-the-meter energy storage as calculated by the program administrators (i.e., utilities) in Massachusetts. Note that these BCRs are based on energy benefits, which include emissions reductions, but they do not take into account non-energy benefits in their calculations. The circled numbers show how results can vary based on sector.

meter, but a BCR of zero when installed behind a residential meter. However, overall, the program administrators' results were similar the CEG-commissioned analysis performed by AEC, showing that in most cases, battery storage is cost-effective.

The proposed new energy efficiency plan was approved by the Massachusetts DPU in January 2019. The plan is expected to provide approximately $13 million in customer-sited performance incentives for demand reduction, which could result in the installation of approximately 34 MW of new behind-the-meter battery storage over three years.

Following the energy efficiency plan's approval, CEG again contracted with AEC to produce additional analysis of battery storage BCRs, as included in the final energy efficiency plan (attached in Appendix 2 of this report).

The plan is expected to provide approximately $13 million in customer-sited performance incentives for demand reduction, which could result in the installation of approximately 34 MW of new behind-the-meter battery storage over three years.

Valuing the non-energy benefits of storage

Although energy storage passed the required cost/benefit test for most applications in the Massachusetts energy efficiency plan, it did so based solely on its energy benefits. It is important to note that storage also provides non-energy benefits, which were not included in the storage BCRs calculated for the Massachusetts energy efficiency plan. CEG therefore contracted with AEC to conduct new analysis valuing the non-energy benefits of battery storage (attached in Appendix 3 of this report).

Establishing the value of non-energy benefits of battery storage is important because unless dollar values can be assigned to these benefits, their value in state cost/benefit analyses is effectively zero. Had the value of the non-energy benefits been included in the cost/benefit calculations for energy storage in Massachusetts, the resulting BCRs would likely have been higher. When other states conduct their own cost/benefit calculations for energy storage, it is important that the non-energy benefits of storage be included; otherwise, storage may be undervalued and may not qualify for energy efficiency incentive funds.

In the "Non-Energy Benefits of Battery Storage" white paper, AEC has identified seven non-energy benefits of battery storage and calculated their values. Though this is not a comprehensive list, it shows that storage has significant non-energy benefits, which should be included in future BCR calculations.

The seven non-energy benefits of battery storage analyzed in AEC's white paper are the following:

1. Avoided power outages
    a. Energy system reliability benefit (the system-wide benefit of fewer grid outages)
    b. Non-energy reliability benefit to consumers (customer's value of backup power)
2. Higher property values (after storage is installed)
3. Avoided fines to utilities for outages
4. Avoided cost to utilities of collections and terminations
5. Avoided cost to utilities of emergency calls during outages
6. Job creation
7. Reduced land use due to peaker replacement (using distributed storage as a peaking resource to avoid investments in new fossil fueled peaker plants, which require more land)[14]

It is important that the non-energy benefits of storage be included; otherwise, storage may be undervalued and may not qualify for energy efficiency incentive funds.

These non-energy benefits are valued by AEC as shown in **Table 3** (p. 12).

Inclusion of these non-energy benefit values in future storage cost/benefit analyses should result in an even greater BCR for battery storage as a demand reduction measure, and it could justify more aggressive investment goals by the Commonwealth of Massachusetts and its utilities.

TABLE 3

Values for Additional Non-Energy Benefits of Battery Storage

	Non-Energy Benefit (2018$)
Avoided Power Outages	
Battery storage measure participants avoid outages, and all of the costs that come with outages for both families and businesses	• Residential: **$172**/kWh • Commercial/Industrial: **$15.64**/kWh
Higher Property Values	
Installing battery storage in buildings increases property values for storage measure participants by increasing leasable space, increasing thermal comfort, increasing marketability of leasable space, and reducing energy costs.	• **$5,325**/housing unit for low-income single family participants • **$510**/housing unit for owners of multi-family housing
Avoided Fines	
Increasing battery storage will result in fewer power outages and fewer potential fines for utilities	• **$24.8 million** in 2012
Avoided Collections and Terminations	
More battery storage reduces the need for costly new power plants, thereby lowering ratepayer bills, and making it easier for ratepayers to consistently pay their bills on time. This reduces the need for utilities to inititate collections and terminations.	• Terminations and Reconnections: **$1.85**/year/participant • Customer Calls: **$0.77**/year/participant
Avoided Safety-Related Emergency Calls	
Increasing battery storage results in fewer power outages, which reduces the risk of emergencies and the need for utilities to make safety-related emergency calls	• **$10.11**/year/participant
Job Creation	
More battery storage benefits society at large by creating jobs in manufacturing, research and development, engineering, and installation.	• **3.3 jobs**/MW • **$310,000**/MW
Less Land Used for Power Plants	
More battery storage reduces the need for peaker plants, which are more land-intensive than storage installations—benefiting society by allowing more land to be used for other purposes.	• **12.4 acres**/MW

Source: AEC

This table shows the values calculated by AEC for seven non-energy benefits of battery storage. These non-energy benefits should be considered by policy makers when calculating the cost/benefit for battery storage. The non-energy benefits are in addition to the energy benefits.

How the Massachusetts program incentivizes battery storage

It is important to understand that the Massachusetts Active Demand Reduction program within the Energy Efficiency Plan *incentivizes peak demand reduction, not the installation of demand-reducing technologies.* This means that customers can qualify for battery performance incentives, but there is no rebate for installing batteries. Customers must shoulder the initial investment (unless developers offer leasing or power purchase agreement options).[15]

Customers installing batteries or other peak demand reduction devices will be able to sign up for a five-year performance contract with their utility. At the end of each season (twice a year) they will be paid an incentive payment based on how much they reduced their load (use of electricity) *on average* in response to utility signals for that season. This program will be offered both to commercial and to residential customers (although a critical mass of residential customers from each area will have to sign up before the utilities issue contracts).

It is anticipated that the program will be marketed to customers by third-party developers. HEAT loans (zero-interest loans) will be available to Massachusetts customers purchasing storage equipment, but developers may also offer their own financing plans, which may include leasing as well as purchasing options.

At this writing, the program performance incentive rates were still being developed by the program administrators. For the "targeted" dispatch program, the summer rate is anticipated to be $100/kWh average load reduction, and the winter rate is anticipated to be $25/kWh average load reduction. Payouts would be calculated seasonally based on the customer's average load reduction in each season.[16]

For a commercial customer signed up for targeted dispatch, this program could provide a modest but significant incentive. For example, a commercial customer installing a 60-kWh battery system might be able to earn $2,500/year or $12,500 over the five-year contract period (for details on how this is calculated, see *duration of discharge* below).

Utility filings indicate that the Massachusetts utilities anticipate spending approximately $13 million over three years on demand reduction incentives (exclusive of the administrative costs of the program). The incentives are expected to result in about 34 MW of new behind-the-meter battery storage being installed in the Commonwealth. If the program is successful, it is reasonable to assume that these levels of investment and the resulting deployment will increase in future energy efficiency plans.

It is important to understand that the Massachusetts Active Demand Reduction program within the Energy Efficiency Plan incentivizes peak demand reduction, not the installation of demand-reducing technologies.

Only new battery installations would be eligible for an incentive. There is no requirement that batteries be paired with renewable generation, but solar+storage customers could take advantage of both the efficiency incentive and the state's SMART solar program, which includes a storage adder. Commercial customers may also be able to engage in demand charge management behind the meter, for additional savings; and solar customers can net-meter excess solar. Other upcoming state programs, such as a clean peak standard now in development, may present additional revenue opportunities for storage customers.

What this means for other states and for the battery storage industry

Clean Energy Group views the inclusion of battery storage as a demand reduction measure in the Massachusetts energy efficiency program as critically important to the development of a robust and competitive battery storage market in the Commonwealth. But beyond that, we see this as an important precedent for other states across the nation.

The larger context for this work is that battery storage has not, to date, enjoyed the kind of broad support from public clean energy funds that other clean energy technologies, such as wind and solar, have relied on. Only a few early adopter states—California, Massachusetts, New York, New Jersey, and Oregon—have established battery storage procurement mandates or portfolios; and even fewer states offer incentives for behind-the-meter battery storage deployment. Thus, there is very little material support in state policy for distributed storage.

Due to competition for public funds, it is difficult for any emerging clean energy technology to attract new dollars for the creation of a new state incentive program. On the other hand, battery storage may fit into existing incentive programs with dedicated funding. Among such programs, energy efficiency is nearly ubiquitous, and a leader in terms of committed funds. With nearly $9 billion spent nationwide in 2017, state efficiency budgets constitute an enormous resource. Equally important to the size of these budgets is their relative permanence and reliability when compared to one-off grant programs and time-limited bridge incentive funding.

The 2018 ACEEE State Scorecard[17] shows that out of the 50 states and the District of Columbia, only Alaska, Kansas and North Dakota spent no money on electric efficiency in 2017. Top annual spenders included California ($1.4 billion/year), Massachusetts ($620 million/year), and New York ($450 million/year). For the third in a row, Massachusetts is ranked first on the 2018 scorecard, which considers policy and program efforts in terms of performance, best practices, and leadership.

These state energy efficiency budgets constitute a large potential new source of support for behind-the-meter storage deployment going forward. If other states follow Massachusetts' lead, bringing demand reduction technologies like battery storage into their energy efficiency programs, battery storage could gain access to many more state incentive dollars than are currently available to it. Conversely, if peak demand-reducing measures remain segregated from mainstream efficiency measures, they will likely continue to receive a fraction of the support given to efficiency measures.

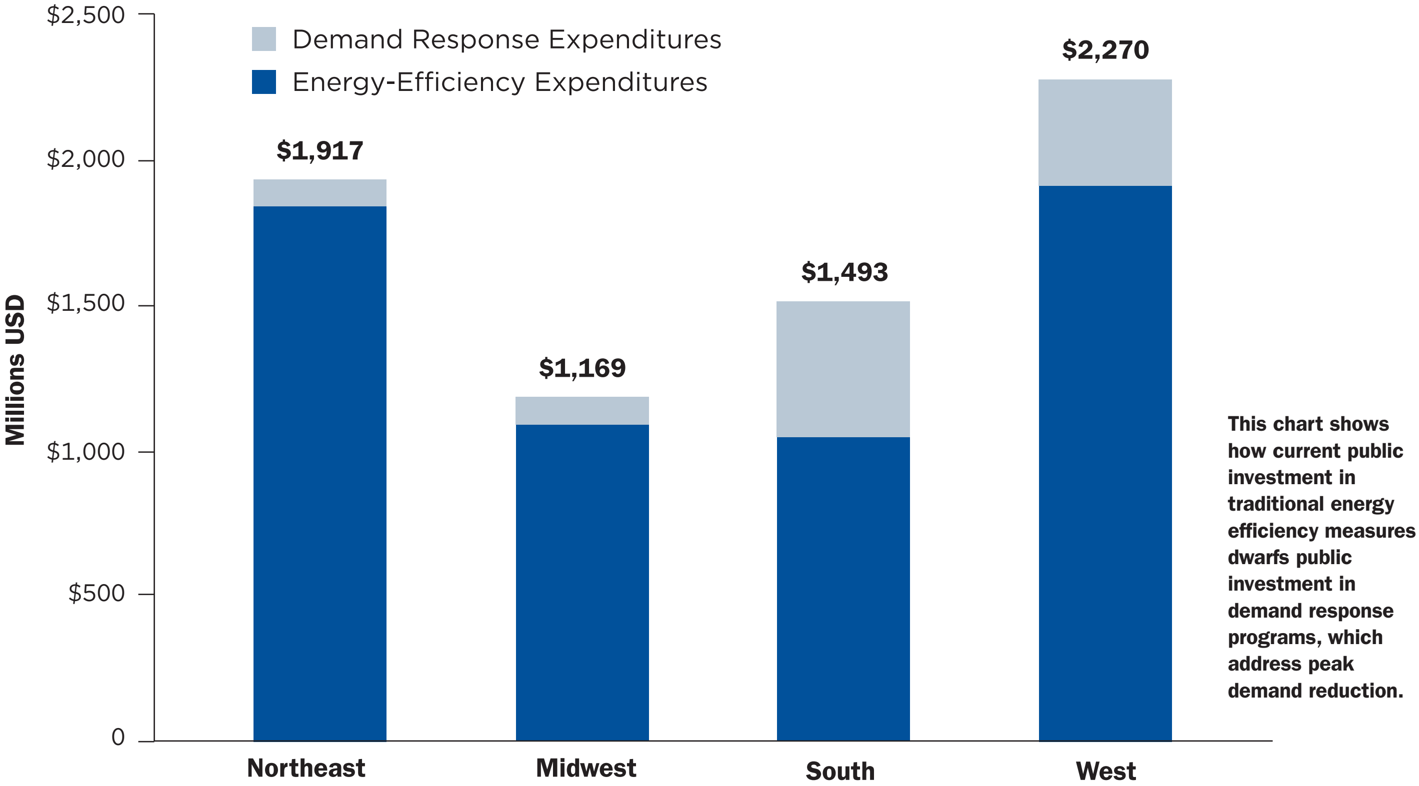
The disparity between public dollars spent on traditional energy efficiency measures versus demand reduction measures is stark. Nationally, demand reduction program budgets account for only about 16 percent of the combined energy efficiency-demand response spend in the US (see **Figure 4**).[18]

Adding battery storage to efficiency programs makes sense for several reasons. First, distributed battery storage is a good fit for efficiency programs. It works well behind the meter, delivers significant cost savings and other benefits to customers, and provides needed services not provided by traditional, passive efficiency measures. Notably, at a time when electricity demand is increasing faster than volumetric electricity sales, battery storage is capable of targeted peak demand reductions—unlike traditional measures, such as low-energy lighting and weatherization measures, which reduce net consumption but do nothing to shift demand peaks.[19] As shown by the "duck curve" phenomenon,[20] which was first noted in California but has now become evident in New England as well, the ability to shift peak loads becomes more important as more solar generation is added to the grid.

Second, it is noteworthy that the rise of battery storage comes at an opportune time, coinciding with the decline of state investment in efficient lighting programs. Long a mainstay of efficiency programs, lighting investments are now declining due to federal standards, which require light bulbs reach higher efficiencies. Unless these federal lighting regulations are rescinded,[21]

FIGURE 4

US Electric Energy Efficiency and Demand Response Expenditures by Region, 2016



Source: Consortium for Energy Efficiency 2017 Annual Industry Report

no incandescent bulb currently on the market will be able to be sold in the US by 2020, and the market will have completed its transition to fluorescent and LED bulbs.[22] Thus, state efficiency dollars currently dedicated to increased lighting efficiency will be freed up, and could be reallocated to support emerging demand reducing resources, including battery storage.

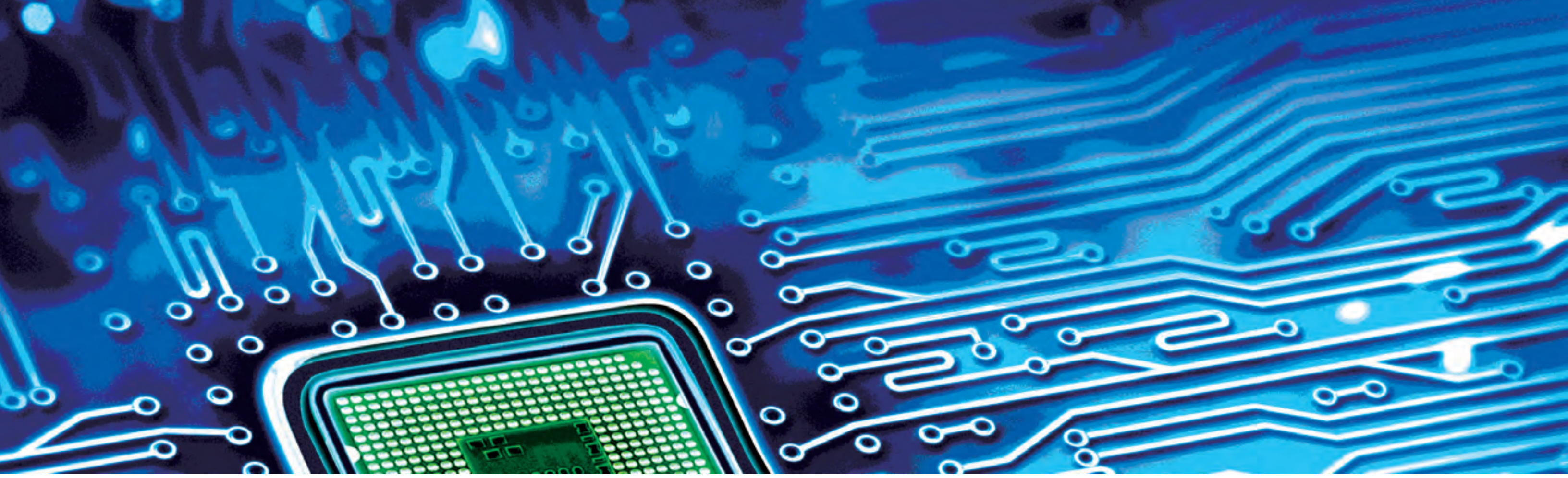
Third, customer and grid benefits are greatest when both kinds of efficiency—consumption reduction and demand reduction—are applied together. For some customers, potential reductions in electricity consumption are limited, and once these limits are reached, only demand management can provide further gains.

Commercial utility customers, in particular, frequently face steep electricity demand charges based on the highest 15-minute demand period each month. These customers need and deserve the ability to reduce demand peaks by employing battery storage behind the meter.[23] Doing so not only saves money for the storage owner—it also saves money across the electric system, by reducing the need to run costly "peaker" power plants and easing congestion on electric lines and substations.

It is also important to recognize that the integration of new technologies like battery storage is well within the history of state energy efficiency programs. In fact, the US EPA cites adding new technologies as a best practice in energy efficiency programs. In its 2008 National Action Plan for Energy Efficiency, EPA explains the importance of introducing new technologies as a best practice for efficiency programs:

> Many of the organizations reviewed have a history of providing programs that change over time to accommodate changes in the market and the introduction of new technologies . . . technology innovation that targets improved energy efficiency and energy management will enable society to advance and sustain energy efficiency in the absence of government-sponsored or regulatory-mandated programs. Robust and competitive consumer-driven markets are needed for energy efficient devices and energy efficiency service. . . . Programs must be able to incorporate new technologies over time. As new technologies are considered, the programs must develop strategies to overcome the barriers specific to these technologies to increase their acceptance.[24]

Massachusetts' groundbreaking inclusion of battery storage in its energy efficiency program is a change that should have significant and far-reaching impacts. Massachusetts is at the cutting edge in the electric efficiency sphere, and the work that has been done to incorporate and value distributed battery storage as an efficiency measure in Massachusetts should inform similar efforts in other states.



Program design considerations

The Massachusetts Three-Year Energy Efficiency Plan was shaped through a collaborative process that included state agencies, utilities, and non-governmental organizations. As the plan evolved, numerous program design considerations arose. We discuss some of these here. States looking to incorporate battery storage into their own efficiency plans will likely need to consider similar program design elements.

INCENTIVE DESIGN

In designing incentives for battery storage deployment, it is important to recognize both the unique operational and economic attributes of batteries, and the barriers they face as an emerging technology.

As discussed above, battery storage operates differently from traditional energy efficiency measures in that it does not usually reduce the net consumption of electricity, but instead, can redistribute consumption to non-peak times. In addition to this peak shifting service, battery storage can often provide other services to both the customer (such as resiliency) and the grid (such as ancillary services).

Battery storage operates differently from traditional energy efficiency measures in that it does not usually reduce the net consumption of electricity, but instead, can redistribute consumption to non-peak times.

Battery storage developers and customers may need to stack several such applications to achieve favorable battery storage project economics (see “Stacking incentives” below). Furthermore, unlike passive efficiency measures, batteries must be discharged at the right times to provide the desired demand reduction benefit; and in some cases must be charged at specific times, or from specific sources, to achieve economies and satisfy regulations and tax rules. These unique attributes should be taken into account when states design battery storage incentives, so that participation in the incentive program does not preclude the use of storage for other revenue-generating or cost-saving applications.

As an emerging technology, battery storage also faces cost and risk barriers. Installed costs of battery storage have declined rapidly in recent years but still present a barrier for customers, especially for low-income customers. Customers also shoulder the burden of economic risk, which is exacerbated when incentives come only in the form of performance incentives. Both these barriers could be addressed by an up-front rebate for battery storage systems.

Massachusetts regulators and efficiency program administrators chose to offer performance incentives for peak demand reduction in response to a utility signal, rather than a straightforward energy storage rebate upon installation. This makes sense from a program administrator’s point of view, because it incentivizes only those uses of storage that achieve the desired load reductions during demand peaks. However, it puts the burden of capital investment entirely on the customer or developer. A more traditional up-front rebate would have shifted this burden in part to the state, but that would not have provided any guarantee that the resulting installed storage capacity would provide the peak load reduction services envisioned in the plan.

Ideally, states would offer both an up-front rebate and performance incentives. This would help to make storage more affordable and accessible, especially to underserved communities, while also incentivizing peak demand reductions.

FINANCING

Another important element of a successful incentive program is financing. The Massachusetts energy efficiency plan makes energy storage eligible for the HEAT loan program, an interest-free loan offered to support the installation of efficiency measures. Unfortunately, the seven-year HEAT loan payback period exceeds the five-year incentive contract the utility program administrators will offer customers.[25] With no assurance that a second five-year contract will be offered after the initial contract period, and with incentive rates subject to change after contracts expire, HEAT loan recipients may have no way to offset the final two years of loan payments. Even during the initial five years, annual incentive payments to battery customers are unlikely to fully offset HEAT loan debt incurred as a result of battery purchases.

In practice, third-party developers may offer their own financing packages when marketing the battery incentive program. This industry financing, if offered, would provide an alternative to some customers. However, customers outside territories targeted by developers may have no recourse other than the Commonwealth's HEAT loan program.

States looking to support customer-owned battery storage deployment should consider providing low- or zero-interest financing with paybacks calibrated to coincide with performance incentive payments. Alternately, a customer rebate would help to offset equipment costs and could reduce the loan burden carried by the customer.

LOW-INCOME PROVISIONS

As noted above, battery storage is a relatively new technology that faces cost and financing barriers. These are particularly problematic when it comes to deploying the technology in low-income communities. To avoid leaving low-income customers behind, it is important that states include provisions for participation by underserved communities in storage incentive programs.

One major shortcoming of the Massachusetts plan is that it lacks any special provisions to support participation by low-income customers, referred to in the Massachusetts energy efficiency plan as "income eligible" customers (see **Table 4**).[26]

TABLE 4

Lack of Income-Eligible Programs by Utility

	Cape Light			Eversource			National Grid			Unitil		
Summer kW Savings	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**	**2019**	**2020**	**2021**
Residential Advanced Demand Management Program												
Program Summer kW Savings	1,055	2,869	3,400	2,050	3,150	4,250	6,099	8,597	11,033	94	112	135
Direct Load Control	1,055	1,618	1,861	2,000	3,000	4,000	5,156	6,785	8,278	94	112	135
Behavioral DR												
Storage System & Performance		1,250	1,539									
Storage Daily Dispatch				50	150	250	903	1,763	2,696			
Storage Targeted Dispatch												
EV Load Management							39	49	60			
Income-Eligible Advanced Demand Management Program												
Program Summer kW Savings		289	385									
Direct Load Control												
Behavioral DR												
Storage System & Performance		289	385									
Storage Daily Dispatch												
Storage Targeted Dispatch												
EV Load Management												
Commercial/Industrial Advanced Demand Management Program												
Program Summer kW Savings	5,798	6,053	6,080	28,000	57,500	96,000	69,500	79,000	90,000	300	500	500
Interruptible Load	5,395	5,458	5,485	27,000	47,000	75,000	66,000	72,000	79,000	200	400	400
Winter Interruptible Load												
Storage System & Performance		192	192									
Storage Daily Dispatch				500	5,000	10,000	2,500	5,000	7,000	100	100	100
Storage Targeted Dispatch				500	5,000	10,000						
Custom	403	403	403		500	1,000	1,000	2,000	4,000			

Source: Applied Economics Clinic

This table shows the program offerings in the Active Demand Reduction program, including battery storage. Note that none of the Commonwealth's utilities provided an income-eligible offering (the blank space indicated by the red oval). Cape Light Compact did propose income-eligible investment, but Cape Light's proposed program was not approved by the DPU.

The result is that while low-income customers can participate through the commercial and residential offerings, there is no dedicated, additional support targeted to low-income communities.

Typically, it is more difficult to provide clean energy options to low-income communities, which need clean, resilient and low-cost energy the most. States looking to incorporate storage into energy efficiency plans should include specific low-income provisions, such as an added incentive, more favorable financing, a carve-out guaranteeing a certain percentage of low-income participation, an up-front rebate, or (preferably) a combination of these.

DEFINING PEAK

Because the value of peak load shifting is tied to the value of energy at peak demand hours, it is important to ensure that these peak hours are defined in a way that 1) allows for battery storage to meaningfully shift peak loads and 2) allows these shifted peak loads to be appropriately valued.

In Massachusetts, peak hours are defined in "Avoided Energy Supply Components in New England: 2018 Report" (AESC) as being from 9 a.m. to 11 p.m. weekdays, excluding holidays, both summer (four months) and winter (eight months). As noted in AEC's July 2018 report, "This broad definition of 'peak' is not useful in representing the strategic use of batteries to relieve tight energy markets in periods of high energy demand or high energy prices."

TABLE 5
Peak/Off-Peak Hours, 2019

		Highest 10% by	
	Total Count	Energy Price	MWh
Summer Peak	1,260	0	317
Summer Off-Peak	1,668	1	313
Winter Peak	2,565	502	128
Winter Off-Peak	3,267	373	118

Source: Applied Economics Clinic calculations

From the perspective of a battery storage provider, the problem with such a broad definition of peak is twofold. First, shifting so many hours (1,260 hours in summer and 2,565 hours in winter) is not feasible (see **Table 5**). Second, the average value of any given peak hour is lowered by the sheer number of hours considered to be "peak." In other words, the more hours defined as "peak," the less valuable any given peak hour is, on average. In Massachusetts, for example, the average value of a peak MWh under this overly broad definition falls into a range of $31–$47. These prices would be significantly higher, however, if the definition of "peak" hours were restricted to the top 10 percent of hours in the year, either by price or by volumetric sales, as suggested in the *State of Charge* report.

TABLE 6
Peak/Off-Peak Hours, 2019

		Highest 10% by	
	Total Count	Energy Price	MWh
Summer Peak	$31	N/A	$37
Summer Off-Peak	$27	$69	$36
Winter Peak	$47	$80	$73
Winter Off-Peak	$42	$78	$75

Source: Applied Economics Clinic calculations

To illustrate the significance of the pricing difference, AEC showed in its July 2018 report that under the AESC definition of peak, the average avoided energy price for a winter peak hour is $47 (see **Table 6**). If defined as the top 10 percent of hours by peak pricing, the same winter peak hour is worth $80. If defined as the top 10 percent of hours by MWh sales, the same hour is worth $73.

States interested in integrating storage into an energy efficiency program should make sure to adopt a definition of "peak" that is narrow enough to allow storage measures to make a meaningful and valuable contribution.

These differences in peak load shifting values are very important for battery storage. Under an extremely broad definition of peak, such as is used in AESC 2018, storage measures represent a net cost to the electric system. Under a more restricted definition of peak as the top 10 percent of hours by price, storage provides a net benefit. Although there are other benefits of storage to be calculated (such as non-energy benefits), this fundamental definition of peak hours provides the basis of the positive BCR for battery storage.

It is important to understand that "peak" may be defined differently for different purposes, and by different entities. For example, ISO-New England recognizes a 2- and 4-hour peaks, while PJM recognizes a 10-hour peak, for their respective demand response programs. These definitions may have a great impact on how battery storage can play in wholesale markets in these regions. However, there is nothing preventing a state from using a different definition of peak within an energy efficiency program.

States interested in integrating storage into an energy efficiency program should make sure to adopt a definition of "peak" that is narrow enough to allow storage measures to make a meaningful and valuable contribution.

DURATION OF DISCHARGE

Related to the above discussion of how peak hours are defined is the issue of the duration of discharge (of the batteries) required for demand reduction measures. Where performance incentives are used, the duration of discharge can have a significant impact on the economic viability of battery storage. The Massachusetts program administrators have indicated that they will call for demand reduction in three-hour blocks. For example, a customer might be called upon to reduce their load from 2 p.m. until 5 p.m. Because the incentive payment is based on the average hourly load reduction across all the hours called in a season, this three-hour signal effectively reduces battery capacity to one-third its nameplate capacity, for purposes of calculating the seasonal incentive payment.[27]

As an example, consider a customer who has a 60-kW battery. When responding to a three-hour call by the utility, the maximum average load reduction possible across those three hours is 20 kW. This average is then multiplied by the incentive rate to arrive at the incentive payment. If the utilities instead employed a two-hour load-reduction call, the same battery would be capable of an average reduction of 30 kW per hour, resulting in a higher incentive payment at season's end. Given a 100/kW incentive rate (the targeted dispatch program's summer rate), the difference in annual incentive payments is significant:

Three-hour call: 20 kW x $100 = $2,000 seasonal payment

Two-hour call: 30 kW x $100 = $3,000 seasonal payment

Note that under the targeted dispatch program, the winter rate is only $25/kWh, so signing up for the winter season does not add much to the customer's annual payout.

Assuming a 60 kW battery (maximum 20 kW load reduction average):

Summer payout = 20 kW x $100 = $2,000

Winter payout = 20 kW x $25 = $500

Annual revenue = $2,500

States that design an incentive based on this average load-reduction model should be aware that the longer the duration of load-reduction calls by the utility, the lower the incentive payment will be to the customer.[28]

MEASURING BENEFITS

The need to show that battery storage passes a cost-effectiveness screen is not unique to Massachusetts. Most states require some sort of cost-effectiveness screening, not only for energy efficiency plans, but also for other types of clean energy incentive programs. Where a benefit/cost test is required, a full accounting of the benefits of battery storage should include both energy benefits and non-energy benefits.

The Massachusetts program administrators' BCR calculations for the 2019–2021 efficiency plan, as shown in **Table 2** (p. 10), are based on the energy benefits of storage, but they do not take into account its many non-energy benefits. These non-energy benefits were omitted despite the fact that they are commonly used in calculating the BCR of traditional efficiency measures in Massachusetts. The current Massachusetts energy efficiency plan describes non-energy benefits, here referred to as non-energy impacts (NEIs), thus:

> "A NEI is a benefit (positive or negative) for participants in energy efficiency beyond the energy savings gained from installing energy efficient measures. NEIs include benefits such as reduced costs for operation and maintenance associated with efficient equipment or practices, or reduced environmental and safety costs. The Department has stated that NEIs are 'a well-established component of the program cost-effectiveness analyses conducted by the Program Administrators' and found that the benefits of the NEIs are quantifiable and flow to Massachusetts ratepayers. 2013-2015 Order at 61. The Department has specifically stated that non-resource benefits (NEIs) should be included in cost-effectiveness. Guidelines at §§ 3.4.4.1, 3.4.4.2."[29]

The plan goes on to state that the program administrators have included benefits associated with NEIs in the current plan's cost-effectiveness calculations for a number of measures, including low-income, health- and safety-related NEIs, C&I new construction NEIs, residential multi-family common area lighting NEIs, residential heat pump NEIs, and others. However, the non-energy benefits of energy storage were not included, meaning that energy storage technologies were likely undervalued compared to other measures included in the plan. A more accurate accounting of the BCR of energy storage would have included its non-energy benefits.

Most states require some sort of cost-effectiveness screening, not only for energy efficiency plans, but also for other types of clean energy incentive programs.

When states omit non-energy benefits from cost/benefit calculations, the value of those non-energy benefits defaults to zero for purposes of finding the BCR of the measure. The result is that the measure being considered will be undervalued, and it may not pass the cost-effectiveness screen. Therefore, it is important for states to begin to assign values to the non-energy benefits of battery storage.

In addition to the omission of non-energy benefits, there are a number of other omissions and errors in the valuation of battery storage in the 2019–2021 Massachusetts energy efficiency plan. The most important of these are discussed in more detail in the Appendices. Future work may focus on further analysis of some of these issues.

It should be noted that calculating the BCR of battery storage is a complicated task that relies on previously established values for services such as avoided emissions and avoided energy demand reduction induced price effects (DRIPE). Many of these underlying values may not be the same for all states. For example, the values associated with avoided emissions and increased capacity will vary from state to state and market to market. Therefore, while the values of various storage benefits presented in this report may serve as a good baseline for other states, additional work may be needed to fully adapt these values to the needs of other states' policymakers.

OWNERSHIP ISSUES

Issues around the ownership and control of battery storage resources are important, and they should be considered carefully when states design storage incentive plans or incorporate storage into existing programs, such as energy efficiency plans. In order to advance battery storage deployment, it is important that customers retain rights of ownership and control of storage resources behind their electric meters.

This is important due to the need to stack benefits, as described below (see "Stacking Incentives").

In order to advance battery storage deployment, it is important that customers retain rights of ownership and control of storage resources behind their electric meters.

Though it does not address issues of battery ownership directly, the Massachusetts energy efficiency plan assumes customer and third-party ownership of battery resources behind the meter. However, Massachusetts law places no restrictions on utility ownership of storage, meaning that utilities could have opted to offer customers utility-owned batteries, as Green Mountain Power has done in Vermont, and Liberty Utilities is doing in New Hampshire.[29] Such a move could have had a negative effect on the nascent distributed, customer-sited battery storage industry in the Commonwealth rather than supporting its development; and future customers could have faced a potential utility monopoly when pursuing battery storage options.

Similar to issues of battery ownership are issues of the ownership and control of battery attributes that have their own market values, such as capacity. This was the subject of a recent Massachusetts DPU docket. In January 2019, the DPU issued a ruling[31] allowing customers to buy back the capacity assets of behind-the-meter, solar+battery storage systems, to which the utilities had previously claimed rights of ownership. This is an important issue not only because battery capacity is a monetizable asset, but also because control over it can determine when and whether customers control the dispatch (use) of their own battery systems. This in turn has significant implications for project economics, particularly for commercial customers who wish to use batteries for demand charge management. If utilities are allowed to own the capacity rights to behind-the-meter battery storage and bid this capacity into markets, as they do in the case of net-metered solar, this can prevent customers from using batteries to reduce demand charges, because the utilities may leave batteries depleted at times when customers need to use them to reduce their own electricity demand.

In the case of the Massachusetts energy efficiency plan, the program administrators will not directly dispatch behind-the-meter storage resources, but instead will compensate customers based on their average load reduction in response to a utility signal. This means customers retain the ability to use their batteries for other purposes if they judge those purposes to be more valuable than the efficiency performance incentive. There is no penalty for failing to respond to a utility dispatch signal, but it does lower the yearly average load reduction, which is used to calculate the customer's incentive payment.

States looking to incorporate batteries into an efficiency program should be aware of this aspect of incentive design. If customers lose control of their battery storage equipment (e.g., utilities can remotely discharge batteries without customer consent), their ability to stack benefits decreases (see "Stacking Incentives," below). In this case, incentive rates may need to be higher to make customer participation worthwhile. The same logic applies to cases where failure to respond to a dispatch call can result in a fine.

STACKING INCENTIVES

Battery storage owners and developers often configure battery systems in such a way as to allow "benefit stacking." This refers to the ability of a single battery system to provide numerous benefits, often generating savings from several incentive or revenue streams. The ability to stack incentives and applications is important, because it gives customers flexibility; and it can help to further defray the cost of investing in a battery system. It follows the principle of allowing battery storage owners to be compensated fairly for all the services that the batteries are able to provide.

For example, a commercial customer who installs a new solar+storage system in Massachusetts may qualify for a SMART solar incentive (rebate) with a storage adder, as well as an energy efficiency demand-reduction incentive.

The customer may be able to net meter solar generation and may also engage in demand charge management (reducing the monthly demand charge that is part of commercial utility bills). Being able to stack values in this way allows the customer greater flexibility and helps to offset the cost of installing the solar+storage system.

Other states interested in developing battery storage policy should consider how various state programs and storage markets may interact, to avoid unduly limiting how the storage resource can be used. Opportunities for combining incentives and market programs should be clearly spelled out to reduce confusion and give consumers and developers a clear understanding of potential project economics, which is important to obtain financing.

TRANSPARENCY

During the development of the Massachusetts energy efficiency plan, numerous stakeholders noted a lack of transparency which made it difficult to provide meaningful stakeholder input. Lack of transparency has also been noted as a shortcoming of the final plan, which leaves significant design elements vague.

For example, the program administrators have stated in docket filings that they intend to offer residential contracts for load reduction performance incentives (for which storage would be eligible) only after a critical mass of applications has been received.[32] However, there is nothing in the plan identifying how many applications are needed to trigger the offer. This creates uncertainty and hinders the efforts of developers in marketing the program to their customers.

Vague, inconsistent, and opaque program language should be avoided when states design battery storage incentive programs.

Similarly, in their white papers, AEC notes that such fundamental terms as "measure" are used to mean different things by different program administrators in different parts of the plan. This kind of internal inconsistency makes it difficult to understand what incentives are available to customers.

Vague, inconsistent, and opaque program language should be avoided when states design battery storage incentive programs. States looking to adapt portions of the Massachusetts energy efficiency plan to support their own policy development for battery storage should be aware of these internal inconsistencies and avoid replicating them. For example, a state could require utilities to agree on the definition of important terms such as "measure," which are necessary to understand how an efficiency program works and what various incentives are worth to customers.

What states should do to promote battery storage

While Massachusetts' integration of battery storage into its energy efficiency plan as a demand reduction measure is not perfect, it does provide a model for other states to follow, along with some lessons learned as identified below.

Other states that are leaders in clean energy programs and policy should consider following the example of Massachusetts. These states should understand that the changing electricity system presents a need and opportunity to identify new types of efficiency. Among these, peak demand reduction will be increasingly important. It is critical that technologies capable of reducing peak demand, such as battery storage, be incorporated fully into state energy efficiency programs, so that behind-the-meter storage markets can come to scale, with incentives commensurate to those offered other clean energy and efficiency measures.

Other states that are leaders in clean energy programs and policy should consider following the example of Massachusetts.

Here are some lessons learned from Massachusetts for states to consider:

- Expand the definition of energy efficiency to include peak demand reduction. This means that state energy efficiency goals would include peak demand reduction goals, and that peak demand reduction measures would be made eligible for efficiency incentives.
- Fully integrate demand reduction measures, including battery storage, into state energy efficiency plans.
  - In some states with separate demand reduction targets and budgets, this might mean merging the efficiency and demand reduction budgets into a single program that encompasses both energy efficiency and demand reduction goals.
- Establish battery storage or demand reduction incentives within the energy efficiency program.
  - These should, in general, include three basic elements: an up-front rebate, a performance incentive, and access to financing.
  - These should also include adders and/or carve-outs for low-income customers. These customers need the cost savings and other benefits of new clean energy technologies the most but are typically the last to gain access.
  - Utility ownership should be limited, so that some substantial portion of the storage deployed will be owned by customers and/or third parties.
  - Third-party developers should be allowed to market the program to customers, provide private financing, offer lease and PPA models, and aggregate capacity to meet program goals.
- Adopt, adapt and build on the economics analysis presented here.
  - Cost/benefit analyses of storage should be conducted using whatever cost-effectiveness tests states apply to other energy efficiency measures. These might include the Total Resource Cost Test, the Societal Cost Test or the Utility/PACT test.
  - BCRs should be calculated based on both the energy and the non-energy benefits of storage.
  - Additional non-energy benefits of storage should be identified and valued.

Key Findings and Conclusion

Many studies have concluded that battery storage offers immense value to the electric grid as well as to consumers. The benefits of storage include not just renewables integration and peak shifting, but other services such as increased resiliency, reduced transmission and distribution investment, ancillary services provision, arbitrage and black start capability. The challenge has been that markets do not yet exist for most of these services; and without markets, it has been very difficult for policymakers to assign values to these benefits of storage, or for storage providers to sell and be compensated for these benefits.

This market failure is a major finding of the Massachusetts *State of Charge* report, which concludes, "The biggest challenge to achieving more storage deployment in Massachusetts is the lack of clear market mechanisms to transfer some portion of the system benefits (e.g., cost savings to ratepayers) created to the storage project developer."[33]

The same problem is discussed in the Massachusetts energy efficiency plan itself, which notes, "There is no beneficial value proposition for individual residential customers to participate in active demand offerings [including battery storage] absent Program Administrator incentives. However, peak demand reductions through active demand management can have a system benefit that reduces overall capacity and temporal-energy costs for all customers."[34]

This basic market failure is a familiar one, and it is one reason why many states invest public funds to support development and deployment of new advanced clean energy resources. However, the investment of public funds, in itself, often requires states to show that this investment will result in a positive return. To do this, it is necessary to attribute dollar values to the many benefits of behind-the-meter battery storage.

This report begins to address the challenges of valuing battery storage by showing that it can and does pass a Total Resource Cost test in Massachusetts; and furthermore, that storage provides many additional non-energy benefits that have definable monetary value in Massachusetts, and that could (and should) be incorporated into future cost/benefit analyses, both in Massachusetts and in other states.

The biggest challenge to achieving more storage deployment in Massachusetts is the lack of clear market mechanisms to transfer some portion of the system benefits (e.g., cost savings to ratepayers) created to the storage project developer.

This report also documents incentive design issues arising from this first-ever inclusion of energy storage in a state energy efficiency plan. These design issues will need to be considered by other policy makers that wish to follow the lead of Massachusetts. The lessons learned from Massachusetts, as discussed in this report, should inform similar efforts in other states.

More work remains to be done to more accurately define the value of storage, including expanding on the non-energy benefits of storage—analyzed for the first time in this report—as well as to further refine program design for storage within state energy efficiency plans. However, this report should provide valuable information to state policymakers and regulators working to incorporate storage in efficiency and other incentive programs.

Key take-aways from this report:

1. At least two major barriers had to be overcome in order to incorporate energy storage into the Massachusetts energy efficiency plan: first, peak demand reduction had to be incorporated into the energy efficiency program; and second, storage had to be shown to pass cost-effectiveness screens. Other states will likely have to confront these barriers when incorporating storage into their own energy efficiency plans.

   a. Peak demand reduction is an important new kind of electric efficiency that offers benefits both to customers and to the grid. Battery storage is a critical technology for shifting peaks when installed behind the customer's meter.

   b. Battery storage passes the Massachusetts cost/benefit test and has been incorporated into the Massachusetts energy efficiency plan for 2019–2021. About 34 MW of behind-the-meter battery storage is expected to be installed in MA over three years under load reduction performance contracts worth about $13 million in customer incentives. Other states should follow the example of Massachusetts and conduct their own cost/benefit analysis of behind-the-meter energy storage.

2. The non-energy benefits of energy storage have significant value and should be included in cost/benefit analyses. This was not done in the 2019–2021 Massachusetts Energy Efficiency Plan but should be included in future iterations of the plan and should be considered by other states when developing energy storage incentives.

3. Numerous program design issues should be addressed when states contemplate creating battery storage incentives, whether within an efficiency plan, or as a free-standing rebate. These include: Incentive design, Defining peak, Dispatch duration, Measuring benefits, Ownership issues, Low-income provisions, Stacking incentives, and Transparency.

4. More work is needed to continue to refine and expand the value of battery storage, including the identification and valuation of more non-energy benefits. Establishing a more accurate BCR for distributed storage will support its inclusion in state energy efficiency programs and other incentive programs (such as rebates) that require measures pass a cost-effectiveness screen. If this is not done, storage will continue to be at a disadvantage relative to other technologies and may not qualify for state incentive programs.

5. State energy efficiency programs represent an important potential source of incentive funding for distributed battery storage. Most states have energy efficiency programs, and these programs collectively represent an investment of nearly $9 billion in public funds annually. Bringing new technologies like storage into state energy efficiency programs is a recommended "best practice."

At least two major barriers had to be overcome in order to incorporate energy storage into the Massachusetts energy efficiency plan: first, peak demand reduction had to be incorporated into the energy efficiency program; and second, storage had to be shown to pass cost-effectiveness screens.

ENDNOTES

1 The Commonwealth of Massachusetts. "Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan 2019–2021." *Department of Public Utilities.* October 31, 2018. *http://ma-eeac.org/wordpress/wp-content/uploads/Exh.-1-Final-Plan-10-31-18-With-Appendices-no-bulk.pdf*.

2 In addition to conducting the economic analysis presented here, CEG advocated for program design elements in the Massachusetts Energy Efficiency plan that would support customer choice, allow the participation of third-party installers and aggregators, provide significant financing and incentives—with an emphasis on the needs of low-income customers and underserved communities—and ensure a competitive and diverse market for behind-the-meter battery storage in Massachusetts.

3 Although it is the first to fully incorporate energy storage into its energy efficiency program, Massachusetts is not the first state to recognize the importance of storage for peak demand reduction. Arizona Corporation Commission (ACC) has included peak demand reduction in its state energy efficiency resource standard, although it caps the contribution of peak demand reductions at 2% (the overall goal is 22% cumulative energy savings by 2020). ACC also ordered Arizona Public Service, the state's largest utility, to develop a residential demand response or load management program that facilitates energy storage technology. APS developed the Demand Response, Energy Storage and Load Management (DRESLM) initiative, which was approved by the ACC in 2016 and offered to customers in 2017. In 2018 APS expanded the DRESLM initiative to include both residential and non-residential customers. ACC has also ordered all regulated Arizona utilities to include energy storage in their integrated resource plans, or explain why it is omitted. For more information on the APS Demand Side Management plan, see *https://www.aps.com/en/ourcompany/aboutus/energyefficiency/Pages/home.aspx*.

4 United States Environmental Protection Agency. "National Action Plan for Energy Efficiency, Chapter 6: Energy Efficiency Program Best Practices." 2015. *https://www.epa.gov/energy/energy-efficiency-program-best-practices*.

5 The Commonwealth of Massachusetts, Department of Public Utilities. *Three Year Energy Efficiency Plans Order.* D.P.U. 18-110 through D.P.U. 18–119. January 29, 2019. *https://www.mass.gov/files/documents/2019/01/31/2019-2021%20Three-Year%20Energy%20Efficiency%20Plans%20Order_1.29.19.pdf*.

6 An Act Relative to Green Communities. The Commonwealth of Massachusetts, Chapter 169. July 2, 2008. Retrieved March 13, 2019. *https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169*.

7 The Commonwealth of Massachusetts. M.G.L. c.25, §21. Retrieved March 12, 2019. https://malegislature.gov/Laws/GeneralLaws/PartI/TitleII/Chapter25/Section21.

8 At the time of this analysis, Massachusetts required individual efficiency measures to pass the TRC cost-effectiveness test. The 2018 Act to Advance Clean Energy amended this requirement so that it now applies to entire sectors rather than individual measures. Note that although the total resource cost test (TRC) is the most commonly used, many states use other cost-effectiveness tests such as the participant cost test (PCT), the utility/program administrator cost test (PACT), the ratepayer impact measure test (RIM), and the societal cost test (SCT). This report does not address how battery storage would fare in tests other than the TRC. For more information on the differences between different types of cost-effectiveness tests, see: National Action Plan for Energy Efficiency. "Understanding Cost-Effectiveness of Energy Efficiency Programs: Best Practices, Technical Methods, and Emerging Issues for Policy-Makers." *United States Environmental Protection Agency and United States Department of Energy.* November 2018. *https://www.epa.gov/sites/production/files/2015-08/documents/cost-effectiveness.pdf*, and Daykin, Elizabeth et al. "Whose Perspective? The Impact of the Utility Cost Test." *Cadmus Group.* December 2011. *https://www.cadmusgroup.com/wp-content/uploads/2012/11/TRC_UCT-Paper_12DEC11.pdf*.

9 Massachusetts Department of Energy Resources and Mass Clean Energy Center. "State of Charge: A Comprehensive Study of Energy Storage in Massachusetts." September 27, 2016. *https://www.mass.gov/service-details/energy-storage-study*.

10 Stanton, Elizabeth A. "Massachusetts Battery Storage Measures: Benefits and Costs." *Clean Energy Group.* July 2018. *https://www.cleanegroup.org/ceg-resources/resource/massachusetts-battery-storage-measures-benefits-and-costs*.

11 Ibid.

12 An Act Relative to Green Communities. The Commonwealth of Massachusetts, Chapter 169. July 2, 2008. Retrieved March 13, 2019. *https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169*.

13 Ibid. The Green Communities act states that "Every three years. . . the electric distribution companies and municipal aggregators with certified efficiency plans shall jointly prepare an electric efficiency investment plan.… Each plan shall provide for the acquisition of all available energy efficiency and demand reduction resources that are cost effective or less expensive than supply."

14 Note that the land use benefit is presented in acres rather than dollars. This is because it is difficult to know the value of the land required for a prospective new peaker plant. However, this benefit could be quite valuable. For example, the average value of land in Boston is $600,000 per acre according to a recent report: Albouy, David et al. "Metropolitan Land Values." *The Review of Economics and Statistics.* July 2018, 100(3): 454–466. *http://davidalbouy.net/landvalue_index.pdf*. Based on this average, the formula to find the value of land saved through use of distributed storage to replace a peaker plant planned for Boston would be $600,000 x 12.4 x MW capacity of peaker. For example, avoiding development of a 60 MW peaker in Boston could save $446.4 million in avoided land use

value. Of course, all land value is highly locational; and this only provides a very rough estimate, which would be different for different cities.

15 Clean Energy Group (CEG) had originally proposed a stand-alone battery storage rebate plan for Massachusetts. Due to a lack of available funds for such a rebate, this proposal was put on hold temporarily, in favor of incorporating storage into the energy efficiency budget. CEG supported this effort, but also continues to advocate for a battery storage rebate, which could be provided within the Commonwealth's energy efficiency plan or as a stand-alone program.

16 There is also a daily dispatch program, which may offer higher incentive rates in exchange for more frequent battery cycling, but this is being offered initially as a pilot program, and may be expanded to a full program offering in coming years.

17 Berg, Weston, et al. "The 2018 State Energy Efficiency Scorecard." *American Council for an Energy-Efficient Economy.* Research Report U1808. October 2018. *https://aceee.org/research-report/u1808*.

18 Consortium for Energy Efficiency. "State of the Efficiency Program Industry: Budgets, Expenditures, and Impacts 2017." March 2018. *https://www.cee1.org/annual-industry-reports*.

19 In this regard, storage is part of an emerging field of smart and grid interactive energy efficiency measures which address, to varying degrees, load shifting and reduced consumption behind the meter. These include wireless thermostats, remotely controlled HVAC and water heater systems, and the like.

20 Spector, Julian. "Massachusetts Is Staring Down a Duck Curve of Its Own. Storage Could Help." *GTM^2.* April 23, 2018. *https://www.greentechmedia.com/articles/read/massachusetts-is-staring-down-a-duck-curve-of-its-own-storage-could-help#gs.3388ma*.

21 deLaski, Andrew and Steve Nadel. "Rollback of light bulb standards would cost consumers billions—$100 per household each year." *The Appliance Standards Awareness Project (ASAP)* and *The American Council for an Energy-Efficient Economy (ACEEE).* February 6, 2019. *https://aceee.org/press/2019/02/rollback-light-bulb-standards-would*.

22 Granda, Chris. "Impacts of the 2020 Federal Light Bulb Efficiency Standard." *Strategies.* February 2018. *https://appliance-standards.org/sites/default/files/AESP2020LightingStandards.pdf*.

23 Commercial/industrial customers in Massachusetts face some of the highest demand charges in the nation, but a recent study conducted by CEG and NREL shows that high demand charges can be found in many parts of the country. See: McLaren, Joyce and Seth Mullendore. "Identifying Potential Markets for Behind-the-Meter Battery Energy Storage: A Survey of U.S. Demand Charges." *National Renewable Energy Laboratory* and *Clean Energy Group.* August 24, 2017. *https://www.cleanegroup.org/ceg-resources/resource/nrel-demand-charges-storage-market*.

24 Environmental Protection Agency. "National Action Plan for Energy Efficiency, Chapter 6: Energy Efficiency Program Best Practices." August 2015. *https://www.epa.gov/energy/energy-efficiency-program-best-practices*.

25 The Massachusetts energy efficiency plan provides for contractual battery storage performance payments to customers over a five-year term. This is an unusual offering in that the incentive term is longer than the term of the three-year energy efficiency plan.

26 In the efficiency plan proposed by the PAs to the DPU, only Cape Light Compact proposed any batteries for income eligible customers. The Cape Light Compact plan was opposed by Eversource and the DPU did not approve it. At this writing it is uncertain whether the Cape Light Compact plan will eventually go forward as proposed.

27 This is because a battery would not have time to discharge, recharge and discharge again during a period of three consecutive hours.

28 Technically, this type of performance incentive can be considered a "payment for performance," rather than a traditional incentive.

29 The Commonwealth of Massachusetts. "Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan 2019–2021" (page 119–120). *Department of Public Utilities.* October 31, 2018. *http://ma-eeac.org/wordpress/wp-content/uploads/Exh.-1-Final-Plan-10-31-18-With-Appendices-no-bulk.pdf*.

30 The Liberty and GMP programs offer residential customers a utility-owned battery in exchange for a monthly fee. The customer can use the battery for backup power in case of a grid outage; during normal operations, the utility draws on the battery to reduce peak demand.

31 The Commonwealth of Massachusetts, Department of Public Utilities. *Net Metering, Smart Provision, And the Forward Capacity Market.* D.P.U. 17-146-B. February 1, 2019. *https://d12v9rtnomnebu.cloudfront.net/library-page/D.P.U._17-146-B_Order_02.01.19.pdf*.

32 The program adminstrators' response to the DPU's Information Request DPU-Electric 2-3, wherein the program administrators state that they "may not offer the statewide storage offerings if they cannot achieve cost-effectiveness, i.e., if there are not enough storage devices already deployed and willing to enroll to be able to overcome any fixed costs necessary to offer the program."

33 Massachusetts Energy Storage Initiative. "State of Charge." *Massachusetts Department of Energy Resources (DOER)* and *Massachusetts Clean Energy Center (MassCEC)* (page xiii). July 2017. *https://www.mass.gov/files/2017-07/state-of-charge-report.pdf*.

34 The Commonwealth of Massachusetts. "Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan 2019–

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Appendix 1

MASSACHUSETTS BATTERY STORAGE MEASURES: BENEFITS AND COSTS

Massachusetts Battery Storage Measures: Benefits and Costs

July 2018 – White Paper

Applied Economics Clinic

Prepared for:

Clean Energy Group

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About Clean Energy Group

Clean Energy Group (CEG) is a leading national, nonprofit advocacy organization working on innovative policy, technology, and finance strategies in the areas of clean energy and climate change. CEG promotes effective clean energy policies, develops new finance tools, and fosters public-private partnerships to advance clean energy markets that will benefit all sectors of society for a just transition. CEG assists states and local governments to create and implement innovative practices and public funding programs for clean energy and resilient power technologies. CEG manages the Clean Energy States Alliance (CESA), a national nonprofit consortium of public funders and agencies working together to accelerate clean energy deployment. Learn more at www.cleanegroup.org.

About Applied Economics Clinic

The Applied Economics Clinic is a 501(c)(3) non-profit consulting group housed at Tufts University's Global Development and Environment Institute. The Clinic provides expert testimony, analysis, modeling, policy briefs, and reports for public interest groups on the topics of energy, environment, consumer protection, and equity, while providing on-the-job training to a new generation of technical experts.

1. Introduction

Lithium-ion batteries for electric storage are considered in Massachusetts' energy efficiency program administrator's 2019-2021 draft plan, released April 30, 2018,[1] and addressed, partially, in the "BCR Model" spreadsheets (publicly released in June 2018) used to calculate cost-effectiveness in the April draft plan. Massachusetts' assessment of the cost-effectiveness of electric demand and peak-reducing measures' depends on the "BCRs"—or benefit-cost ratios—estimated in these spreadsheets. For measures to be included in the funding allocation and program implementation described in the 2019-2021 plan they must receive a benefit-cost ratio of 1.0 or higher; that is, a measure's benefits must have a higher value than its costs.

This Applied Economic Clinic white paper provides the calculations and assumptions necessary to estimate complete 2019 benefit-cost ratios for battery storage measures in Massachusetts, using a methodology identical to that of the program administrator's own "BCR Model" spreadsheets for the 2019-2021 and previous three-year efficiency plans. The resulting Massachusetts benefit-cost ratios for battery storage in 2019 are:

- 2.8 for a single-family home battery under the low-income efficiency program
- 3.4 for a multi-family apartment complex battery under the commercial and industrial efficiency programs

The benefits of electric battery storage outweigh their costs, and, therefore, must be offered by Massachusetts electric program administrators to their customers, in accordance with the Green Communities Act.[2] This white paper reviews the calculation of a value for battery storage of the cost and each type of benefit included in Massachusetts' cost-effectiveness assessment: avoided energy, avoided energy demand reduction induced price effects (DRIPE), summer generation capacity, winter generation capacity, electric capacity DRIPE, transmission, distribution, and reliability, non-energy benefits, and non-embedded environmental costs. Of these benefits, avoided capacity costs are by far the most substantial.

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[1] Massachusetts Program Administrators. 2018. "Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan: 2019-2021". http://ma-eeac.org/wordpress/wp-content/uploads/2019-2021-Three-Year-Energy-Efficiency-Plan-April-2018.pdf

[2] The General Court of the Commonwealth of Massachusetts. 2008. Acts 308-80: An Act Relative to Green Communities. Chapter 169. https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169.

2. Engineering Assumptions

Lazard's *Levelized Cost of Storage 3.0* report outlines two behind-the-meter energy storage use cases: Case 4, commercial, and Case 5, residential.[3] Case 4, commercial, represents storage "designed for behind-the-meter peak shaving and demand charge reduction services for commercial energy users" while Case 5, residential, represents storage "designed for behind-the-meter residential home use," that "provide backup power, power quality improvements and extend the usefulness of self-generation".[4] This analysis adopts the lithium-ion assumptions for both Cases.

Figure 1 presents the technical parameters of all cases, with Cases 4 and 5 highlighted.

Figure 1. Energy storage use cases—operational parameters

		Project Life (Years)	MW[(1)]	MWh of Capacity[(2)]	100% DOD Cycles/Day[(3)]	Days/ Year[(4)]	Annual MWh	Project MWh
In-Front-of-the-Meter	1 Peaker Replacement	20	100	400	1	350	140,000	2,800,000
	2 Distribution	20	10	60	1	350	21,000	420,000
	3 Microgrid	10	1	4	2	350	2,800	28,000
Behind-the-Meter	4 Commercial	10	0.125	0.25	1	250	62.5	625
	5 Residential	10	0.005	0.01	1	250	2.5	25

= "Usable Energy"[(5)]

Source: Reproduced from Lazard's Levelized Cost of Storage Analysis – Version 3.0, page 9. https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf. *Emphasis added by Applied Economics Clinic.*

Figure 2 below presents Lazard's levelized cost of storage for Cases 4 and 5 according to their "high" component costs: capital, operations and maintenance (O&M), charging, taxes and other costs. In the calculations presented in this white paper, the following changes are made to Lazard's treatment of the components:

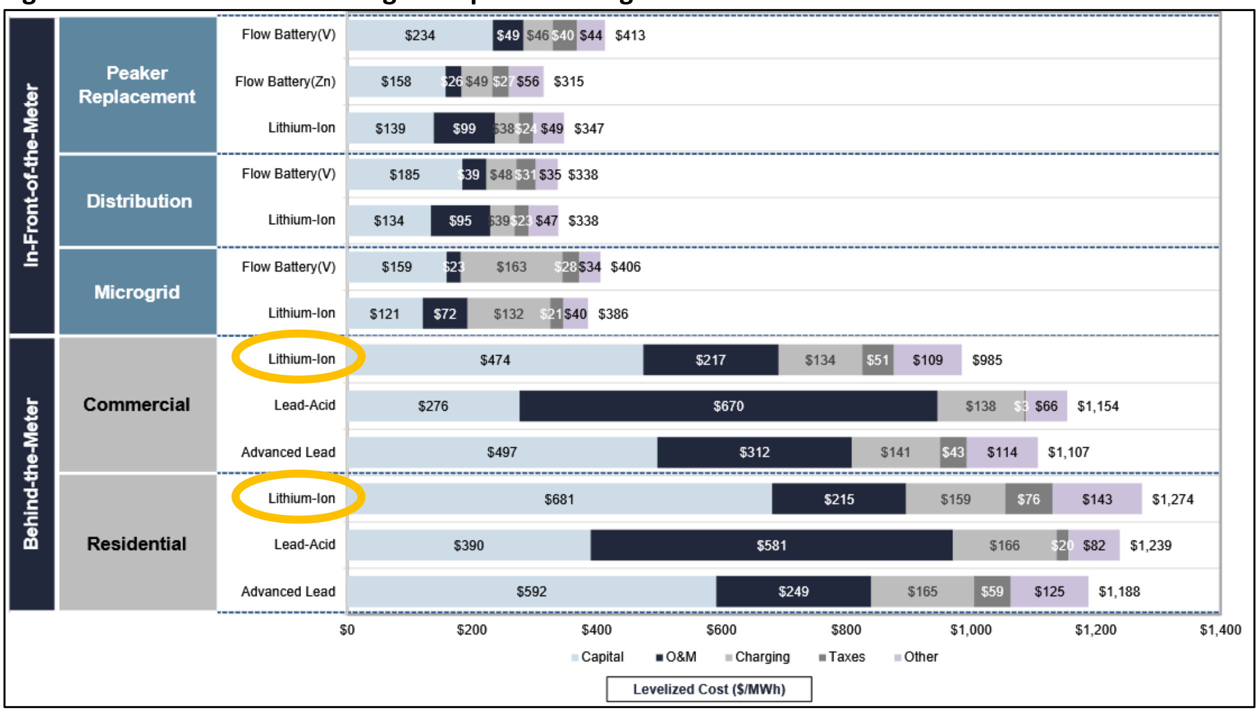
- Capital costs are de-escalated by 20 percent from the 2017 cost, following Lazard's assumption, to estimate the 2019 capital cost.

[3] Lazard. November 2017. *Lazard's Levelized Cost of Storage Analysis – Version 3.0*, page 8. https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf

[4] Ibid.

- Capital costs per MWh of battery capacity are adjusted to instead reflect capacity costs per MWh of use based on 52 days of use per year (that is, 52 full cycles per year—on average, one cycle per week) instead of the frequency of use shown in Figure 1.
- Charging costs are removed because, in Massachusetts, costs and savings related to the use of electricity are included in the benefits calculations of benefit-cost ratios. For measures—like storage—where on an annual basis megawatt-hours (MWhs) are lost instead of saved the net costs of charging are considered negative benefits. To include charging in these measures' levelized cost would be double counting.

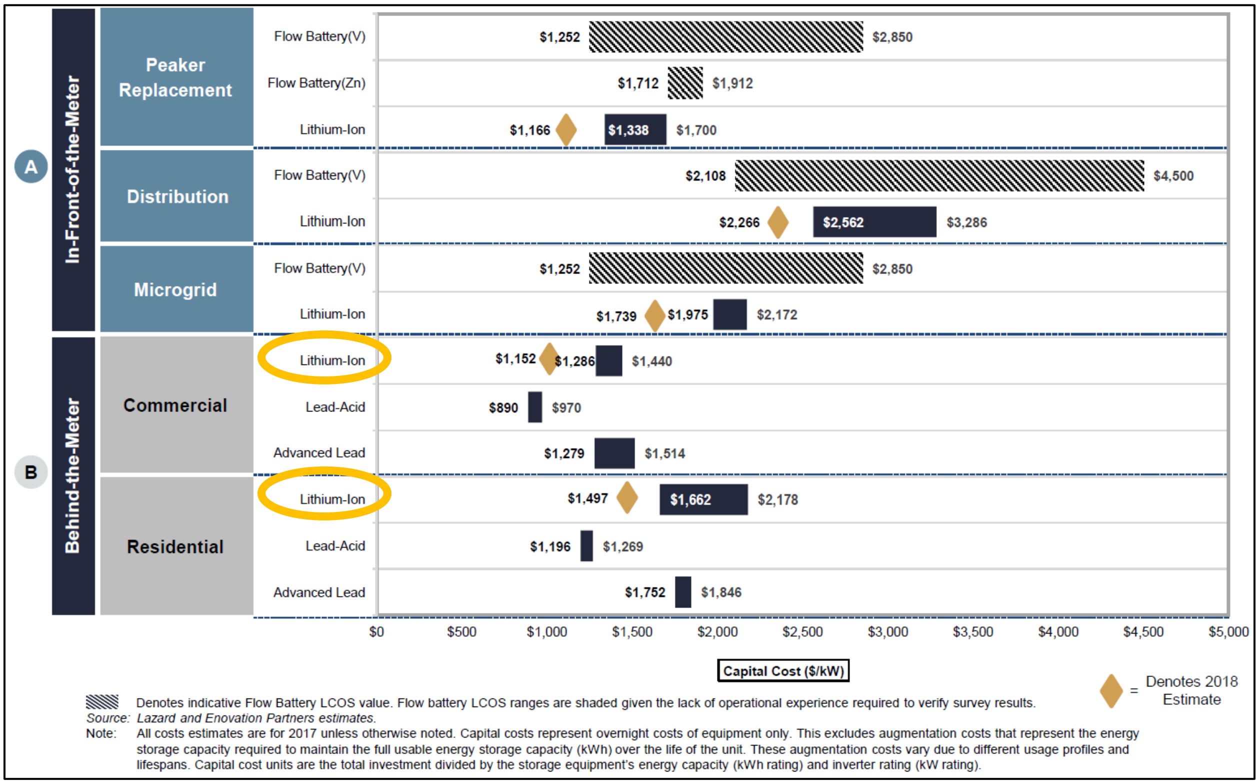
Figure 2. Levelized cost of storage components—high



Source: Reproduced from Lazard's Levelized Cost of Storage Analysis – Version 3.0, page 29. https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf. *Emphasis added by Applied Economics Clinic.*

Figure 2 and Figure 3 together show that Lazard's levelized capital costs of $474/MWh for commercial multi-family and $681/MWh for low-income single-family represent 1,440/kW for commercial and $2,178/kW for residential. When we reduce these costs by 20 percent for 2019, the per kW capital costs are $1,152/kW for multi-family and $1,742/kW for single-family.

Figure 3. Capital cost comparison: $/kW



Source: Reproduced from Lazard's Levelized Cost of Storage Analysis – Version 3.0, page 15. https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf. *Emphasis added by Applied Economics Clinic.*

3. Total Resource Cost

The total resource cost is calculated as the product of the measure or system life in years, the annual production in MWh, and the levelized cost in dollars per MWh, scaled proportionately to the kW size of the system being analyzed. These kW system sizes used in this report are: 6 kW for a single-family battery in the low-income efficiency program, and 30 kW for multi-family battery in the commercial and industrial efficiency program. In their "BCR Model" spreadsheets, National Grid assumes 2.5 kW for residential batteries, and Cape Light Compact assumes 5 kW for residential and 5 kW for commercial and industrial batteries. Eversource and Unitil do not include any system size measures in their "BCR Model" spreadsheets. Because technical assumptions regarding battery performance and cost are proportional to system size throughout these calculations, system size does not impact on cost-effectiveness.

For simplicity, a single system of each kind of measure (residential and commercial) is assumed for the calculations presented in this white paper. This should not be interpreted as a recommendation for how many measures the program administrators should strive to provide.

Using this method, total resource costs for each measure are $13,163 for low-income measures and $46,322 for commercial and industrial measures (see Table 1 below). It is important to note that these total resource costs represent levelized costs per MWh of battery discharge, not capital costs, and are estimated for the 10-year lifetime of the measures.

Table 1. Total resource cost

Parameter for 2019	Low-Income	C&I	Source
Quantity	1	1	
Measure Life	10	10	Lazard's Levelized Cost of Storage Analysis v.3.0 November 2017, p.9
Maximum Load Reduction (kW)	6	30	
Annual kWh Production (kWh)	624	3,120	Lazard's Levelized Cost of Storage Analysis v.3.0 November 2017, p.9
2019 Levelized Cost ($/MWh) without capital costs	$434	$377	Lazard's Levelized Cost of Storage Analysis v.3.0 November 2017, p.12, 14, 29; "high" cost of storage components; 2017 total cost per MWh less capital and charging costs
2019 capital cost ($/kW)	$1,742	$1,152	Lazard's Levelized Cost of Storage Analysis v.3.0 November 2017, p.15, "high" cost of storage components; 2017 capital cost less 10% per year per Lazard
Total Resource Cost ($)	**$13,163**	**$46,322**	**Calculation; multiplied by measure life**

Source: Applied Economics Clinic calculation

4. Energy Use by Time Period

The program administrators' "BCR Model" methodology has traditionally been used to estimate the benefits and costs of energy efficiency measures that reduce annual energy demand. While the methodology includes the apparatus and assumptions necessary to estimate benefits from peak shifting measures—such as batteries—that change the pattern of energy demand but do not lower the annual total, this is not the way these spreadsheets have typically been used. For a typical energy efficiency measure, the gross annual kWh savings would be a positive value, but for the battery storage measures shown here, they are negative, due to round-trip efficiency losses inherent in batteries. Batteries are typically charged at times of low demand or low energy price and discharged at times of high demand or high energy prices. If batteries had perfect round-trip efficiency (no energy was lost in storing and discharging the battery), then gross annual kWh savings would equal zero. Energy out would equal energy in. However, Lazard assumes 15 percent efficiency losses for commercial batteries and 14 percent efficiency losses for residential batteries.[5] For this reason, gross annual kWh saved shows a loss, or negative value: negative 87.4 kWh for low-income and negative 468 kWh for commercial and industrial (see Table 2 below).

Table 2. Energy use by time period

Parameter for 2019	Low-Income	C&I	Source
EE: Gross Annual kWh Saved	(87.4)	(468.0)	Assume 15% efficiency loss for commercial; 14% for residential Lazard's Levelized Cost of Storage Analysis v.3.0 November 2017, p.31
Summer Peak Energy (%)	33.3%	33.3%	By assumption: representing a peak shifting measure
Summer Off-Peak Energy (%)	-33.3%	-33.3%	
Winter Peak Energy (%)	66.7%	66.7%	
Winter Off-Peak Energy (%)	-66.7%	-66.7%	
Summer Coincident (%)	100.0%	100.0%	MA PAs assumption
Winter Coincident (%)	100.0%	100.0%	By assumption
Summer Peak Energy MWh Net Lifetime	2.1	10.4	Changed PA calculation to refer to total peak MWh instead of total annual MWh savings/losses
Summer Off-Peak Energy MWh Net Lifetime	-2.4	-12.2	Changed PA calculation to refer to total off-peak MWh instead of total annual MWh savings/losses; off peak calculated as 100%/(1-efficiency rate)
Winter Peak Energy MWh Net Lifetime	4.2	20.8	Changed PA calculation to refer to total peak MWh instead of total annual MWh savings/losses
Winter Off-Peak Energy MWh Net Lifetime	-4.8	-24.5	Changed PA calculation to refer to total off-peak MWh instead of total annual MWh savings/losses; off peak calculated as 100%/(1-efficiency rate)

Source: Applied Economics Clinic calculations

[5] Lazard. November 2017. *Lazard's Levelized Cost of Storage Analysis – Version 3.0*, page 31. https://www.lazard.com/media/450338/lazard-levelized-cost-of-storage-version-30.pdf

The program administrators' "BCR Model" takes the annual kWh saved and divides it into four time-periods—summer peak, summer off-peak, winter peak, winter off-peak—totaling 100 percent. For example, National Grid's new residential buildings high-rise lighting measure is assumed to have annual savings allocated as follows: 12.9 percent summer peak, 15.2 percent summer off-peak, 36.3 percent winter peak, and 35.6 percent winter off-peak.

Alternatively, for a storage measure, the assumption used in this white paper is that energy is subtracted from energy demand during summer and winter peak (a negative percentage) and added on to demand during summer and winter off-peak (a positive percentage), adding up to zero across the four time-periods. (Efficiency losses are included in the calculation of gross annual kWh saved and are therefore not included in these shares to avoid double counting.) The values use in these calculations (shown in Table 2) are 33.3 percent summer peak and 66.7 percent winter peak, negative 33.3 percent summer off-peak and negative 66.7 percent winter off-peak, and 100 percent summer and winter coincident.[6] This is equivalent to assumption an equal use of the battery in every month of the year (where summer is assumed to last for four months, and winter for eight months).

Based on these assumptions, the avoided energy over a ten-year system life from a 6 kW low-income single-family battery is: 2.1 MWh of summer peak energy and 4.2 MWh of winter peak energy, and negative 2.4 MWh of summer off-peak energy and negative 4.8 MWh of winter off-peak energy. The avoided energy over a ten-year system life from a 30 kW commercial multi-family battery is: 10.4 MWh of summer peak energy and 20.8 MWh of winter peak energy, and negative 12.2 MWh of summer off-peak energy and negative 24.5 MWh of winter off-peak energy (see Table 2 above).

5. Avoided-Energy Benefits

Avoided-energy benefits are the product of avoided energy (in MWh) and avoided energy prices, as calculated in the *Avoided Energy Supply Components in New England: 2018 Report* (AESC 2018).[7] Avoided energy prices are calculated on an hourly basis in AESC 2018 and then aggregated to summer peak, summer off-peak, winter peak, winter off-peak. The average energy prices for these time periods, by year, are very sensitive to changes in the assignment of hours as peak or off-peak. AESC 2018 follows the definition of peak as 9 am to 11 pm each weekday (excluded holidays) for both summer (four months) and winter (eight months). This broad definition of "peak" is not useful in representing the strategic use of batteries to relieve tight energy markets in periods of high energy demand or high energy prices.

[6] Program administrators hard-code a winter coincidence to peak of 0 percent (see "BCR Model" spreadsheets, 'ADMYr1 tab, AE4:AE123).
[7] Synapse Energy Economics. June 1, 2018. Avoided Energy Supply Components in New England: 2018 Report. http://www.synapse-energy.com/sites/default/files/AESC-2018-17-080-June-Release.pdf

As shown in Table 3, redefining peak as those hours with the highest energy prices or highest MWh sales results in a very different allocation of hours between summer peak, summer off-peak, winter peak, winter off-peak. By energy price, all but one of the highest priced hours are in the winter months, and 43 percent of these are off-peak. By demand, 28 percent are in winter and 48 percent of these are off-peak.

Table 3. Peak/Off-peak hours for 2019

	Total Count	Highest 10% by	
		Energy Price	MWh
Summer peak	1,260	0	317
Summer offpeak	1,668	1	313
Winter peak	2,565	502	128
Winter offpeak	3,267	373	118

Source: Applied Economics Clinic calculations

Table 4 demonstrates how average energy prices change based on each of these definitions. The average avoided energy price for winter peak is $47 under the AESC 2018 definition of peak, $80 under the definition of peak as those hours with the highest energy prices, and $73 under the definition of peak as those hours with the highest MWh sales. The average avoided energy price for winter off-peak is $42 under the AESC 2018 definition of peak, $78 under the definition of peak as those hours with the highest energy prices, and $75 under the definition of peak as those hours with the highest MWh sales.

The average avoided energy price for summer peak is $31 under the AESC 2018 definition of peak and $37 under the definition of peak as those hours with the highest MWh sales. The average avoided energy price for summer off-peak is $27 under the AESC 2018 definition of peak, $69 under the definition of peak as those hours with the highest energy prices, and $36 under the definition of peak as those hours with the highest MWh sales.

Table 4. Peak/Off-peak energy prices for 2019

	Total Count	Highest 10% by	
		Energy Price	MWh
Summer peak	$31	n/a	$37
Summer offpeak	$27	$69	$36
Winter peak	$47	$80	$73
Winter offpeak	$42	$78	$75

Source: Applied Economics Clinic calculation

Table 5 and Table 6 below present avoided-energy benefits using two different definitions.

Table 5 presents avoided-energy benefits using the AESC 2018 definition of peak; benefits are negative for both storage measures, meaning a cost to the electric system: -$22 for low-income single-family and -$138 for commercial multi-family.

Table 5. Avoided energy benefits: AESC 2018 definition of peak

Parameter for 2019	Low-Income	C&I	Source
Summer Peak Energy Benefits ($)	$113	$563	Changed PA calculation to refer to total peak MWh instead of total annual MWh; corrected erroneous cell reference to wrong avoided costs
Summer Off-Peak Energy Benefits ($)	(113.0)	(572.0)	Changed PA calculation to refer to total off-peak MWh instead of total annual MWh; off peak calculated as 100%/(1-efficiency rate); corrected erroneous cell reference to wrong avoided costs
Winter Peak Energy Benefits ($)	$288	$1,440	Changed PA calculation to refer to total peak MWh instead of total annual MWh; corrected erroneous cell reference to wrong avoided costs
Winter Off-Peak Energy Benefits ($)	($310)	($1,569)	Changed PA calculation to refer to total off-peak MWh instead of total annual MWh; off peak calculated as 100%/(1-efficiency rate); corrected erroneous cell reference to wrong avoided costs
Total Avoided Energy Benefits ($)	**($22)**	**($138)**	**Sum**

Source: Applied Economics Clinic calculation; cell references corrected in "BCR Model" spreadsheets, 'ADMStrategies' tab.

Table 6 presents avoided-energy benefits using the percent of hours by energy price definition that is consistent with discharging an average of one time per week: the highest 2.2 percent of hours by energy price in winter and the highest 5.0 percent of hours by energy price in summer. Following this method, batteries would have time to charge in between each discharge. In addition, discharges occur during times of highest energy prices. With just 52 discharges per year, it is possible to select times of very high energy prices, and still have time to charge between each discharge. Using this definition, benefits are positive for both storage measures—meaning a positive benefit to the system: $162 for low-income single-family and $787 for commercial multi-family.

Table 6. Avoided energy benefits: Discharging 52 times per year

Parameter for 2019	Low-Income	C&I	Source
Summer Peak Energy Benefits ($)	$136	$682	With peak definition adjusted to match 52 discharges per year
Summer Off-Peak Energy Benefits ($)	($119)	($602)	
Winter Peak Energy Benefits ($)	$461	$2,305	
Winter Off-Peak Energy Benefits ($)	($316)	($1,598)	
Total Avoided Energy Benefits ($)	**$162**	**$787**	**Sum**

Source: Applied Economics Clinic calculation

6. Avoided-Energy DRIPE Benefits

Demand reduction induced price effects (DRIPE) are defined in AESC 2018 as "the reduction in prices in the wholesale markets for capacity and energy, relative to the prices forecast in the Reference case, resulting from the reduction in quantities of capacity and of energy required from those markets due to the impact of efficiency and/or demand response programs. Thus, DRIPE is a measure of the value of efficiency in terms of the reductions in wholesale prices seen by all retail customers in a given period."[8] Avoided-energy DRIPE benefits are the product of avoided energy and avoided-energy DRIPE as presented in AESC 2018.

The avoided-energy DRIPE benefits presented in Table 7 have been adapted to the definition of peak as the highest 10 percent by energy price, although this change makes relatively little difference to the resulting benefits. Benefits are positive for both storage measures, meaning a positive benefit to the system: $38 for low-income single-family and $185 for commercial multi-family.

[8] Synapse Energy Economics. June 1, 2018. "Avoided Energy Supply Components in New England: 2018 Report". Page 13. http://www.synapse-energy.com/sites/default/files/AESC-2018-17-080-June-Release.pdf.

Table 7. Avoided-energy DRIPE benefits

Parameter for 2019	Low-Income	C&I	Source
Summer Peak Energy DRIPE Benefits ($)	$41	$206	Changed PA calculation to refer to total peak MWh instead of total annual MWh saved/lost; corrected erroneous cell reference to wrong avoided costs
Summer Off-Peak Energy DRIPE Benefits ($)	($33)	($165)	Changed PA calulation to refer to total off-peak MWH instead of total annual MWh saved/lost; off-peak calculated as 100$/(1-efficiency rate); corrected erroneous cell reference to wrong avoided costs
Winter Peak Energy DRIPE Benefits ($)	$126	$631	Changed PA calculation to refer to total peak MWH instead of total annual MWh saved/lost; corrected erroneous cell reference to wrong avoided costs
Winter Off-Peak Energy DRIPE Benefits ($)	($85)	($429)	Changed PA calculation to refer to total off-peak MWH instead of total annual MWh saved/lost; off-peak calculated as 100$/(1-efficiency rate); corrected erroneous cell reference to wrong avoided costs
Energy Electric Cross DRIPE Benefits ($)	($11)	($58)	
Total Energy DRIPE Benefits ($)	**$38**	**$185**	**Sum**

Source: Applied Economics Clinic calculations

7. Avoided-Capacity Benefits

The program administrator's "BCR Model" awards measures with benefits based on avoided costs of summer generation capacity, winter generation capacity, electric capacity DRIPE, transmission, distribution, and reliability—together referred to as "avoided-capacity benefits." The benefits shown in Table 8 are calculated following the program administrator's methodology exactly with one important change: the program administrator's assumption of a winter capacity value of $0/kW for storage measure has been adjusted to the AESC 2018 un-cleared capacity value by year.[9] The sum of all avoided-

[9] Un-cleared capacity chosen as a proxy to replace zero values. Program administrators hard-code a winter capacity value of $0/kW (see "BCR Model" spreadsheets, 'Avoided Cost' tab, O9:O40), which applies to both energy efficiency and advanced demand management measures.

capacity benefits for the two storage measures is positive, $30,861 for low-income single-family and $154,300 for commercial multi-family.

Table 8. Avoided-capacity benefits

Parameter for 2019	Low-Income	C&I	Source
Summer Generation Capacity Benefits ($)	$2,586	$12,928	
Winter Generation Capacity Benefits ($)	$2,586	$12,928	Changed PA calculation to use uncleared capacity value per kW instead of $0. Note that PAs assign winter generation a value of $0/kW for all measures.
Electric Capacity DRIPE Benefits ($)	$14,362	$71,810	
Transmission Benefits ($)	$2,491	$12,454	
Distribution Benefits ($)	$8,342	$41,708	
Reliability Benefits ($)	$494	$2,472	
Total Electric Capacity Benefits ($)	**$30,861**	**$154,300**	**Sum**

Source: Applied Economics Clinic calculations

8. Avoided-Non-Energy Benefits

The program administrators' "BCR Model" assigns non-energy benefits to numerous energy efficiency measures based on the *Massachusetts Program Administrators' Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts Evaluation*.[10] Table 9 lists non-energy benefits for which monetary values were provided in the 2011 Evaluation; marked in green are the subset of these benefits assigned to measures in the program administrator's 2019-2021 April draft plan.

[10] Massachusetts Program Administrators. 2011. *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation*. http://ma-eeac.org/wordpress/wp-content/uploads/Special-and-Cross-Sector-Studies-Area-Residential-and-Low-Income-Non-Energy-Impacts-Evaluation-Final-Report.pdf

Table 9. Avoided-non-energy benefits

NEI	Duration
UTILITY PERSPECTIVE	
Arrearages	Annual
Bad debt write-offs	Annual
Terminations and reconnections	Annual
Rate discounts	Annual
Customer calls	Annual
Collections notices	Annual
Safety-related emergency calls	Annual
Insurance savings	—
SOCIETAL PERSPECTIVE	
National Security	Annual
NON-RESOURCE BENEFITS	
Appliance Recycling – Avoided landfill space	One time
Appliance Recycling – Reduced emissions due to recycling plastic and glass, reduced emissions	One time
Appliance Recycling – Reduced emissions due to incineration of insulating foam	One time
PARTICIPANT PERSPECTIVE (OWNERS OF LOW-INCOME RENTAL HOUSING), PER HOUSING UNIT	
Marketability/ease of finding renters	Annual
Reduced tenant turnover	Annual
Property value	One time
Equipment maintenance (heating and cooling systems)	Annual
Reduced maintenance (lighting)	Annual
Durability of property	Annual
Tenant complaints	Annual
PARTICIPANT PESPECTIVE (OCCUPANT)	
Higher comfort levels	Annual
Quieter interior environment	Annual
Lighting quality & lifetime	One time
Increased housing property value	One time (Annual for NLI RNC)
Reduced water usage and sewer costs (dishwashers)	Annual
Reduced water usage and sewer costs (faucet aerators)	Annual
Reduced water usage and sewer costs (low flow showerheads)	Annual
More durable home and less maintenance	Annual
Equipment and appliance maintenance requirements	Annual
Health related NEIs	Annual
Improved safety (heating system, ventilation, carbon monoxide, fires)	Annual
Window AC NEIs	Annual

**** Green cells showing the Benefits in April Draft of 2019-2021 Plan**

Source: Massachusetts Program Administrators. 2011. Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation. *Emphasis added by Applied Economics Clinic.*

While storage may provide many non-energy benefits, our literature review did not turn up any valuations of these benefits (see Table 10).

Table 10. Non-energy benefits sources reviewed

Eichman et al. December 2015. "Operational Benefits of Meeting California's Energy Storage Targets." National Renewable Energy Laboratory.
Edmunds et al. February 2017. "The Value of Energy Storage and Demand Response for Renewable Integration in California." Lawrence Livermore National Laboratory.
Edmunds et al. June 2013. "The Value of Energy Storage and Demand Response for Renewable Integration in California." Prepared for the California Energy Commission by Lawrence Livermore National Laboratory.
Energy Storage Association. 2018. "Incidental and Other Benefits." http://energystorage.org/energy-storage/energy-storage-benefits/benefit-categories/incidental-and-other-benefits
Hledik, et al. 2017. "Stacked Benefits: Comprehensively Valuing Battery Storage in California." Prepared for Eos Energy Storage.
Lazard. 2017. "Lazard's Levelized Cost of Storage Analysis – Version 3.0."
Massachusetts Department of Energy Resources and Massachusetts Clean Energy Center. 2016. "State of Charge: Massachusetts Energy Storage Initiative."
Massachusetts Program Administrators. 2011. "Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation." NMR Group, Inc.
Medina et al. 2014. "Electrical Energy Storage Systems: Technologies' State-of-the-Art, Techo-Economic Benefits and Applications Analysis." 47th Hawaii International Conference on System Sciences.
New York Department of Public Service. July 2015. "Staff White Paper on Benefit-Cost Analysis in the Reforming Energy Vision Proceeding." Paper No. 14-M-0101.
NMR Group, Inc. August 2011. "Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation." Prepared for Massachusetts Program Administrators.
ReOpt Web Tool User Manual. https://reopt.nrel.gov/tool/REopt%20Lite%20Web%20Tool%20User%20Manual.pdf
Stark et al. February 2015. "Renewable Electricity: Insights for the Coming Decade." Prepared by Joint Institute for Strategic Energy Analysis for the National Renewable Energy Laboratory.
U.S. Energy Information Administration. 2018. "U.S. Battery Storage Market Trends." U.S. Department of Energy.
Woolf et al. September 2014. "Benefit-Cost Analysis for Distributed Energy Resources." Advanced Energy Economy Institute and Synapse Energy Economics.

Therefore, the calculations presented in this white paper include only one non-energy benefit: a one-time increase to property values of adding a storage system. These values are calculated using the "low-income" benefit from the 2011 Evaluation for a heating retrofit: which was reported to be $949 in the *Massachusetts Program Administrators' Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts Evaluation*. The sum of all avoided-non-energy benefits for the two storage measures is positive, $5,235 for low-income single-family and $510 for commercial multi-family (see Table 11).

Table 11. Avoided-non-energy benefits

Parameter for 2019	Low-Income	C&I	Source
One time per Unit (Net)	**$5,235**	**$510**	Massachusetts' Program Administrators' Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts Evaluation August 15, 2011; p.1-6, 1-8: Increased housing property value is $949 for LI; for multi-family property owners (marketability/ease of finding renters, property value; equipment maintenance) is $17.03 per unit Electric State-wide Cost and Savings Table for 2011: LI 1-4 family heating retrofit TRC for one measure is $1,895; for multi-family $1,155 Resulting assumption: LI housing property value increase by 1/2 of measure capital cost for single-family and 1% for owners of multi-family

Source: Applied Economics Clinic calculations

Avoided-non-energy benefits are the only benefit category in this cost-effectiveness assessment that would change if these batteries were offered in a residential efficiency program, and not in a "low-income" or means-tested program.

9. Avoided Non-Embedded Environmental Costs

Avoided non-embedded-costs are the product of avoided emissions and the avoided cost of emissions from AESC 2018. These avoided costs are "non-embedded" in the sense that they are externality costs: costs that are not included in market prices but have value to Massachusetts. In the program administrators' "BCR Model" spreadsheets' non-embedded costs are set to zero; the benefit-cost ratios present below adopt this same assumption of zero non-embedded environmental costs.

The section presents the benefits that would occur if non-embedded costs instead included a $100 per metric ton cost of carbon dioxide (CO_2), the lower of two non-embedded CO_2 costs provided in AESC 2018. Here, AESC 2018's definition of peak is important in two ways.

First, AESC 2018 assumes (as a result of its modeling of the hourly dispatch of New England electric generation resources) that CO_2 emissions rates (lbs/MWh) are higher in off-peak hours than they are in peak hours (see Table 12).

Table 12. Electric-sector CO_2 and NO_x emissions rate (lbs/MWh)

	Winter		Summer	
	On Peak	*Off Peak*	*On Peak*	*Off Peak*
CO_2	978	999	952	959
NO_X	0.212	0.241	0.173	0.180

Note: Emissions rates do not vary substantially across years.
Source: EnCompass modeling outputs for main 2018 AESC case

Source: Avoided Energy Supply Components in New England: 2018 Report by Synapse Energy, Inc. Table 150. http://www.synapse-energy.com/sites/default/files/AESC-2018-17-080-June-Release.pdf.

This finding runs counter to the more common assumption that, in New England, CO_2 emissions rates are lower in off-peak hours and higher in peak hours. ISO-New England reported higher peak than off-peak emissions in is its 2016 annual emissions report (see Table 13), which has held true in the last two years (see Figure 4).

Table 13. 2016 LMU Marginal Emission Rates—All LMUs (lb/MWh)

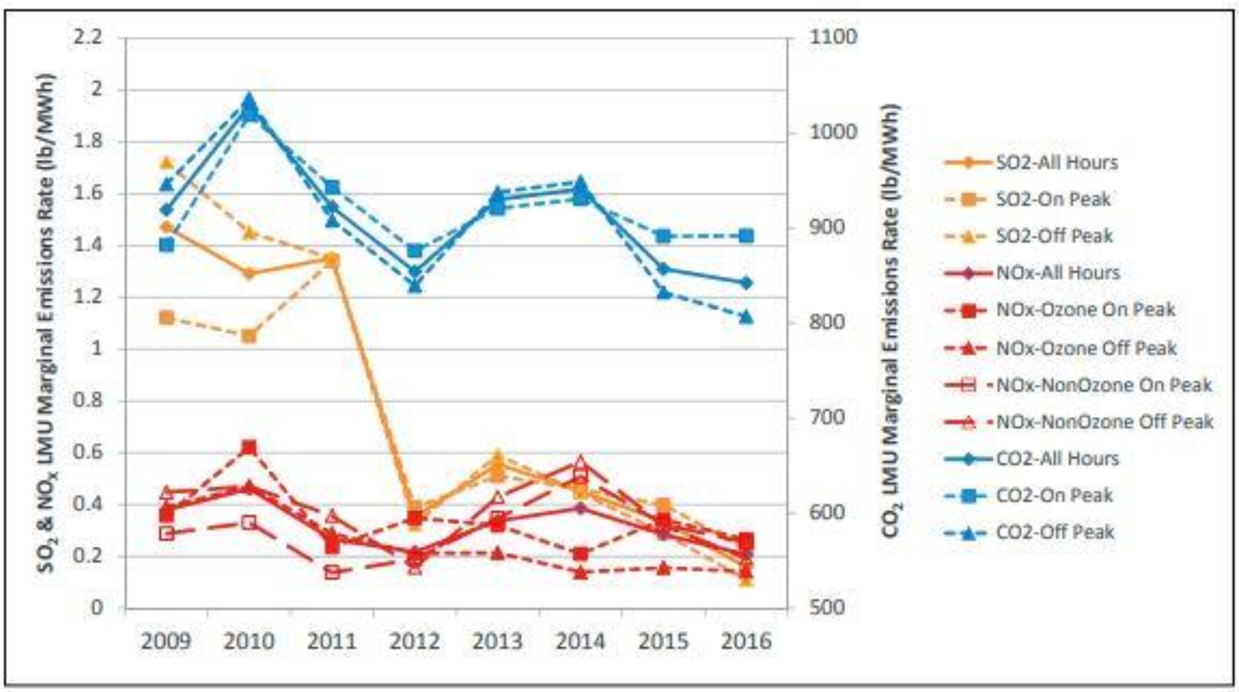
Ozone / Non-Ozone Season Emissions (NOx)					
Air Emission	Ozone Season		Non-Ozone Season		Annual Average (All Hours)
	On-Peak	Off-Peak	On-Peak	Off-Peak	
NO_X	0.26	0.14	0.25	0.19	0.21
Annual Emissions (SO_2 and CO_2)					
Air Emission		Annual			Annual Average (All Hours)
		On-Peak	Off-Peak		
SO_2		0.22	0.11		0.16
CO_2		892	807		842

(a) The ozone season occurs between May 1 and September 30, while the non-ozone season occurs from January 1 to April 30 and from October 1 to December 31.

(b) On-peak hours consist of all weekdays between 8:00 a.m. and 10:00 p.m. Off-peak hours consist of all weekdays between 10:00 p.m. and 8:00 a.m. and all weekend hours.

Source: ISO-NE 2016 Emissions Report, Table 5-3. https://www.iso-ne.com/static-assets/documents/2018/01/2016_emissions_report.pdf.

Figure 4. 2009-2016 Marginal Emissions Rates, all LMUs (lb/MWh)



Source: ISO-NE 2016 Emissions Report, Table 5-9. https://www.iso-ne.com/static-assets/documents/2018/01/2016_emissions_report.pdf.

Second, the definition of peak impacts not only energy prices (see Table 3 and Table 4 above) but also the average emissions rates for these periods. The calculations presented in this white paper do not include any correction or revised definition with regards to emission rates. The necessary data are not available in the AESC 2018 report or user interface.

Both Table 14 and Table 15 present avoided non-energy-costs using AESC 2018's definition of peak. Table 14 presents avoided non-embedded costs using the AESC 2018 peak and off-peak emission rates; benefits are negative for both storage measures—meaning a cost to the system: -$51 for low-income single-family and -$270 for commercial multi-family.

Table 14. Avoided-non-embedded costs: AESC 2018 peak and off-peak emissions rates

Parameter for 2019	Low-Income	C&I	Source
Summer Peak Energy Benefits ($)	$90	$452	Changed PA calculation to refer to total peak MWh instead of total annual MWh; changed peak and off-peak CO2 emissions rates
Summer Off-Peak Energy Benefits ($)	($106)	($535)	Changed PA calculation to refer to total off-peak MWh instead of total annual MWh; off peak calculated as 100%/(1-efficiency rate); changed peak and off-peak CO2 emissions rates
Winter Peak Energy Benefits ($)	$186	$930	Changed PA calculation to refer to total peak MWh instead of total annual MWh; changed peak and off-peak CO2 emissions rates
Winter Off-Peak Energy Benefits ($)	($221)	($1,117)	Changed PA calculation to refer to total off-peak MWh instead of total annual MWh; off peak calculated as 100%/(1-efficiency rate); changed peak and off-peak CO2 emissions rates
Total Avoided Non-Embedded Benefits ($)	**($51)**	**($270)**	**Sum**

Source: Applied Economics Clinic calculations

Table 15 presents avoided non-energy-costs using the peak and off-peak emission rates for ISO-New England's 2018 emissions report; benefits are negative (but smaller) for both storage measures, meaning a cost to the system: -$12 low-income single-family and -$83 for commercial multi-family.

Table 15. Avoided-non-embedded costs: ISO-New England peak and off-peak emissions rates

Parameter for 2019	Low-Income	C&I	Source
Summer Peak Energy Benefits ($)	$85	$423	With peak / offpeak emission rates changed to 2016 ISO-NE values: 2016 ISO New England Generator Air Emissions Report, January 2018, Table 5-3, https://www.iso-ne.com/static-assets/documents/2018/01/2016_emissions_report.pdf
Summer Off-Peak Energy Benefits ($)	($89)	($451)	
Winter Peak Energy Benefits ($)	$170	$848	
Winter Off-Peak Energy Benefits ($)	($178)	($903)	
Total Avoided Non-Embedded Benefits ($)	**($12)**	**($83)**	**Sum**

Source: Applied Economics Clinic calculations

In the total benefits and benefit-cost ratios presented below, non-embedded environmental costs are set to zero, following the program administrators' "BCR Model" assumption.

10. Total Benefits

Table 16 sums up total benefits for these two storage measures assuming the peak definite of highest 10 percent of hours by energy price for energy benefits, non-energy impacts for low-income households, and zero non-embedded environmental costs. For low-income single-family measure, $36,296; for commercial multi-family measure, $155,782.

Table 16. Total benefits

Parameter for 2019	Low-Income	C&I
Total Avoided Energy Benefits ($)	$162	$787
Total Energy DRIPE Benefits ($)	$38	$185
Total Electric Capacity Benefits ($)	$30,861	$154,300
Total Non-Energy Impacts ($)	$5,235	$510
Total Avoided Non-Embedded Benefits ($)	$0	$0
Total Electric Benefits ($)	**$36,296**	**$155,782**

Source: Applied Economics Clinic calculations

11. Benefit-Cost Ratio

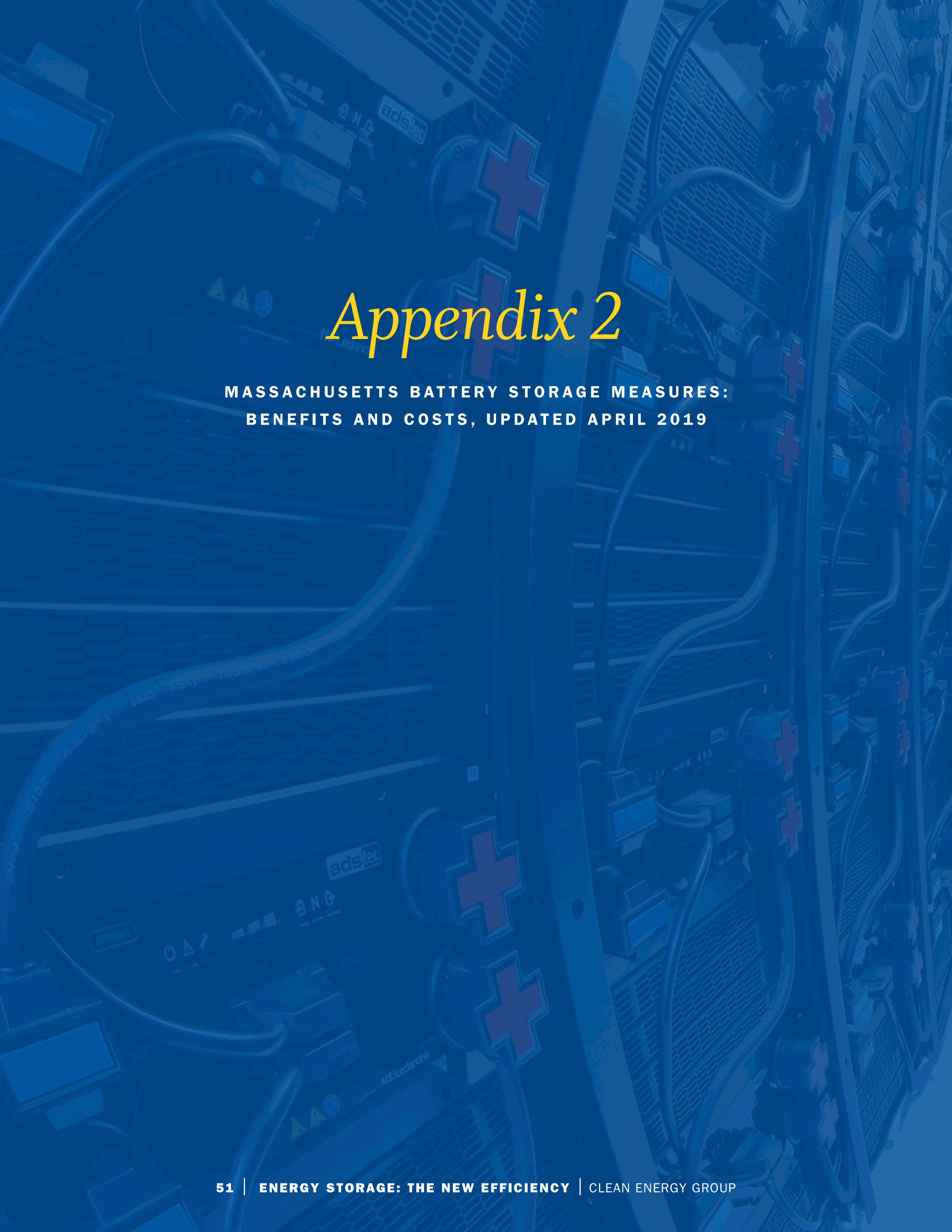
Based on the assumptions and methodology presented in this white paper, the benefit-cost ratio for the low-income single-family measure is 2.8 (that is, the value of benefits is nearly three times that of the costs, see Table 17) and the benefit-cost ratio for the commercial multi-family measure is 3.4. Both measures pass the cost-effectiveness test for Massachusetts.

Table 17. Total benefits and costs

Parameter for 2019	Low-Income	C&I
Total Electric Benefits ($)	$36,296	$155,782
Total Resource Cost ($)	$13,163	$46,322
Benefit-Cost Ratio	**2.8**	**3.4**

Source: Applied Economics Clinic calculations

If avoided-non-energy benefits were removed from these calculations, their benefit-cost ratios would be reduced to 2.4 for the single-family battery and 3.4 for the multi-family battery.



Appendix 2

MASSACHUSETTS BATTERY STORAGE MEASURES: BENEFITS AND COSTS, UPDATED APRIL 2019

Massachusetts Battery Storage Measures: Benefits and Costs

Updated April 2, 2018 – White Paper

Applied Economics Clinic

Prepared for:

Clean Energy Group

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Executive Summary

On January 29, 2019, the Massachusetts Department of Public Utilities (DPU) approved—with some exceptions and limitations—program administrators' 2019-2021 three-year energy efficiency plan. The program administrators' plan includes incentives for battery storage along with cost-effectiveness assessment of these storage measures. This Applied Economics Clinic white paper updates the July 2018 white paper[1] of the same name: The July 2018 white paper reviewed the program administrators' April 2018 cost-effectiveness assessment and provided an independent cost-effectiveness analysis whereas this white paper reviews program administrators' final assessment submitted October 31, 2018. The October assessment of battery storage measures' specifications, associated programs, and related costs differ substantially from the plans submitted in April.[2]

This white paper reviews the methodology, assumptions, and results of the cost-effectiveness assessment of storage measures presented in the approved 2019-2021 plan and the assessment of battery measures that was submitted to DPU by Cape Light Compact but not approved, including discussion of:

- ***Measure specification:*** Program administrators' storage measures differ, and these differences impact on cost-effectiveness. Nonetheless, almost all of the included active demand response programs are cost effective.
- ***Inclusion of measures in the final plan:*** Program administrators' way of presenting storage measure adoption is inconsistent and sometimes difficult to interpret. With that limitation in mind, the approved 2019-2021 plan appears to include battery storage equivalent to 0.1 to 0.5 percent of peak load, depending on electric distributor (for a total of about 34 megawatts of storage statewide).
- ***Improvements to April draft plan:*** Corrections to program administrators' April draft cost-effectiveness assessments include the treatment of storage measures' charging and discharging periods, and the inclusion of a Massachusetts-specific cost of Global Warming Solutions Act compliance. These needed corrections were discussed in the July 2018 white paper.
- ***Critical omissions:*** Despite improvements and corrections, the final plan still includes several critical omissions in the program administrators' calculations of the benefit-cost ratios of

[1] Stanton, E.A. July 2018. *Massachusetts Battery Storage Measures: Benefits and Costs*. Applied Economics Clinic White Paper. AEC-2018-07-WP-02. https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs

[2] The July 2018 white paper does not apply to the final (October 31, 2018) version of Massachusetts' program administrator efficiency and storage plan.

storage, including the omission of any value related to non-energy benefits, the omission of any value related to winter reliability, and the undervaluing of summer capacity benefits.

The findings of this white paper are limited by the extent of information made available by the program administrators at the time of this writing.[3]While several of these issues likely have the effect of undervaluing benefits in storage measures' cost-effectiveness analysis, all program administrators have assessed the programs that include storage measures as cost-effective in all years (with the exception of Unitil in 2019).

The total Massachusetts summer peak capacity addition three-year plan offering for behind-the-meter storage was 34 MW, or two-fifths of the Commonwealth's assessed storage potential (84 MW). Nevertheless, these omissions should be corrected in future energy efficiency planning, to more completely and fairly evaluate the cost-effectiveness of behind-the-meter energy storage.

[3] Somewhat more detailed descriptions of Massachusetts' storage measures have been made available in two March 2019 presentations to the Energy Efficiency Advisory Council: Schlegel, J. March 20, 2019. *Active Demand Management: Where Are We Now Plus A Look Ahead.* Slide presentation by the EEAC Consultant Team to the Massachusetts Energy Efficiency Advisory Council. Available at: http://ma-eeac.org/march-20-eeac-meeting/; Massachusetts Energy Efficiency Program Administrators. March 20, 2019. *Active Demand Reduction Demonstration & Initiative Update.* Slide presentation by the EEAC Consultant Team to the Massachusetts Energy Efficiency Advisory Council. Available at: http://ma-eeac.org/march-20-eeac-meeting/;

1. Introduction

Lithium-ion batteries for electric storage are considered in Massachusetts' energy efficiency program administrator's 2019-2021 plan, last updated October 31, 2018,[4] and addressed in the "BCR Model" spreadsheets (provided in November 2018) used to calculate the values in the approved plan and in the assessment of battery measures submitted by Cape Light Compact but not approved. Massachusetts' assessment of electric demand and peak-reducing measures' cost-effectiveness depends on the "BCRs"—or benefit-cost ratios—estimated in these spreadsheets. For measures to be included in the funding allocation and program implementation described in the 2019-2021 plan, they must receive a benefit-cost ratio of 1.0 or higher; that is, a measure's benefits must have a higher value than its costs.[5]

This Applied Economic Clinic white paper reviews the calculations and assumptions used by program administrators to estimate complete 2019-2021 benefit-cost ratios for battery storage measures in Massachusetts, according to the methodology shown in program administrator's own "BCR Model" spreadsheets for the October 31, 2018 plan.[6]

Massachusetts program administrators' benefit-cost ratios for 2019 range from 0.0 to 6.2 for individual storage measures (benefit-cost ratios of 1.0 and higher indicate cost-effectiveness) and from 0.7 to 7.9 for the advanced demand management programs (called "active demand reduction" or ADR in the approved three-year plan) that include storage measures. Only one ADR program (that is, the group of measures considered jointly) for one utility in one year (Unitil's residential ADR program for 2019) failed to achieve cost-effectiveness. All other utility storage-related programs for all years were found to be cost effective.

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[4] Massachusetts Department of Public Utilities. Docket Nos. 18-116, 18-117, 18-118, 18-119. *Three Year Energy Efficiency Plan for 2019 through 2021.* October 31, 2018. "Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan: 2019-2021". Available at: http://ma-eeac.org/wordpress/wp-content/uploads/Exh.-1-Final-Plan-10-31-18-With-Appendices-no-bulk.pdf

[5] The General Court of the Commonwealth of Massachusetts. 2008. Acts 308-80: *An Act Relative to Green Communities.* Chapter 169. https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169.

[6] This February 2019 AEC white paper updates a July 2018 white paper of the same name: Stanton. July 2018. *Massachusetts Battery Storage Measures: Benefits and Costs.* Applied Economics Clinic White Paper. AEC-2018-07-WP-02. https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs

Because the benefits of electric battery storage outweigh their costs, as shown in this report, these cost-effective measures must be offered by Massachusetts electric distributors to their customers, in accordance with the Green Communities Act.[7]

Each program administrator may offer three ADR programs—residential, income-eligible, and commercial/industrial. The Massachusetts program administrators have developed different battery measures (along with other ADR measures) to offer to their customers: System and Performance, Daily Dispatch, and Targeted Performance (discussed below). Storage cost effectiveness depends on measure specification.

Massachusetts energy efficiency program administrators' benefit-cost ratios for the ADR programs that include battery storage show cost-effectiveness (i.e., are greater than 1.0), with the exception of Unitil's residential program in 2019. Cost-effectiveness can be measured either at the program or the measure level. Massachusetts program administrators have three storage-related programs in parallel to the three programs offered for energy efficiency: residential, income-eligible, and commercial and industrial ADR (see Table 1). Each of these three programs can include three types of measures (described in more detail below): storage system and performance, storage daily dispatch, and storage targeted performance. Not every program administrator offers every measure type.

Table 1. MA program administrators' storage-related programs and measures

Programs	Measures
Residential Advanced Demand Management Program (A2e)	A2e Storage System and Performance
	A2e Storage Daily Dispatch
	A2e Storage Targeted Dispatch
Income-Eligible Advanced Demand Management Program (B1b)	B1b Storage System and Performance
	B1b Storage Daily Dispatch
	B1b Storage Targeted Dispatch
Commercial/Industrial Advanced Demand Management Program (C2c)	C2c Storage System and Performance
	C2c Storage Daily Dispatch
	C2c Storage Targeted Dispatch

Program cost-effectiveness is calculated as the summed benefits of measures in the program divided by the summed costs of these measures plus the costs of the program's administration. Storage program cost-effectiveness depends, therefore, on three factors: (1) the cost-effectiveness of the measures in the programs; (2) the composition of those measures (how many of each measure is included); and (3) the expected costs to administer the program.

[7] The General Court of the Commonwealth of Massachusetts. 2008. Acts 308-80: *An Act Relative to Green Communities*. Chapter 169. https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169

Storage ***measure*** cost-effectiveness depends on the specification of these measures, and Massachusetts' program administrators have designed very different storage measures for inclusion in their final 2019-2021 plan.

Programs and measures not achieving cost-effectiveness are shown in orange text in Table 2.

Table 2. MA program administrators' benefit-cost ratios for ADR measures

BCRs	Cape Light			Eversource			National Grid			Unitil		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Residential Advanced Demand Management Program (A2e)												
Program BCRs	*1.6*	*2.4*	*2.4*	*1.0*	*1.4*	*1.6*	*1.5*	*2.4*	*2.5*	*0.7*	*1.1*	*1.2*
Direct Load Control	4.9	6.6	7.4	5.0	5.0	5.0	5.3	5.5	5.3	5.2	9.6	9.6
Behavioral DR												
Storage System and Performance		3.0	3.0									
Storage Daily Dispatch				1.5	1.5	1.5	4.9	4.9	5.0			
Storage Targeted Dispatch				0.0	0.0	0.0	0.1	0.1	0.1			
EV Load Management								0.8	0.8			
Income-Eligible Advanced Demand Management Program (B1b)												
Program BCRs		*2.3*	*2.4*					*2.4*	*2.4*			
Direct Load Control												
Behavioral DR												
Storage System and Performance		3.0	3.0									
Storage Daily Dispatch												
Storage Targeted Dispatch												
EV Load Management												
Commercial/Industrial Advanced Demand Management Program (C2c)												
Program BCRs	*7.5*	*4.6*	*4.7*	*2.9*	*2.9*	*2.8*	*7.9*	*4.8*	*4.9*	*2.7*	*2.9*	*3.1*
Interruptible Load	9.7	9.8	9.8	7.9	7.9	7.9	7.5	7.5	7.5	4.2	4.2	4.2
Winter Interruptible Load												
Storage System and Performance		3.0	3.0									
Storage Daily Dispatch				1.7	1.7	1.7	4.9	4.9	5.0	6.2	6.2	6.2
Storage Targeted Dispatch				3.2	3.2	3.2	0.1	0.1	0.1	0.1	0.1	0.1
Custom	8.3	8.3	8.3		2.0	2.0	1.3	1.3	1.3			

Note: Blank cells indicate that no measures were offered.

Among the battery storage measures offered by program administrators in their final 2019-2021 plan, only Eversource and National Grid's residential Storage Targeted Dispatch measures, and National Grid's commercial and industrial Storage Targeted Dispatch measure do not meet cost-effectiveness in all three years.

"Storage System and Performance" measures: Cape Light Compact's proposed storage measures differ from those of other program administrators and from the description of storage measures approved in the 2019-2021 plan. The Cape Light Compact proposed storage measures would provide 1,000 participants with free 4-kilowatt (kW) batteries and then manage the batteries' charging and discharge to reduce system peak demand without an additional incentive. (In contrast, the other program administrators' approved storage measures do not provide batteries to participants.) Cape Light Compact's proposed measures have a 10-year measure life.

"Storage Daily and Targeted Dispatch" measures: Eversource, National Grid, and Unitil's proposed storage measures use a "bring your own battery" structure: participants provide their own batteries and receive financial incentives for allowing the program administrators to send dispatch signals (to which either the customer or a third-party aggregator then respond):

> *The 2019-2021 Plan includes new statewide Active Demand Reduction Offerings for residential and commercial and industrial sectors designed to reduce summer and winter peak demand. Customers will earn an incentive for verifiably shedding load in response to events called by Program Administrators…The Program Administrators will offer a technology agnostic approach in order to encourage innovations and capture all cost-effective demand reductions. (2019-2021 3YP, p.9)*

> *[A] new bring-your-own device active demand reduction initiative that allows residential and income eligible customers to expand the use of controllable efficiency equipment that can provide demand reduction during peak hours;…a new specialized storage performance offering will provide enhanced incentives to customers to dispatch energy storage during daily peak hours in the summer and winter months. (2019-2021 3YP, p.14)*

The Eversource, National Grid, and Unitil "measures" are an incentive, not a battery. These incentives have a 1-year measure life.

While the System and Performance, and Daily Dispatch measures are cost-effective in all years, some Targeted Dispatch measures are not. Of program administrators' residential (Eversource and National Grid) and commercial and industrial (Eversource, National Grid, and Unitil) Targeted Dispatch measures, only one—Eversource's commercial and industrial measure—is cost-effective. Among Targeted Dispatch measures, Eversource's cost-effective commercial and industrial measure differs from the measures that are not cost-effective in one important regard: The cost-effective measure includes summer discharge and benefits, the others do not. The absence of summer discharge for certain measures raises questions regarding measure design that cannot be answer given current public materials. Greater transparency in providing detailed descriptions of each storage measure would facilitate third-party reviewers in offering useful critique and analysis, and could lead to improvements in measure design and selection.

The Targeted Dispatch measures, which (according to program administrators' BCR spreadsheets) are not dispatched in summer months, are assigned no benefit for their kW savings and cannot achieve cost-effectiveness.

2. Storage is included only minimally for some program administrators

The number of storage measures included in the final 2019-2021 plan is difficult to interpret and is not comparable among the program administrators (see Table 3).

Table 3. MA program administrators' number of measures for ADR measures

Number of Measrues	Cape Light			Eversource			National Grid			Unitil		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Residential Advanced Demand Management Program (A2e)												
Program Number of Measures	*1,918*	*4,242*	*4,984*	*5*	*5*	*5*	*10,609*	*14,464*	*18,154*	*170*	*204*	*245*
Direct Load Control	1,918	2,942	3,384	1	1	1	9,375	12,336	15,050	170	204	245
Behavioral DR												
Storage System and Performance		1,300	1,600									
Storage Daily Dispatch				2	2	2	420	820	1,254			
Storage Targeted Dispatch				2	2	2	420	820	1,254			
EV Load Management							393	488	596			
Income-Eligible Advanced Demand Management Program (B1b)												
Program Number of Measures		*300*	*400*									
Direct Load Control												
Behavioral DR												
Storage System and Performance		300	400									
Storage Daily Dispatch												
Storage Targeted Dispatch												
EV Load Management												
Commercial/Industrial Advanced Demand Management Program (C2c)												
Program Number of Measures	*215*	*529*	*578*	*8*	*9*	*9*	*7*	*7*	*7*	*6*	*8*	*8*
Interruptible Load	214	328	377	1	1	1	1	1	1	1	2	2
Winter Interruptible Load				1	1	1	1	1	1	1	2	2
Storage System and Performance		200	200									
Storage Daily Dispatch				2	2	2	2	2	2	2	2	2
Storage Targeted Dispatch				4	4	4	2	2	2	2	2	2
Custom	1	1	1		1	1	1	1	1			

Different program administrators appear to be using different definitions of a "storage measure" and may even be defining a "measure" differently for different sectors. Cape Light Compact's System and Performance measure is a single 4-kW battery provided to a participant together with the Compact's managed discharge of that battery. For Eversource, National Grid, and Unitil's commercial and industrial Daily and Targeted Dispatch measures, and for Eversource's residential Daily and Targeted Dispatch measures, the measure appears to be the aggregated managed discharge of all batteries signed up with the program. For National Grid and Unitil's residential Daily and Targeted Dispatch measures, however, the measure appears to be each battery signed up for the program (see Table 4). (That there is a difference between Cape Light Compact and National Grid's residential storage measures can be observed in their measures lives: 10 years for Cape Light Compact's battery provision measure and 1 year for National Grid's bring-your-own battery measure.)

Table 4. Definition of measure

	Cape Light	Eversource	National Grid	Unitil
Residential Advanced Demand Management Program (A2e)	Single battery provided	Aggregate of BYO batteries	Single BYO battery	Single BYO battery
Income-Eligible Advanced Demand Management Program (B1b)	Single battery provided	N/A	N/A	N/A
Commercial/Industrial Advanced Demand Management Program (C2c)	Single battery provided	Aggregate of BYO batteries	Aggregate of BYO batteries	Aggregate of BYO batteries

The Massachusetts Energy Efficiency Advisory Council's consultant team identified the potential for including 84.3 megawatts (MW) of summer peak behind-the-meter storage capacity in the 2019-2021 plan, and a total of 250 MW for all ADR programs. Table 5 presents the programs administrators' ADR offering in summer peak kW, from their October 31, 2018 filing. (Massachusetts' program administrators' winter storage offering is not the same as that for summer.) Here, again, the information provided is difficult to interpret and is not comparable among the program administrators. Eversource, National Grid, and Unitil's Daily and Targeted Dispatch measures have a one-year measure life and therefore the capacity additions do not accumulate. Cape Light Compact's System and Performance measures have a 10-year measure life and the summer peak capacity presented likely refers to annual incremental additions to storage capacity (i.e. new batteries given to participants in each year). Assuming that Cape Light Compact's summer capacity accumulates but the other program administrators' does not, the total Massachusetts summer peak capacity addition offering for behind-the-meter storage was 33.9 MW, or two-fifths of the consulting team's estimate of storage potential.

Table 5. MA program administrators' summer kW savings for ADR measures

Summer kW Savings	Cape Light			Eversource			National Grid			Unitil		
	2019	2020	2021	2019	2020	2021	2019	2020	2021	2019	2020	2021
Residential Advanced Demand Management Program												
Program Summer kW Savings	*1,055*	*2,869*	*3,400*	*2,050*	*3,150*	*4,250*	*6,099*	*8,597*	*11,033*	*94*	*112*	*135*
Direct Load Control	1,055	1,618	1,861	2,000	3,000	4,000	5,156	6,785	8,278	94	112	135
Behavioral DR												
Storage System and Performance		1,250	1,539									
Storage Daily Dispatch				50	150	250	903	1,763	2,696			
Storage Targeted Dispatch												
EV Load Management							39	49	60			
Income-Eligible Advanced Demand Management Program												
Program Summer kW Savings		*289*	*385*									
Direct Load Control												
Behavioral DR												
Storage System and Performance		289	385									
Storage Daily Dispatch												
Storage Targeted Dispatch												
EV Load Management												
Commercial/Industrial Advanced Demand Management Program												
Program Summer kW Savings	*5,798*	*6,053*	*6,080*	*28,000*	*57,500*	*96,000*	*69,500*	*79,000*	*90,000*	*300*	*500*	*500*
Interruptible Load	5,395	5,458	5,485	27,000	47,000	75,000	66,000	72,000	79,000	200	400	400
Winter Interruptible Load												
Storage System and Performance		192	192									
Storage Daily Dispatch				500	5,000	10,000	2,500	5,000	7,000	100	100	100
Storage Targeted Dispatch				500	5,000	10,000						
Custom	403	403	403		500	1,000	1,000	2,000	4,000			

By program administrator, total summer capacity for storage measures is as follows:

- Cape Light Compact (adding together 2020 and 2021 as discussed above): 3.8 MW (not approved)
- Eversource: 20.3 MW
- National Grid: 9.7 MW
- Unitil: 0.1 MW
- **Total: 33.9 MW including Cape Light Compact; 30.1 MW without Cape Light Compact**

Eversource and Cape Light Compact's combined proposed storage measures amounted to 0.5 percent of Eversource's peak load (or 0.4 percent after removing Cape Light Compact's peak savings), National Grid's measures amount to 0.2 percent of its peak load, and Unitil's measures amount to 0.1 percent of its peak load.[8] For comparison, the Energy Efficiency Advisory Council's consultant team's estimated

[8] ISO-NE Regional Network Load data. August 2018. https://www.iso-ne.com/isoexpress/web/reports/load-and-demand/-/tree/reg-net-load-costs

potential storage capacity of 84.3 MW is 0.9 percent of Eversource, National Grid, and Unitil's combined summer peak load.

3. Improvements from the April draft storage benefit-cost analysis

Massachusetts' program administrators' approved cost-effectiveness analysis of storage measures offered in their final 2019-2021 plan includes several improvements over their April 2018 draft.[9]

Peak shifting

The April draft represented peak shifting by allocating peak energy (MWh) savings across four seasons (summer peak and off-peak, winter peak and off-peak), rather than explicitly showing charging and discharging in its calculations. The approved 2019-2021 plan instead treats both winter and summer, and charging and discharging as separate "measures."[10] This new method allows for a clearer accounting of what is and is not valued. It should be noted, however, that storage measures' benefit-cost ratios only have meaning for the aggregate of these four "measures" (summer charging, summer discharging, winter charging, winter discharging). The four "measures" together make up the storage measure as one would normally understand it.

Avoided non-embedded costs

The April draft assumes a $0 per metric ton non-embedded cost of carbon dioxide (CO_2). The final 2019-2021 plan includes the Massachusetts-specific avoid cost of Global Warming Solutions Act compliance as developed in the August 2018 supplement[11] to the *Avoided Energy Supply Components in New England: 2018 Report* (AESC 2018)[12]: $35 per short ton of CO_2. This adds to the measured benefits of storage.

[9] For a complete review of Massachusetts program administrators April 2018 draft 2019-2021 benefit-cost analysis for storage measures see: Stanton. July 2018. Massachusetts Battery Storage Measures: Benefits and Costs. Applied Economics Clinic White Paper. AEC-2018-07-WP-02. https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs

[10] Some program administrators' storage programs do not have savings in every season. The framework for calculating benefits reported in the three-year plans, however, is consistent across program administators.

[11] Knight, Pat, et al. August 2018. *Analysis of the Avoided Costs of Compliance of the Massachusetts Global Warming Solutions Act: Supplement to 2018 AESC Study*. Prepared for Massachusetts Department of Energy Resources and Massachusetts Department of Environmental Protection. http://ma-eeac.org/wordpress/wp-content/uploads/MA-GWSA-Supplement-to-2018-AESC-Study.pdf

[12] Synapse. June 2018. *Avoided Energy Supply Components in New England: 2018 Report.* http://www.synapse-energy.com/sites/default/files/AESC-2018-17-080-June-Release.pdf

4. Remaining concerns from the April draft storage benefit-cost analysis

Some other issues presented in the July 2018 version[13] of this critique have not been addressed and remain concerns in the approved 2019-2021 plan:

Non-energy benefits are omitted

Program administrators did not include non-energy benefits (such as avoided utility costs, national security, benefits to landlords, increased property values, improved comfort levels, safety, and health, and reduced home maintenance) in their cost-effectiveness assessment of battery measures, although non-energy benefits such as these are included in the cost-effectiveness assessments of energy efficiency measures. This omission is discussed in Section 6.

Summer capacity values are undervalued

Program administrators include only one-tenth of the capacity prices associated with summer peak reductions from batteries in their cost-effectiveness assessment. This largely unexplained assumption is discussed in Section 6.

Winter reliability values are omitted

Program administrators assign a value of $0 to the reliability of Massachusetts' winter electric service in their cost-effectiveness assessment of battery measures. This omission is discussed in Section 6.

Peak versus off-peak emissions

Avoided non-embedded-costs are the product of avoided emissions and the avoided cost of emissions from AESC 2018. These avoided costs are "non-embedded" in the sense that they are externality costs: costs are that are not included in market prices but have value to Massachusetts. AESC 2018 assumes (as a result of its modeling of the hourly dispatch of New England electric generation resources) that CO_2 emissions rates (lbs/MWh) are higher in off-peak hours than they are in peak hours (see Table 6).

[13] Stanton. July 2018. Massachusetts Battery Storage Measures: Benefits and Costs. Applied Economics Clinic White Paper. AEC-2018-07-WP-02. https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs

Table 6. Electric-sector CO_2 and NO_x emissions rate (lbs/MWh)

	Winter		Summer	
	On Peak	*Off Peak*	*On Peak*	*Off Peak*
CO_2	978	999	952	959
NO_X	0.212	0.241	0.173	0.180

Note: Emissions rates do not vary substantially across years.
Source: EnCompass modeling outputs for main 2018 AESC case

Source: Avoided Energy Supply Components in New England: 2018 Report by Synapse Energy, Inc. Table 150. Available online at http://www.synapse-energy.com/sites/default/files/AESC-2018-17-080-June-Release.pdf.

This assumption runs counter to the more commonly used assumption that, in New England, CO_2 emissions rates are lower in off-peak hours, and higher in peak hours. Higher peak emissions are reported by ISO-New England is its 2016 annual emissions report (see Table 7) and have been so in the last two years as shown in Figure 1. The definition of peak impacts not only on energy prices but also on the average emissions rates for these periods.

Table 7. 2016 LMU Marginal Emission Rates—All LMUs (lb/MWh)

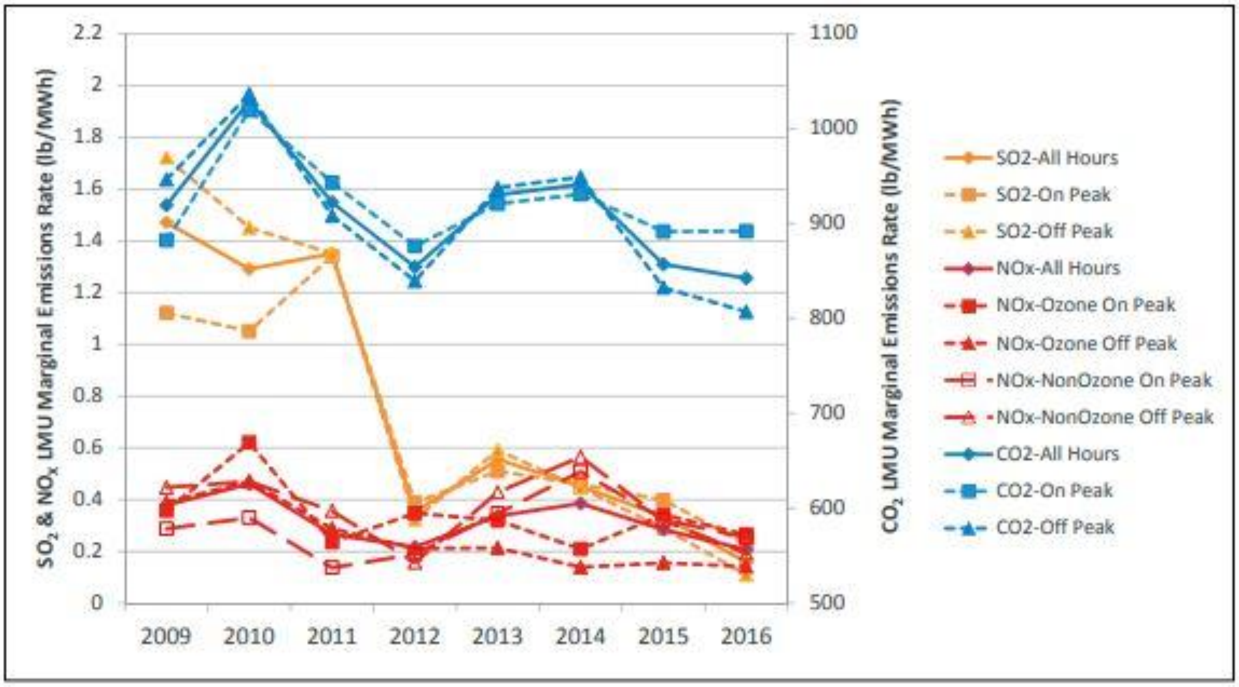
Ozone / Non-Ozone Season Emissions (NOx)					
Air Emission	Ozone Season		Non-Ozone Season		Annual Average (All Hours)
	On-Peak	Off-Peak	On-Peak	Off-Peak	
NO_X	0.26	0.14	0.25	0.19	0.21
Annual Emissions (SO_2 and CO_2)					
Air Emission		Annual			Annual Average (All Hours)
		On-Peak	Off-Peak		
SO_2		0.22	0.11		0.16
CO_2		892	807		842

(a) The ozone season occurs between May 1 and September 30, while the non-ozone season occurs from January 1 to April 30 and from October 1 to December 31.

(b) On-peak hours consist of all weekdays between 8:00 a.m. and 10:00 p.m. Off-peak hours consist of all weekdays between 10:00 p.m. and 8:00 a.m. and all weekend hours.

Source: ISO-NE 2016 Emissions Report. Table 5-3. Available online at: https://www.iso-ne.com/static-assets/documents/2018/01/2016_emissions_report.pdf.

Figure 1. 2009-2016 Marginal Emissions Rates, all LMUs (lb/MWh)



Source: ISO-NE 2016 Emissions Report, Table 5-9. Available online at: https://www.iso-ne.com/static-assets/documents/2018/01/2016_emissions_report.pdf*.*

Program administrators' final plan continues to follow the AESC 2018 assumption that (contrary to ISO-New England historical data) New England generator's CO_2 emission rates are higher off-peak than on. The adoption of this unfounded assumption in program administrators' plan means that storage energy benefits, which include emissions benefits, are likely lower than they would otherwise be.

Average energy price by time period

Battery measures' avoided-energy benefits are the product of avoided energy (in MWh) and avoided energy prices, as calculated in AESC 2018. Avoided energy prices are calculated on an hourly basis in AESC 2018 and then aggregated to summer peak, summer off-peak, winter peak, winter off-peak. The average energy prices for these time periods, by year, are very sensitive to changes in the assignment of hours as peak or off-peak. AESC 2018 follows the definition of peak as from 9 am to 11 pm each weekday (excluded holidays) for both summer (four months) and winter (eight months).

As shown in

Table 8, redefining peak as those hours with the highest energy prices or highest MWh sales results in a very different allocation of hours between summer peak, summer off-peak, winter peak, winter off-peak. By energy price, all but one of the highest priced hours are in the winter months, and 43 percent of these are off peak. By demand, 28 percent are in winter and 50 percent of these are off peak.

Table 8. Peak/Off-peak hours for 2019

	Total Count	Highest 10% by Energy Price	MWh
Summer peak	1,260	0	317
Summer offpeak	1,668	1	313
Winter peak	2,565	502	128
Winter offpeak	3,267	373	118

Source: Stanton. July 2018. Massachusetts Battery Storage Measures: Benefits and Costs. Applied Economics Clinic White Paper. AEC-2018-07-WP-02. https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs

The program administrators continue to assume average summer and winter, peak and off-peak, energy prices instead of using hourly data from AESC 2018 modeling to better identify energy prices during expected periods of charging and discharging for storage measures. The approved 2019-2021 plan continues this practice with the likely result that energy prices during periods of discharge are being undervalued in storage measures' cost-effectiveness assessments.

5. Critical omissions in October methodology

Three key methodological choices stand out as areas of particular concern in the cost-effectiveness assessments for storage measures presented in the final 2019-2021 plans: no value is assigned to non-energy benefits, summer capacity is undervalued, and no value is assigned to winter reliability.

Non-energy benefits valued at $0

In addition to energy benefits (avoided cost of: energy, generation capacity, transmission and distribution infrastructure, and emission permits), storage-related measures also provide non-energy benefits to both consumers and utilities. The program administrators' "BCR Model" assigns non-energy benefits to numerous energy efficiency measures based on the *Massachusetts Program Administrators' Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts Evaluation*[14], including: avoided utility costs, national security, benefits to landlords, increased property values, improved comfort levels, safety, and health, and reduced home maintenance.

The Massachusetts' program administrators have omitted the value of the non-energy benefits of storage in their 2018 cost-effectiveness assessments. A March 2019 Applied Economics Clinic white paper, *Massachusetts Non-Energy Benefits of Battery Storage*, addresses this issue in detail and provides evidence of the following benefits: avoided power outages, higher property values, avoided fines, avoided collections and terminations, avoided safety-related emergency calls, job creation, and reduced

[14] Massachusetts Program Administrators. 2011. *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation*. http://ma-eeac.org/wordpress/wp-content/uploads/Special-and-Cross-Sector-Studies-Area-Residential-and-Low-Income-Non-Energy-Impacts-Evaluation-Final-Report.pdf

power plant land usage.[15] The program administrators' failure to include these non-energy benefit values in their benefit-cost ratio calculations for energy storage likely resulted in their undervaluing storage in the three-year energy efficiency plan.

Summer capacity is undervalued

Program administrators' approved cost-effectiveness assessments reduce the summer capacity and electric capacity price sensitivity (called "DRIPE") to 10 percent of its calculated value for almost all storage measures. The BCR spreadsheets refer to this 90 percent reduction as the "Limited Demand Response Scaling Factor," but neither explain nor cite the source of this modeling choice. AESC 2018 includes two oblique references that may refer to this benefit reduction:

> *The PJM load forecasters ran sensitivities on their generally similar regression-based forecasts at the request of the Maryland Office of Peoples Counsel. Those sensitivities showed that an equal-percentage load reduction on all hours for three years resulted in a reduction in the forecast by 10 to 30 percent of the load reduction starting by the seventh year (four years after the end of the modeled load reduction).* (p.104)

> *The PJM load forecasters ran sensitivities on their econometric forecasting model and found that load reductions on a few high-load days each summer would reduce the load forecast by only about 10 percent of that from an energy efficiency reduction in all hours. Program administrators should model the effect of selective high-hour reductions on the ISO New England load forecast before claiming any avoided capacity costs from those resources. For initial screening, program administrators may wish to credit those measures with 10 percent of the values in Table 41.[107] (Footnote 107: On the other hand, a PA may theoretically claim additional savings if it can demonstrate that its summer DR program reduces load every day during the July/August summer peak forecast period.)* (p.105)

Massachusetts' program administrators appear to have chosen to take a sensitivity analysis conducted for Maryland on electric peak demand forecasts for the PJM region as evidence that not only demand response but most advanced demand or storage measures only operate during 10 percent of peak hours. With this assumption in place, storage BCRs are approximately one-third lower than they would otherwise be (e.g. a BCR of 0.5 with this scaling factor would otherwise be 1.5 without it). Only 10 percent of peak hours are assigned a value, and the value assigned is that of the average across all peak hours defined as 9am to 11pm on weekdays. This method neither captures the high value of avoiding the small number of hours with very high energy costs, nor the smaller per hour value of other "peak hours" (as defined by the program administrators).

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[15] Woods, B. and Stanton, E.A. March 2019. *Massachusetts Non-Energy Benefits of Battery Storage*. Applied Economics Clinic White Paper. AEC-2019-03-WP-01. Available online: https://aeclinic.org/publicationpages/2019/3/15/massachusetts-non-energy-benefits-of-battery-storage.

Winter reliability values at $0

Because New England's peak times for electric consumption occur in summer months, it is this "summer peak" that is used to calibrate markets for generation capacity. Avoided capacity costs are, therefore, the savings from reduced needs to capacity investments vis-à-vis summer peak.

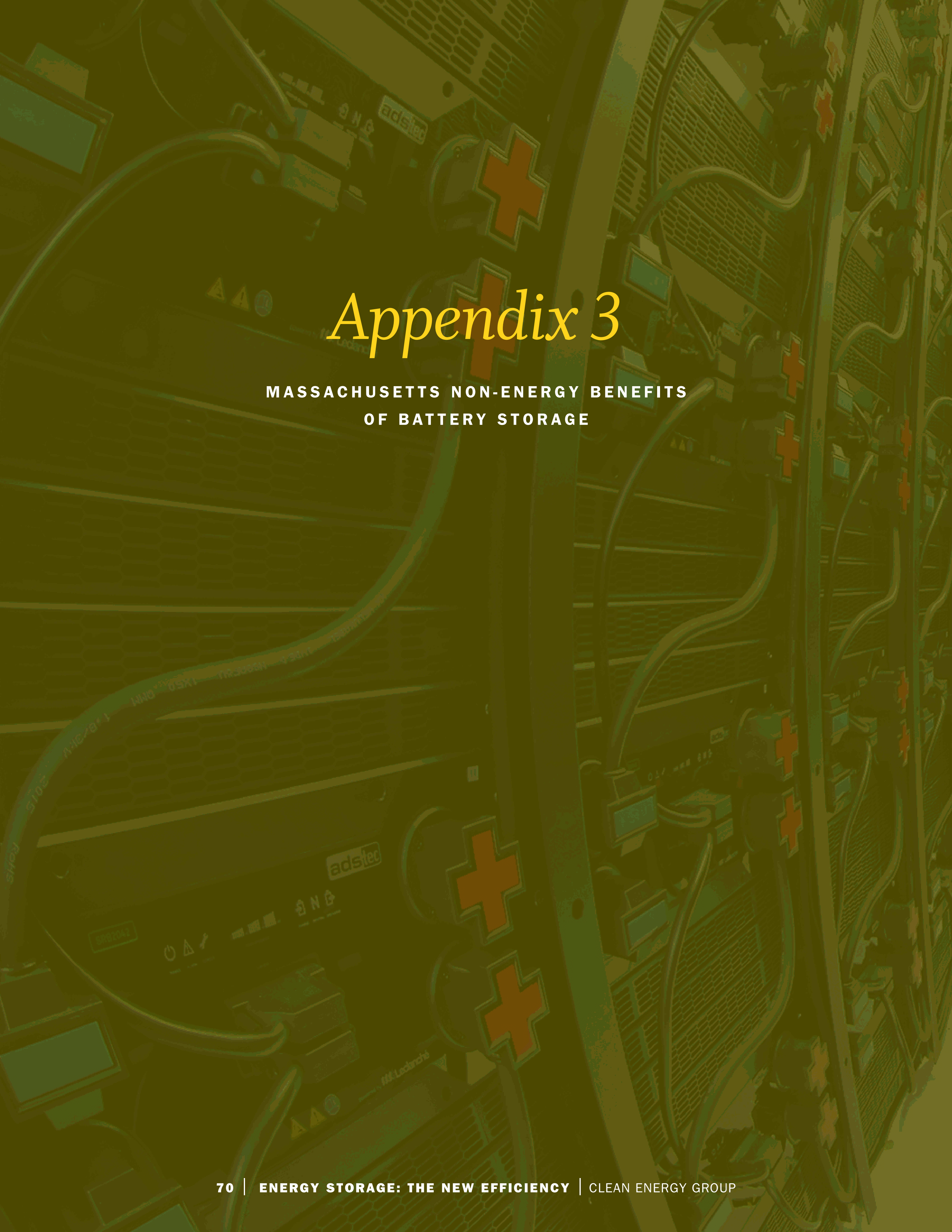
Reduced demand for peak generation capacity in winter does not avoid New England capacity market purchases and is called "winter reliability" in reference to this difference. Nonetheless, reduced winter peak capacity demands (increased winter reliability) holds a substantial value for Massachusetts as the Commonwealth works to balance coincident demands for natural gas used for heating and for electric generation.

Program administrators' final 2019-2021 plan acknowledges storage measures' impact on winter reliability:

> *The innovations in this Plan include new active demand reduction efforts that will have an impact on summer peak demand and winter reliability, while strongly supporting the Commonwealth's greenhouse gas reduction goals. (p.29-30)*

but omits a value for winter reliability. The approved 2019-2021 plan explains that a winter reliability benefit is under development:

> *The Program Administrators have agreed with DOER and the Attorney General to conduct a study to be commenced in Q1 of 2019 to quantify any benefits associated with winter peak capacity reduction. The PAs will issue an RFP and conduct this study in collaboration with the DOER, the Attorney General and the Council consultants. Study results will be aligned with and compatible with the 2018 AESC. If new benefits are identified as a result of this study, the Program Administrators will apply those benefits to reported values. (p.169)*



Appendix 3

MASSACHUSETTS NON-ENERGY BENEFITS OF BATTERY STORAGE

Massachusetts Non-Energy Benefits of Battery Storage

April 2019 – White Paper

Applied Economics Clinic

Prepared for:
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Executive Summary

Behind the meter battery storage in Massachusetts benefits the energy system itself—lowering costs—and also affords "non-energy benefits" to the participants of storage programs, to electric distributors, and to society. To date, these non-energy benefits have not been included in efforts by utility program administrators to calculate energy storage benefit-cost ratios. For an energy efficiency measure to be included in a program administrator's energy efficiency program, that measure must have a benefit-cost ratio that is greater than 1—that is, the benefits must be found to outweigh the costs. Leaving non-energy benefits out of cost-benefit calculations may lead to energy efficiency programs that are not offering all the cost-effective efficiency measures that are available. Some of non-energy benefits may be more difficult to quantify than energy system benefits, but leaving non-energy benefits out of programmatic cost-effectiveness assessments has the same effect as assuming they have no value. Omitting these important values may lead to decisions regarding battery investments that are not strategic or economic for the Commonwealth, and puts battery storage measures at a disadvantage vis-à-vis demand response measures and efficiency measures that do include non-energy benefits in their cost-benefit calculations. In this white paper, we present the results of a preliminary assessment of seven non-energy benefits of battery storage, as summarized in Table ES-1.

Table ES-1. Non-energy benefits of battery storage in Massachusetts

	Non-Energy Benefit (2018$)
1) Avoided power outages	
Battery storage helps avoid outages, and all of the costs that come with outages for families, businesses, generators and distribution companies	Residential: **$1.72**/kWh Commercial/Industrial: **$15.64**/kWh
2) Higher property values	
Installing battery storage in buildings increases property values for storage measure participants by: (1) increasing leasable space; (2) increasing thermal comfort; (3) increasing marketability of leasable space; and (4) reducing energy costs	**$5,325/**housing unit for low-income single family participants **$510/**housing unit for owners of multi-family housing
3) Avoided fines	
Increasing battery storage will result in fewer power outages and fewer potential fines for utilities	**$24.8 million** in 2012
4) Avoided collections and terminations	
More battery storage reduces the need for costly new power plants, thereby lowering ratepayer bills, and making it easier for ratepayers to consistently pay their bills on time. This reduces the need for utilities to initiate collections and terminations	Terminations and Reconnections: **$1.85**/year/participant Customer calls: **$0.77**/year/participant
5) Avoided safety-related emergency calls	
Increasing battery storage results in fewer power outages, which reduces the risk of emergencies and the need for utilities to make safety-related	**$10.11**/year/participant
6) Job creation	
More battery storage benefits society at large by creating jobs in manufacturing, research and development, engineering, and installation	**3.3 jobs**/MW **$310,000**/MW
7) Less land used for power plants	
More battery storage reduces the need for peaker plants, which are more land-intensive than storage installations—benefitting society by allowing more land to be used for other purposes	**12.4 acres**/MW

Background

Battery storage accounts for a small but growing share of U.S. electric capacity.[1] According to the U.S. Energy Information Administration (EIA), as of July 2018, the United States has a total electric capacity of 1.2 million megawatts (MW), of which 763 MW is battery storage, accounting for 0.06 percent of all electric capacity in the nation. Massachusetts' 4 MW of battery storage capacity amounts to just 0.03 percent of electric capacity in the Commonwealth.

In 2008, Massachusetts passed into law the Green Communities Act (GCA)[2] and the Global Warming Solutions Act (GWSA)[3]. GCA required electric distributors to pursue all cost-effective energy efficiency opportunities for their customers, created the state's Energy Efficiency Advisory Council, increased the state's renewable energy portfolio requirements, and set aside $10 million per year to assist municipalities seeking to build renewable and alternative energy facilities. GWSA set statewide greenhouse gas emission reduction requirements, including an 80 percent reduction by 2050 (from a 1990 baseline).[4]

GCA and GWSA laid the groundwork for the Baker Administration, in 2015, to set aside $10 million—a figure that doubled to $20 million in 2017[5]—to explore and promote energy storage technology, develop the state's storage market, and recommend policy for the adoption of energy storage to help the state meet its clean energy and climate goals. Following this initiative, the *State of Charge* report, published by the Massachusetts Clean Energy Center (CEC) and Department of Energy Resources (DOER), found that "[t]here is great potential in Massachusetts for new advanced energy storage to enhance the efficiency, affordability, resiliency and cleanliness of the entire electric grid by modernizing the way we generate and deliver electricity."[6] The study found that the electric grid in Massachusetts could cost effectively utilize 1,766 MW of battery storage by 2020.[7] In 2018, Massachusetts passed *An*

[1] U.S. Department of Energy. February 22, 2012. *Energy Storage: The Key to a Reliable, Clean Electricity Supply*. Available online: https://www.energy.gov/articles/energy-storage-key-reliable-clean-electricity-supply.
[2] The 190th General Court of the Commonwealth of Massachusetts. 2008. Chapter 169: An Act Relative to Green Communities. Available online: https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter169.
[3] The 190th General Court of the Commonwealth of Massachusetts. 2008. Chapter 298: An Act Establishing the Global Warming Solutions Act. Available online: https://malegislature.gov/Laws/SessionLaws/Acts/2008/Chapter298.
[4] For a fuller accounting of the GCA, GWSA, and Massachusetts' clean energy policy history, see: Woods, Schlegel and Stanton. May 2018. *Massachusetts' Clean Energy Policy Overview*. Available online: https://aeclinic.org/publicationpages/2018/6/18/history-of-ma-energy-sector-policy-brief.
[5] Mass.gov. December 7, 2017. Baker-Polito Administration Awards $20 Million for Energy Storage Projects. Available online: https://www.mass.gov/news/baker-polito-administration-awards-20-million-for-energy-storage-projects.
[6] Massachusetts Clean Energy Center and Department of Energy Resources. 2017. *State of Charge: Massachusetts Energy Storage Initiative Study*. Available online: https://www.mass.gov/files/2017-07/state-of-charge-report.pdf. p.i.
[7] MA CEC/DOER 2017. *State of Charge.* p. 77.

Act to Advance Clean Energy, which sets an target of 1,000 megawatt-hours of energy storage in service by 2026.[8]

Massachusetts' 2019-2021 energy efficiency plans, approved January 29, 2019,[9] include a proposed new active demand management program with electric battery storage measures. Active demand management is a comprehensive set of actions intended to shift energy demand away from peak times to avoid building new, expensive generating plants, and includes: battery storage, exploiting flexibility on both the supply-side and demand-side, and coordinating demand-side measures with energy efficiency opportunities to more cheaply and efficiently supply energy. For battery storage to receive funding under GCA—in the same way that energy efficiency measures have historically—each program administrator's active demand management program offering for the three-year plan must be found to be cost effective. (Each electric distribution company or utility has a "program administrator" responsible for running their energy efficiency program.) The 2018 *Act to Advance Clean Energy* states:

> *There shall be an energy storage target of 1,000 megawatt hours to be achieved by December 31, 2025. To achieve this target, the department of energy resources may consider a variety of policies to encourage the cost-effective deployment of energy storage systems, including the refinement of existing procurement methods to properly value energy storage systems, 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 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.*[10]

For storage measures to be included in the funding allocation and program implementation described in the Massachusetts' program administrators 2019-2021 plans,[11] each group of measures' benefits must have a higher value than that group's costs.[12] Although the program administrators did find storage measures to be cost effective, their benefit-cost calculations were based only on the energy benefits of storage, not taking into account the non-energy benefits explored in this paper. This likely resulted in an undervaluing of energy storage, and therefore a lower benefit-cost ratio than would have been calculated had all benefits of storage measures been evaluated. As noted in CEC/DOER's *State of Charge*

[8] The 190th General Court of the Commonwealth of Massachusetts. 2018. Chapter 227: An Act to Advance Clean Energy. Available online: https://malegislature.gov/Bills/190/H4857/BillHistory. Lines 148-9.
[9] MA DPU 18-116, 18-117, 18-118, 18-119. *Three Year Energy Efficiency Plan for 2019 through 2021.*
[10] An Act to Advance Clean Energy. Lines 148-157.
[11] Massachusetts Department of Public Utilities. Docket Nos. 18-116, 18-117, 18-118, 18-119. *Three Year Energy Efficiency Plan for 2019 through 2021.* Available online: http://ma-eeac.org/wordpress/wp-content/uploads/2019-2021-Three-YearEnergy-Efficiency-Plan-April-2018.pdf.
[12] Cost-effectiveness is currently assessed at the program level in Massachusetts.

report, while the ability to monetize all the benefits associated with increased battery storage deployment may be limited, non-monetizable benefits have value nonetheless.[13]

In Massachusetts' 2019-2021 energy efficiency plans include a new active demand management program with electric battery storage measures. Massachusetts program administrators' assessment of energy efficiency measures' cost effectiveness includes two main categories of benefits: 1) energy system benefits (or energy avoided costs), and 2) non-energy benefits (see text box below for a brief explanation of energy versus non-energy benefits). In the 2019-2021 plan, active demand management measures have been assigned values for the former category but not the latter: In other words, non-energy benefits of storage are given no value in assessing these measures' cost effectiveness.

	Benefits of Battery Storage	
	Energy Benefits	**Non-Energy Benefits**
Who benefits?	Benefits to the energy system	Benefits to participants in battery storage programs, electric distribution companies and/or society at large
How does benefit manifest?	Benefit conferred through reductions in the cost of supplying energy	Benefit conferred directly to beneficiary
Examples	▪ Reduced peak energy demand ▪ Reduced need for new generating capacity ▪ Transmission and distribution cost reductions ▪ Increased grid resiliency ▪ Facilitates renewable energy integration	▪ Avoided value losses to cusomters and utilities from power outages ▪ Enhanced value to customers from reduced incidence of power outages ▪ Enhanced property values ▪ Enhanced ability to pay less expensive electric bills ▪ Job creation

While many states use cost-benefit analyses to determine which traditional energy efficiency measures to pursue, Massachusetts is the first state in the country to apply a similar methodological approach for battery storage. To achieve the best decision making, it is critical that Massachusetts recognize the full value of these benefits. To this end, this white paper explores the non-energy benefits of electric storage measures in Massachusetts.

What are the benefits of battery storage?

GCA requires that all cost-effective actions be taken regarding energy efficiency and renewable energy. Massachusetts program administrators perform benefit-cost analyses to determine which energy efficiency and active demand management programs to include in their three-year plans. Capturing a full range of benefits and costs is essential to ensure the most strategic program implementation in the

[13] MA CEC/DOER 2017. *State of Charge.*

Commonwealth.[14] CEC/DOER's *State of Charge* report found that installing 1,766 MW of advanced energy storage in Massachusetts could save electric consumers $2.3 billion through 2020 (see Table 1 below).

Table 1. *State of Charge* total system benefits from Massachusetts energy storage

Benefit	Ratepayer Savings (billions $)
Energy Cost Reduction	$0.3
Reduced Peak Capacity	$1.1
Ancillary Services Cost Reduction	$0.2
Wholesale Market Cost Reduction	$0.2
Transmission and Distribution Cost Reduction	$0.3
Integrating Distributed Renewable Generation Cost Reduction	$0.2
Total System Benefits	**$2.3**

Source: MA CEC/DOER 2017. State of Charge. p.xii.

State of Charge highlights many commonly discussed energy system benefits from battery storage. An electric grid that has built-in backup in the form of storage can more reliably supply energy on demand and is more resilient to disruptions. Improving the grid's ability to store energy produced at one time and dispatch it at another time would facilitate the increased use of intermittent renewable energy sources. Increasing the grid's share of renewable energy would also result in fewer greenhouse gas emissions from fossil fuel energy generation and associated environmental disruptions like gas leaks or pipeline spills. Increasing the share of renewable energy in New England's electric grid will boost the economy by increasing the value of those resources and by creating jobs associated with an increased need to produce, transport, install and maintain new energy infrastructure.[15]

Perhaps battery storage's most critical energy system benefit, however, is its use in reducing New England's peak energy demand and the substantial costs associated with peak. As battery storage reduces the need for generation at peak, it lowers costs by shrinking the amount of capacity that electric distributors must possess to meet peak demand, and lowers required capacity reserve margins as well. For example, for every 1 MW of reduced peak demand in New England, there is an associated reduced capacity need of approximately 1.15 MW.[16]

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[14] Stanton, E.A. July 2018. *Massachusetts Battery Storage Measures: Benefits and Costs.* Applied Economics Clinic White Paper. AEC-2018-07-WP-02. Available online: https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs; and Stanton, E.A. March 2019. *Updated Massachusetts Battery Storage Measures: Benefits and Costs.* Applied Economics Clinic White Paper. AEC-2019-03-WP-02. Available online: https://aeclinic.org/publicationpages/2019/3/15/updated-massachusetts-battery-storage-measures-benefits-and-costs.

[15] Accounts for 15 percent operating reserve margin. Source: MA CEC/DOER 2017. *State of Charge*.

[16] Kotha, M. June 13, 2018. *Future Representative Installed Capacity Requirements for CCP 2023-2024 through CCP 2027-2028*. Slide 8. Available online: https://www.iso-ne.com/static-assets/documents/2018/06/a9_representative_icr_values_for_ccp_2023_2024_through_2027_2028.pdf.

These types of energy system benefits (often referred to as avoided energy costs) are estimated in more detail by the *Avoided Energy Supply Components in New England* (AESC) reports, most recently released in March 2018 and updated in June 2018 (hereafter referred to as AESC 2018).[17] The energy system benefits estimated in that report include avoided fuel costs, avoided electric generating capacity costs, and avoided costs of complying with GWSA.

In addition to energy system benefits, however, storage measures confer several “non-energy benefits” that are separate from those directly applicable to the cost of energy supply. Battery storage provides benefits to electric distributors and to ratepayers, including both families and businesses, and to society at large. These non-energy benefits of storage are the topic of this white paper.

What are non-energy benefits?

Non-energy benefits of battery storage are conferred not through changes to the cost of electric services (energy system benefits), but directly to participants in storage programs, the electric distribution companies themselves, or to society as a whole. For example, during a power outage, storage systems can enable businesses to stay open, residents to stay in their homes, and hospitals to continue to operate—resulting in clear benefits that are unrelated to the cost of electricity, such as: avoided loss of customers and revenue; avoided equipment damage; avoided loss of perishable materials and goods; and avoided data losses. Some of these non-energy benefits may be more difficult to quantify than energy system benefits, or may require new and different measurement tools.[18] To leave these critical benefits unmeasured, however, is equivalent to assuming that they have no value in a benefit-cost analysis, which has the result of lowering benefit-cost metrics and reducing the likelihood that storage measures and programs will achieve cost effectiveness and be included in program administrators’ three-year energy efficiency plans.

Massachusetts energy efficiency program administrators have a long history of assigning values to the non-energy benefits of weatherization, insulation, heating and cooling upgrades, retrofits, lighting and appliance upgrades and other efficiency measures. Program administrators prepare—and periodically update and expand upon—*Non-Energy Impact (NEI) Evaluation* studies that estimate the non-energy benefits of energy efficiency measures for residential and low-income ratepayers in the state, including, for example: reduced asthma, reduced thermal stress on occupants, fewer missed days of work, reduced risk of fire, and reduced noise. The MA NEI Evaluation 2011 study considered utility and societal non-energy impacts in addition to residential and low-income ratepayer non-energy impacts.[19] The MA

[17] Synapse Energy Economics. June 1, 2018. *Avoided Energy Supply Components in New England: 2018 Report* . Prepared for AESC 2018 Study Group. Available online: https://www.ct.gov/deep/lib/deep/energy/aesc-2018-17-080-june-1-release.pdf.

[18] Energy Storage Association (ESA). November 2017. *35x25: A Vision for Energy Storage*. Available online: http://energystorage.org/system/files/attachments/esa_vision_2025_final.pdf.

[19] Massachusetts Program Administrators. August 15, 2011. *Massachusetts Special and Cross-Sector Studies Area, Residential and Low-Income Non-Energy Impacts (NEI) Evaluation*. Prepared by NMR. Available online: http://ma-eeac.org/wordpress/wp-content/uploads/Special-and-Cross-Sector-Studies-Area-Residential-and-Low-Income-Non-Energy-Impacts-Evaluation-Final-Report.pdf.

NEI Evaluation 2016 study focused exclusively on residential and low-income ratepayer non-energy impacts.[20] Table 2 (on the following page) lists the non-energy benefits for which monetary values were provided in the MA NEI Evaluation 2011; rows marked in green indicate the subset of these benefits assigned to measures in the program administrator's 2019-2021 plan.

Currently, the non-energy benefits of battery storage are not included in Massachusetts active demand management program planning. Omitting these non-energy benefits introduces a downward bias on storage measures' benefit-cost assessments. Without a full consideration of all benefits, Massachusetts is unlikely to make the best strategic decisions regarding these important cost-saving measures.

[20] Massachusetts Program Administrators. August 5, 2016. *Massachusetts Special and Cross-Cutting Research Area: Low-Income Single-Family Health-and Safety-Related Non-Energy Impacts (NEIs) Study*. Prepared by Three, Inc. and NMR. Available online: http://ma-eeac.org/wordpress/wp-content/uploads/Low-Income-Single-Family-Health-and-Safety-Related-Non-Energy-Impacts-Study.pdf.

Table 2. Massachusetts non-energy benefits of energy efficiency

NEI	Duration
UTILITY PERSPECTIVE	
Arrearages	Annual
Bad debt write-offs	Annual
Terminations and reconnections	Annual
Rate discounts	Annual
Customer calls	Annual
Collections notices	Annual
Safety-related emergency calls	Annual
Insurance savings	—
SOCIETAL PERSPECTIVE	
National Security	Annual
NON-RESOURCE BENEFITS	
Appliance Recycling – Avoided landfill space	One time
Appliance Recycling – Reduced emissions due to recycling plastic and glass, reduced emissions	One time
Appliance Recycling – Reduced emissions due to incineration of insulating foam	One time
NEI	**Duration**
PARTICIPANT PERSPECTIVE (OWNERS OF LOW-INCOME RENTAL HOUSING), PER HOUSING UNIT	
Marketability/ease of finding renters	Annual
Reduced tenant turnover	Annual
Property value	One time
Equipment maintenance (heating and cooling systems)	Annual
Reduced maintenance (lighting)	Annual
Durability of property	Annual
Tenant complaints	Annual
PARTICIPANT PESPECTIVE (OCCUPANT)	
Higher comfort levels	Annual
Quieter interior environment	Annual
Lighting quality & lifetime	One time
Increased housing property value	One time (Annual for NLI RNC)
Reduced water usage and sewer costs (dishwashers)	Annual
Reduced water usage and sewer costs (faucet aerators)	Annual
Reduced water usage and sewer costs (low flow showerheads)	Annual
More durable home and less maintenance	Annual
Equipment and appliance maintenance requirements	Annual
Health related NEIs	Annual
Improved safety (heating system, ventilation, carbon monoxide, fires)	Annual
Window AC NEIs	Annual
**** Green cells showing the Benefits in April Draft of 2019-2021 Plan**	

Source: MA NEI Evaluation 2011. Reproduced from: Stanton, E.A. July 2018. Massachusetts Battery Storage Measures: Benefits and Costs. Applied Economics Clinic White Paper. AEC-2018-07-WP-02. Available online: *https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs*.

Non-Energy Benefits of Battery Storage

This white paper presents seven non-energy benefits of electric storage measures in Massachusetts: 1) avoided power outages; 2) higher property values; 3) avoided fines; 4) avoided collections and terminations; 5) avoided safety-related emergency calls; 6) job creation; and 7) less land used for power plants. In the following sections, we discuss each non-energy benefit in terms of how it works, how it is valued, and how and why it applies to Massachusetts. (Energy and emission-reduction benefits of storage are evaluated in AESC 2018 and, therefore, including in battery measures' cost-effectiveness assessment.)

The seven storage non-energy benefits presented here do not represent a comprehensive set of all such benefits. Rather, this list and the monetized benefits that we have assembled are a starting point for a discussion of how best to fully measure the advantages to Massachusetts of battery storage. The measures selected for inclusion in this white paper are drawn from our review of the literature and are recurring benefits, with one exception: an increase in property value is a one-time benefit.

1. Avoided power outages

Power outages entail costs to generators, distribution companies, and consumers. Battery storage, if charged and discharged at appropriate times, reduces peak load, thereby increasing reserve margins and enhancing grid reliability; it also reduces the incidence and duration of power outages. Avoiding power outages is beneficial for electric distributors and for ratepayers. From an energy system point of view, the benefit of avoided power outages is lower total system costs. From the storage measure participants' point of view, the benefit of avoided power outages is the reduction of costly—and potentially dangerous—disruptions to life and work.

AESC 2018 introduces estimation of a new energy system reliability benefit: the avoided costs of power outages to the electric system. As we describe in this section, this energy system reliability benefit is distinct from the non-energy benefits to consumers of avoided outages. Some understandable confusion between these two kinds of benefits may, nonetheless, arise: the non-energy benefits of avoided outages to families and businesses is often called the "value of lost load" (VoLL). AESC 2018 follows—but does not explain—the common practice of using ratepayers' VoLL as a proxy to estimate the energy system costs of outages. This use of ratepayers' VoLL as a proxy for system costs should not, however, suggest that system costs are in fact the VoLL.

1. ***Energy system reliability benefit:*** Greater reliability lowers system costs. This avoided cost is typically measured indirectly by assuming—based on economic theory—that system reliability costs are equal to the benefits to consumers of avoided outages. AESC 2018 uses ratepayers' VoLL as a proxy to estimate the avoided system costs of enhanced reliability.

2. ***Non-energy reliability benefit to consumers:*** VoLL is a measure of the value to families and businesses of lost load (outages). Storage measure participants' non-energy VoLL benefit is distinct from the energy system reliability benefit estimated by AESC 2018.

Energy system reliability benefit

Reliable electric service is a benefit for both electric distributors and consumers, but valuing the benefit is made difficult by the fact that there is no market for the reliability of energy, or for energy interruptions. As a result, most valuation exercises seek to determine the reverse; according to an overview of VoLL studies and their use: "It proves often easier to estimate the costs of the effects of supply interruptions for energy consumers."[21] VoLL accomplishes that by expressing what a *Frontiers in Energy Research* article called the "monetary evaluation of uninterruptedness of power supply."[22] VoLL estimates the cost per kilowatt-hour (kWh) of a power outage. According to economic theory, energy system reliability can be assumed to have a value equal to the costs to customers in the event of power outages. (Power suppliers would pay up to, but not beyond, this value in order to avoid losses.[23])

AESC 2018 follows the practice of using VoLL as a proxy for energy system reliability benefits, and presents four values for U.S. VoLL taken from the literature (see Table 3).

Table 3. AESC 2018 results of reported values of lost load literature review (2018$/kWh)

Report year	Author	Region	Small C&I	Large C&I	Residential	Average across sectors
2015	LBNL[a]	US	$280	$16	$2	$37[d]
2014	London Economics[b]	ERCOT	$7	$4	--	$12[d]
2014	London Economics[b]	US	$46	$31	$2	--
2010	Centolella[c]	Midwest	$56	$28	$5	--

[a] Sullivan et al. 2015. Updated Value of Service Reliability Estimates for Electric Utility Customers in the United States. Prepared for Office of Electricity Delivery and Energy Reliability, U.S. Department of Energy. Lawrence Berkeley National Laboratory (LBNL). [b] London Economics International LLC. 2013. Estimating the Value of Lost Load. Prepared for the Electric Reliability Council of Texas, Inc. [c] Centolella, P. 2010. Estimates of the Value of Uninterrupted Service for The Mid-West Independent System Operator. Harvard Electricity Policy Group. [d] AESC 2018.

AESC 2018 presents $25 per kWh—the average of the first two U.S. VoLL estimates from Table 3—as the New England VoLL and, by proxy, as the New England system reliability avoided cost. The other two VoLL results in Table 3 were not included in AESC 2018's VoLL estimate. The second London Economics result (Row 3 in Table 3) is taken from the same study as the ERCOT VoLL and reports the results of an

[21] van der Welle, A. and van der Zwaan, B. 2007. *An Overview of Selected Studies on the Value of Lost Load (VoLL).* Energy Research Centre of the Netherlands. p.2.

[22] Schröder and Kuckshinrichs. December 24, 2015. "Value of Lost Load: An Efficient Economic Indicator for Power Supply Security? A Literature Review", *Frontiers in Energy Research*. Available online: https://www.frontiersin.org/articles/10.3389/fenrg.2015.00055/full. p.2

[23] "In the optimum cases, the level of supply security should be defined in such a way that the marginal damage costs, expressed by VoLL, are equal to the marginal costs for ensuring uninterrupted electricity supply. Accordingly, the calculation of the economic indicator VoLL represents, on the one hand, an opportunity to determine the level of damage caused by a power interruption, the results of which, on the other hand, describes the value of power supply security." Schröder and Kuckshinrichs, 2015. p.4.

older version of the Centolella 2010 study[24] (Row 4 in Table 3). In the Centolella 2010 study, Paul Centolella and coauthors, on behalf of SAIC, estimate U.S. Midwest VoLL, based on the methodology and data used in an earlier version of the LBNL 2015 study[25] (Row 1 in Table 3).

AESC 2018 accepts the LBNL 2015's "willingness-to-pay" survey results as presented, changing only their dollar year and calculating an average value appropriate to the relevant distribution of outage durations in New England. For the London Economics 2014 study, however, AESC 2018 re-calculates New England-specific results following London Economics' production function methodology, citing a U.S. AID study on the Republic of Georgia[26] in substantiating this methodology.

Cleveland State University's 2017 report on valuing resiliency from microgrids describes the VoLL production function methodology in detail and provides U.S.-wide results, with results ranging up to $110 per kWh across different industries.[27] We replicated the production function methodology used in AESC 2018 for New England states but got somewhat different results, as shown in Table 4.

Table 4. Ratio of 2016 GDP to energy usage: AESC 2018 and AEC (2018$/kWh)

State	AESC 2018 GDP/kWh	AEC GDP/kWh
MA	**$15.15**	**$15.64**
CT	$8.98	$16.54
RI	$7.60	$13.47
VT	$5.70	$9.35
NH	$7.05	$12.45
ME	$5.00	$8.96
New England	**$11.63**	**$14.46**

Source: AESC 2018, Table 95, p.224. Data for AEC calculations: GDP—Bureau of Economic Analysis, Regional Data, Gross Domestic Product by State, NACIS All GDP components, available online: https://apps.bea.gov/regional/downloadzip.cfm. Energy usage—EIA-861, Retail Sales of Electricity by State by Sector by Provider, available online: https://www.eia.gov/electricity/data/state/. GDP and sales values originally provided in 2016 dollars have been updated to 2018 dollars using the CPI-U index.

[24] Centolella et al. (2006). *Estimates of the Value of Uninterrupted Service for The Midwest Independent System Operator*. Science Applications International Corporation (SAIC).

[25] Sullivan et al. (2009). *Estimated Value of Service Reliability for Electric Utility Customers in the United States. Prepared for Office of Electricity Delivery and Energy Reliability*. U.S. Department of Energy. Lawrence Berkeley National Laboratory (LBNL). Available online: http://eta-publications.lbl.gov/sites/default/files/lbnl-2132e.pdf.

[26] Khujadze, S. May 2014. *A Study of the Value of Lost Load (VoLL) for Georgia*. Prepared by Deloitte Consulting for the United States Agency for International Development's Hydro Power and Energy Planning Project (USAID-HPEP).

[27] Thomas, A.R. and Henning, M. December 1, 2017. *Valuing Resiliency from Microgrids: How End Users can Estimate the Marginal Value of Resilient Power*. Cleveland State University, Urban Publications. Available online: https://engagedscholarship.csuohio.edu/urban_facpub/1516/. Values originally provided in 2012 dollars have been updated to 2018 dollars using the CPI-U index.

While our Massachusetts production function-based VoLL matched that of AESC 2018 very closely, results for the other New England states differ. Our New England average, using this method, was $14 per kWh, compared to $12 per kWh reported in AESC 2018. Replacing AESC 2018 with our correction raises the final cross-methodology average VoLL only slightly: from $25 per kWh to $26 per kWh.

Non-energy reliability benefit to consumers

Whereas AESC 2018's estimate of energy system reliability benefits uses ratepayer VoLL only as a proxy for avoided system costs, our estimate of Massachusetts' non-energy reliability benefit to storage measure participants is the VoLL itself. Reliability can and does provide many distinct benefits and it is important to note that VoLL accounts for some, but not all of these benefits. For example, more resilient power enables providers of safety and health services—like hospitals or community health centers—to continue to provide services that are highly valuable to society during outages associated with natural disasters, a distinct non-energy benefit that may not be adequately accounted for in VoLL. There is additional value of avoided power outages for customers who are elderly, disabled or have serious health conditions and rely on electronic devices and are more vulnerable to power outages than the average customer. Research has found that in the United States—among the 175 million people covered by employer-sponsored health insurance—approximately 218 per 100,000 people are "electricity-dependent residing at home".[28] Investor-owned utilities in Massachusetts and other states are required to maintain lists of health critical customers (called "life support customers" in Massachusetts) who cannot have their power shut off, and are prioritized in power restoration efforts, because they are reliant on electrical medical devices, and to be without power would be harmful or life threatening.[29]

Including multiple benefits from increased reliability does not represent double counting. Increased reliability is a benefit to *both* to the energy system as a whole and to ratepayers participating in storage programs. A 2015 study in the journal *Frontiers in Energy Research* (see Figure 1 below) provides an overview of multiple, distinct benefits from battery storage including both "investments in grid construction via charges (network tariffs)" (or energy system benefits) and various non-energy ratepayer benefits discussed in this white paper, including the value of lost load to residential, commercial and industrial ratepayers, and effects on property values.

[28] Molinari, N.A.M., Chen, B., Krishna, N., and Morris, T. March 2017. "Who's at Risk When the Power Goes Out? The At-home Electricity-Dependent Population in the United States, 2012." *Journal of Public Health Management and Practice*, 23(2), 152-159. Available online: https://www.ncbi.nlm.nih.gov/pmc/articles/PMC5007208/.

[29] See: Code of Massachusetts Regulations Title 220. January 27, 2017. 220 CMR 19.00: Standards of Performance for Emergency Preparation and Restoration of Service for Electric Distribution and Gas Companies. Available online: https://www.mass.gov/files/documents/2016/08/rr/220cmr1900.pdf for Massachusetts law governing utility responsibilities towards health-critical customers.

Figure 1. Avoided costs from battery storage

Economy (industry, commercial users)			Private Individuals		
Damage costs		Mitigation costs	Damage costs		Mitigation costs
Direct	Indirect		Direct	Indirect	
(a) Opportunity costs of idle resources • Labor	(a) Delayed deliveries along the value chain	Procurement of standby generators, batteries, etc.	(a) Restrictions on activities, lost leisure, stress	Restrictions on acquisition of goods	Procurement of standby generators, batteries, etc.
• Country • Capital • Profits	(b) Damage for consumers if the company produces an end product	Investments in grid construction via charges (network tariffs)	(b) Financial costs • Damage to premises and real estate • Food spoilage • Data loss	Costs for other private individuals and companies	Investments in grid construction via charges (network tariffs)
(b) Production holdups and restart times	(c) Costs/benefits for some manufacturers		(c) Health and safety aspects		
(c) Adverse effects and damage to capital goods, data loss	(d) Health and safety aspects				
(d) Health and safety aspects					

Source: Reproduced from Schröder and Kuckshinrichs, 2015. Table 2, p. 3.

For use in Massachusetts non-energy benefits of storage, residential VoLL can be estimated using the LBNL 2015 willingness-to-pay survey results for residential customers as cited in AESC 2018. EIA data indicates that 4 hours is the average duration of power outages in the United States across all utility types.[30] LBLN's 4-hour outage VoLL estimate for residential customers is $1.72 per kWh.[31]

Table 5. Estimated cost per event, average kW and unserved kWh, residential (2018$)

	Momentary	30 Minutes	1 hour	4 hours	8 hours	16 hours
Cost per Event	$4.19	$4.83	$5.47	$10.20	$18.46	$34.77
Cost per Average kW	$2.79	$3.11	$3.54	$6.65	$12.13	$22.75
Cost per Unserved kWh	$33.16	$6.33	$3.54	$1.72	$1.50	$1.40

Source: LNBL, 2015. Values originally provided in 2013 dollars have been updated to 2018 dollars using the CPI-U index. Cost per event refers to the "cost for an individual interruption for a typical customer". Cost per average kW refers to the "cost per event

[30] U.S. Energy Information Administration. April 5, 2018. *Average frequency and duration of electric distribution outages vary by states*. Available online: https://www.eia.gov/todayinenergy/detail.php?id=35652.
[31] Clean Energy Group and Greenlink have a series of forthcoming publications that presents outage estimates for the Southeast: Clean Energy Group, "Resilient Southeast Report Series", pending publication, 2019.

normalized by average demand". Cost per unserved kWh refers to the "cost per event normalized by the expected amount of unserved kWh for each interruption duration".

While the cost of power outages to residential customers may seem small on a per kWh basis, power outages are highly disruptive. As the Energy Storage Association points out in their *Vision for Energy* Storage report:

> *For a homeowner, the economic cost may seem minimal, but the cost to quality of life is high: medication and food refrigeration, shelter and access to water are among those critical losses.*[32]

Power outages also have the potential to cause disruptions for commercial and industrial customers:

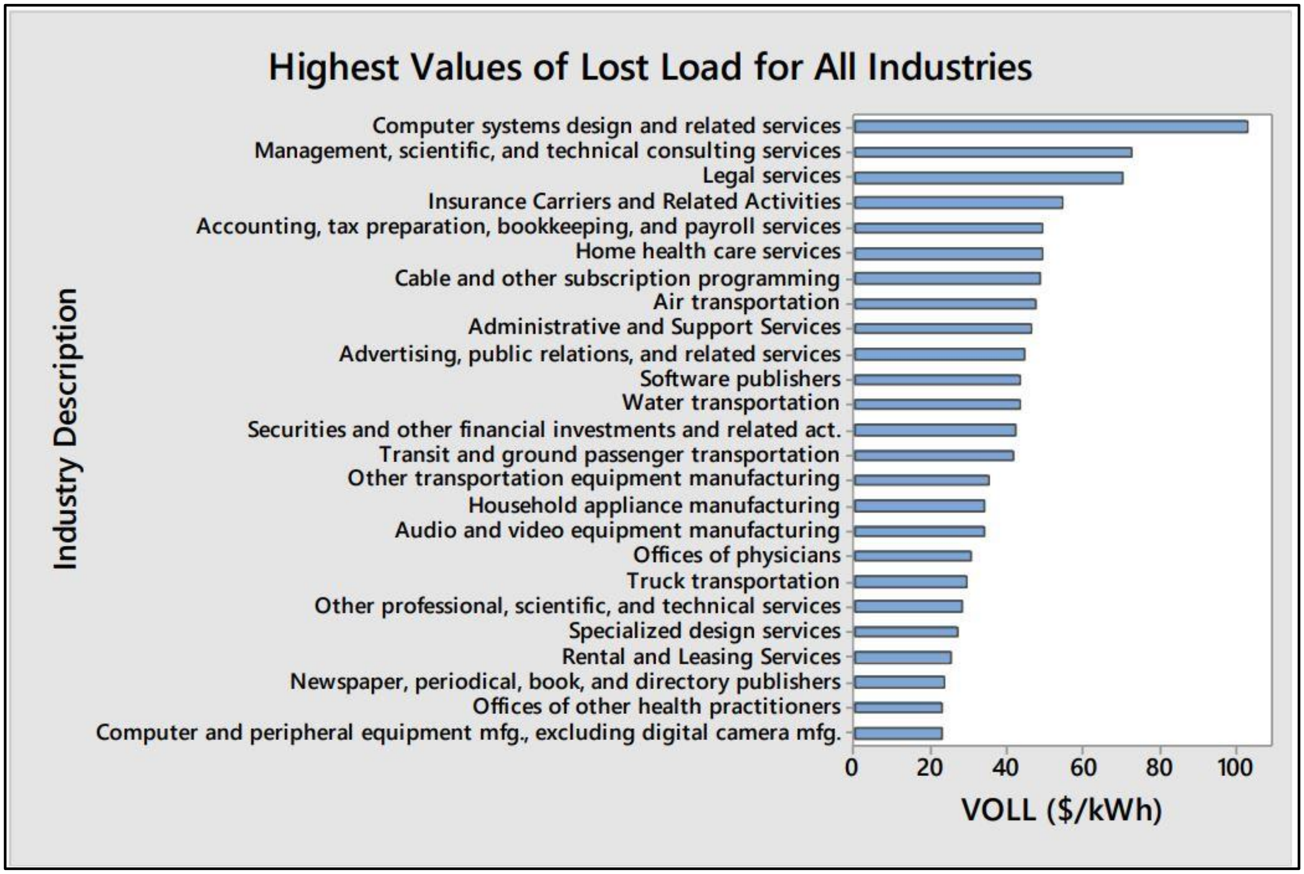
> *As enhanced connectivity drives increases in computing capability and economic value in the same footprint, every server that loses power will only have a greater economic cost to it—rippling even further throughout society. The higher VOLL extends to almost all commercial enterprises. Grocers lose perishable products, stores are unable to sell their wares, and credit card systems lose capability to process payments at data centers and points of sale.*[33]

For commercial and industrial non-energy benefits of storage, AESC 2018's Massachusetts-specific production function-based VoLL is $15.64 per kWh. However, it should be noted that the Cleveland State University 2017 analysis of U.S. VoLL suggests a very wide range of values by business sector (see Figure 2). The VoLL values in Figure 2 are not Massachusetts-specific (and are, therefore, not included in this analysis); the wide range of U.S. VoLL values points to a need for additional analysis in New England to fully capture variation in VoLL by industry.

The application of these per kWh non-energy benefits values should follow that of current non-energy benefits for energy efficiency measures. To this end, moving forward, it will be important to consider the extent to which battery storage measures can prevent power outages and the total kWhs of expected outages (absent these measures) in a given year.

[32] ESA 2017. p.4.
[33] ESA 2017. p.4.

Figure 2. Cleveland State University (2017) VoLL per kWh by industry



Source: Reproduced from Thomas and Henning, 2017. Figure 2, p. 13.

2. Higher property values

Installing storage in buildings can increase property values in several ways. Battery storage systems can keep heating and cooling systems running during a power outage, contributing to the increased thermal comfort of buildings and increasing their value.[34] Energy backup systems also serve to increase the marketability of units for landlords, again, increasing the value of the property.[35] Battery storage systems can also reduce maintenance costs by providing energy use data that allows building operators to assess and optimize real-time energy usage.

This non-energy benefit has a value to ratepayers as a one-time increase to property values from adding a storage system. These values can be calculated using the "low-income" single and multi-families benefits for a heating retrofit from the MA NEI Evaluation 2011: one-half of measure capital cost for single family, and 1 percent of measure capital cost for owners of multi-family housing. The Applied Economic Clinic's July 2018 White Paper, *Massachusetts Battery Storage Measures: Benefit and Costs*,

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[34] ACEEE. 2012. *Measuring Participant Perspective Non-Energy Impacts (NEIs)*. Available online: https://aceee.org/files/proceedings/2012/data/papers/0193-000046.pdf.

[35] MA NEI Evaluation 2011.

assigned values of $5,325 per housing unit for low-income single-family participants and $510 per unit for owners of multi-family housing based on the MA NEI Evaluation 2011 benefit to capital cost ratios.[36,37] An increase in property values would also accrue to residential storage-measure participants who are not income eligible, and to commercial and industrial storage-measure participants.

It is important to note that installing solar arrays can increase a building's value. Evidence shows that home buyers across the United States are willing to pay a premium of about $15,000 for a home with solar panels.[38] Massachusetts offers solar property tax exemptions for both residential and non-residential solar customers; under current law (M.G.L. c. 59, sec. 59) "[a] solar or wind powered system or device which is being utilized as a primary or auxiliary power system for the purpose of heating or otherwise supplying the energy needs of property taxable under this chapter; provided, however, that the exemption under this clause shall be allowed only for a period of twenty years from the date of the installation of such system or device."[39] That means, even when the value of a building increases after a solar system is installed, property taxes still reflect the pre-solar value of the building. While such policies do not currently exist for battery storage in the Commonwealth, tax exemptions are an important tool to incentivize the uptake of storage in homes and businesses.

3. *Avoided outage fines*

As installed battery storage increases, the risk of power outages falls[40]—which means that utilities may avoid costly fines associated with severe power outage events.

In 2012, the Massachusetts Department of Public Utilities (DPU) levied penalties totaling $24.8 million against National Grid, NSTAR, and Western Massachusetts Electric Company (WEMCO) related to their response to power outages caused by Tropical Storm Irene and the Halloween Blizzard of 2011.The fines were levied after customer complaints prompted state officials to launch an investigation into the utilities' preparedness and response to the 2011 storms. The investigation was extensive with 16 public hearings, a dozen evidentiary hearings, and over one thousand exhibits. National Grid, NSTAR and WEMCO were required submit their plans to pay the fines to the DPU within 30 days. The penalties were applied as a credit for ratepayers per a law passed in 2012 that made it illegal for utilities to change rates in order to pay fines for subpar performance.[41] The constitutionality of this law was challenged in

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[36] Stanton, E.A. July 31, 2018. Massachusetts Battery Storage Measures: Benefits and Costs. Prepared for Clean Energy Group. AEC-2018-07-WP-02. Available online: https://aeclinic.org/publicationpages/2018/7/30/massachusetts-battery-storage-measures-benefits-and-costs. p.17.

[37] Note that these values do not include any associated increase in property taxes.

[38] Energy.gov. No Date. Solar Homes Sell for a Premium. Available online: https://www.energy.gov/eere/solar/downloads/solar-homes-sell-premium.

[39] The 191st General Court of the Commonwealth of Massachusetts. General Laws, Chapter 59, Section 59. Available online: https://malegislature.gov/Laws/GeneralLaws/PartI/TitleIX/Chapter59.

[40] Zhang, T., Cialdea, S., Orr, J.A., and Emanuel, A.E. 2014. Outage Avoidance and Amelioration using Battery Energy Storage Systems. *IEEE*. Available online: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6808127.

[41] Howard, Z. December 11, 2012. *Massachusetts slaps utilities with record fines for 2011 outages*. Reuters. Available online: https://www.reuters.com/article/us-usa-massachusetts-power/massachusetts-slaps-utilities-with-

Fitchburg Gas and Electric Light Company v. DPU, but was ultimately upheld by the Massachusetts Supreme Judicial Court.[42]

Together, National Grid, NSTAR, and WEMCO were fined a total of $24.8 million[43] for violating various storm response obligations from their respective emergency response plans, such as: failing to adequately communicate with customers and municipalities; failing to provide damage assessments in a timely fashion; failing to respond to public safety calls; failing to effectively assess the severity of the storms; and failing to directly contact customers with medical needs.[44] Costs paid in fines do not include the legal and procedural expenses from fighting the fines. While the fines were levied due to the inadequate response of various utilities to power outages rather than due to the outages themselves, it is important to reiterate that increased deployment of battery storage makes power outages—and, by extension, the fines that may accompany them—less likely.[45]

With detailed outage data—outage duration, number of affected customers and total lost load—it would be possible to calculate a dollar per kWh estimate of fines and legal costs that Massachusetts utilities could avoid through battery storage programs and avoided severe power outages.

4. Avoided collections and terminations

Battery storage provides electric supply during times of peak demand, reducing the need for costly new peaker plants and the resulting capacity costs that are passed on to ratepayers through their rates and bills. When ratepayers face lower costs they are better able to pay their bills. Electric distributors benefit by avoiding costs associated with collections and terminations.

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record-fines-for-2011-outages-idUSBRE8BA19420121211. Ring, D. December 11, 2012. Massachusetts utility regulators: National Grid and Western Massachusetts Electric Company face multimillion dollar fines for Irene, October snowstorm responses. MassLive. Available online: https://www.masslive.com/news/index.ssf/2012/12/national_grid_to_be_fined_1872.html.

[42] Supreme Judicial Court and Appeals Court of Massachusetts. April 14, 2014. Fitchburg Gas and Electric Light Company vs. Department of Public Utilities. Case Docket SJC-11397. Online: http://www.ma-appellatecourts.org/display_docket.php?dno=SJC-11397.

[43] National Grid was fined $18.7 million, NSTAR $4.1 million and WEMCO $2 million.

[44] Mass.gov. July 26, 2012. AG Seeks More Than $16 Million in Penalties for Inadequate Storm Response by National Grid. Available online: http://www.mass.gov/ago/news-and-updates/press-releases/2012/2012-07-26-natl-grid-dpu.html?_ga=2.175198242.1077349657.1539625103-207293685.1523300621. Mass.gov. July 12, 2012. AG Seeks $4 Million in Penalties for Inadequate Storm Response by Western Massachusetts Electric Company. Available online: http://www.mass.gov/ago/news-and-updates/press-releases/2012/2012-07-12-wmeco-dpu-recommendation.html. Mass.gov. August 7, 2012. AG Seeks Close to $10 Million in Penalties for Inadequate Storm Response by NSTAR. Available online: http://www.mass.gov/ago/news-and-updates/press-releases/2012/2012-08-07-nstar-dpu.html.

[45] Zhang, T., Cialdea, S., Orr, J.A., and Emanuel, A.E. 2014. Outage Avoidance and Amelioration using Battery Energy Storage Systems. *IEEE*. Available online: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6808127.

MA NEI Evaluation 2011 presents non-energy benefits of avoided collections and terminations for energy efficiency measures, explaining that:

> *Utilities can realize a number of NEIs from their energy efficiency programs in the form of financial savings. Energy-efficient technologies installed by PA programs often result in reduced energy bills for participants, which can decrease the likelihood that customers experience difficulties with paying their utility bills. In turn, utilities realize financial savings through reduced costs associated with arrearages and late payments, uncollectible bills and bad debt write-offs, service terminations and reconnections, bill-related customer calls, and the bill collections process.*[46]

Battery storage—like energy efficiency—can reduce the need for expensive peaker plants and provide electricity at peak more cheaply (assuming that battery storage is appropriately charged at times of inexpensive supply and discharged at times of peak, expensive demand). When rates and bills are lowered and customers are better able to consistently pay their bills, electric distributors need to make fewer collection calls, terminations and reconnections.[47]

Table 6 presents the MA NEI Evaluation 2011 values recommended for these avoided collections and terminations costs for energy efficiency. Because battery storage also lowers peak energy use and ratepayer costs, with the same result—that customers are better able to pay their bills on time—these same benefits are equally applicable to battery storage program participants. The program administrator-recommended value for these avoided costs for terminations and reconnections and customer calls are, respectively: $1.85 and $0.77 per year per participant.

[46] MA NEI Evaluation 2011. p. 1-2.

[47] Woolf et al. September 22, 2014. *Benefit-Cost Analysis for Distributed Energy Resources: A Framework for Accounting for All Relevant Costs and Benefits*. Prepared for the Advanced Energy Economy Institute. Synapse Energy Economics. Available online: http://www.synapse-energy.com/sites/default/files/Final%20Report.pdf. p.25.

Table 6. Benefits of avoided terminations, reconnections, and customer calls

Study	$/year/participant (Adjusted 2018$)
Terminations and Reconnections	
WI Low-Income Weatherization (Skumatz and Gardner, 2005)	$0.17
National Low-Income Weatherization NEBs Study (Schweitzer and Tonn, 2002)	$0.75
CT Low-Income Weatherization (Skumatz and Nordeen, 2002)	$0.14
CA Low-Income Public Purpose Test (TecMarket Works, Skumatz Economic Research Inc., and Megdal Associates, 2001)	$0.10
VT Low-Income Weatherization (Riggert et al., 1999)	$10.33
CA Low-Income Weatherization (Skumatz and Dickerson, 1999)	$0.48
Venture Partners Pilot Program (Skumatz and Dickerson, 1997)	$0.97
Average of 2018$ Adjusted Values	**$1.85**
Customer Calls	
WI Low-Income Weatherization (Skumatz and Gardner, 2005)	$0.55
MA Low-Income Weatherization (Skumatz Economic Research Associates, 2002)	$0.81
CT Low-Income Weatherization (Skumatz and Nordeen, 2002)	$0.75
CA Low-Income Public Purpose Test (TecMarket Works, Skumatz Economic Research Inc., and Megdal Associates, 2001)	$2.22
CA Low-Income Weatherization (Skumatz and Dickerson, 1999)	$0.10
Venture Partners Pilot Program (Skumatz and Dickerson, 1997)	$0.19
Average of 2018$ Adjusted Values	**$0.77**

Source: MA NEI Evaluation 2011. p. D-5 and D-6. MA NEI Evaluation provided values in 2010$. Values originally provided in 2010 dollars have been updated to 2018 dollars using the CPI-U index.

5. Avoided safety-related emergency calls

As the amount of battery storage connected to the electric grid increases, the frequency and duration of power outages is reduced.[48] Power outages entail risks and can and do result in safety-related emergency calls to customers. When families and businesses experience fewer power outages, electric distributors avoid making some safety-related emergency calls and the expenses associated with those calls.

MA NEI Evaluation 2011 presents non-energy benefits of avoided safety related emergency calls, and describes the related savings to electric distributors: as electric load during peak periods is reduced, "utilities may realize financial savings due to a reduction in safety-related emergency calls and insurance

[48] (1) Nexight Group. December 2010. *Electric Power Industry Needs for Grid-Scale Storage Applications*. Prepared on behalf of the U.S. Department of Energy's (DOE) Office of Electricity Delivery and Energy Reliability and the DOE's Office of Energy Efficiency and Renewable Energy Solar Technologies Program. Available online: https://www.energy.gov/sites/prod/files/oeprod/DocumentsandMedia/Utility_12-30-10_FINAL_lowres.pdf. (2) Zhang, T., Cialdea, S., Orr, J.A., and Emanuel, A.E. 2014. Outage Avoidance and Amelioration using Battery Energy Storage Systems. *IEEE*. Available online: https://ieeexplore.ieee.org/stamp/stamp.jsp?tp=&arnumber=6808127.

costs, due to reduced fires and other emergencies."[49] This benefit may be particularly applicable for electric distributors that offer efficiency programs that repair or replace appliances to low-income households, who may be more likely to have old or damaged space and water heating appliances, gas appliances, and gas connectors.[50]

Non-energy benefits of battery storage reducing emergency calls may exist as well, to the extent that outages and related safety risks are avoided. Table 7 shows the program administrator-recommended value for this avoided cost in the context of energy efficiency: $10.11 per year per participant.

Table 7. Benefits of avoided safety-related emergency calls

Study	$/year/participant (Adjusted 2018$)
Safety-Related Emergency Calls	
National Low-Income Weatherization NEBs Study (Schweitzer and Tonn, 2002)	$9.48
MA Low-Income Weatherization (Skumatz Economic Research Associates, 2002)	$0.55
CT Low-Income Weatherization (Skumatz and Nordeen, 2002)	$0.29
CA Low-Income Public Purpose Test (TecMarket Works, Skumatz Economic Research Inc., and Megdal Associates, 2001)	$0.10
VT Low-Income Weatherization (Riggert et al., 1999)	$25.38
CA Low-Income Weatherization (Skumatz and Dickerson, 1999)	$11.67
Venture Partners Pilot Program (Skumatz and Dickerson, 1997)	$23.27
Average of 2018$ Adjusted Values	**$10.11**

Source: Adapted from MA NEI Evaluation 2011. p. D-8. MA NEI Evaluation provided values in 2010$. Values originally provided in 2010 dollars have been updated to 2018 dollars using the CPI-U index.

6. Job Creation

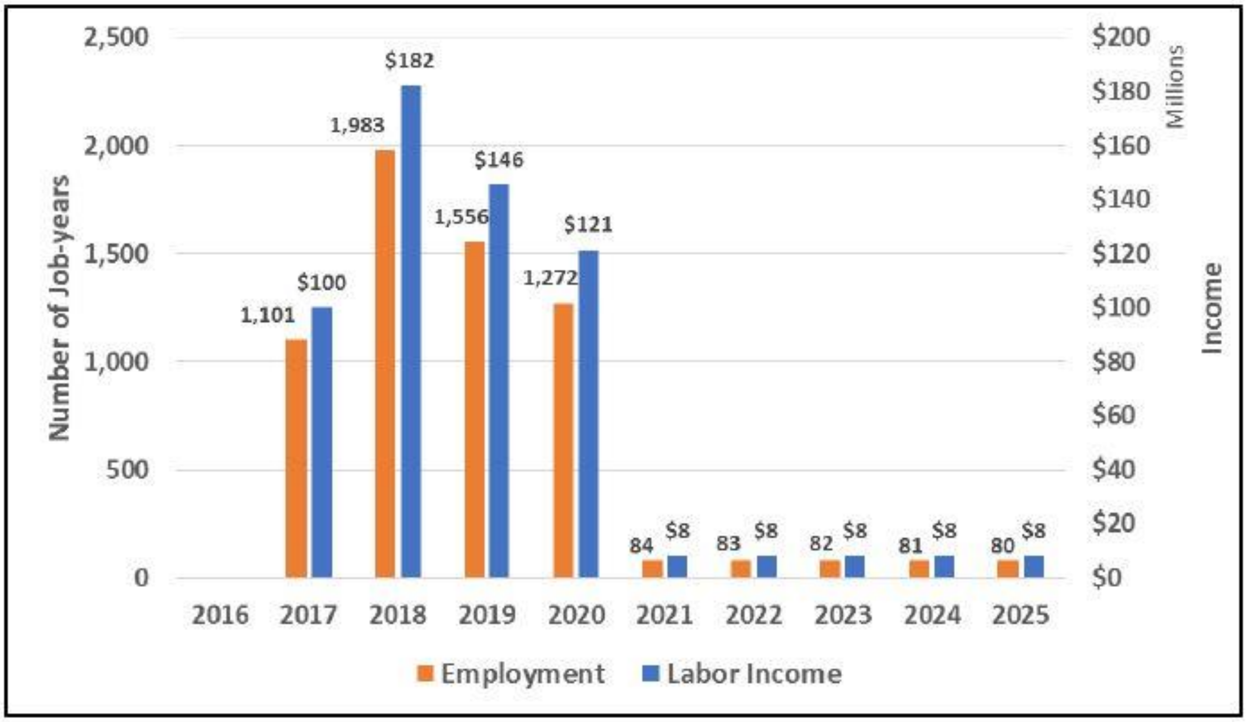
As investment in storage grows in Massachusetts, related jobs will be created along the entire supply chain, including in: battery manufacturing, research and development, engineering, construction, operations and maintenance, sales, marketing, management, and administration. While job creation is not considered in Massachusetts program administrators benefit-cost ratios for energy efficiency, increasing employment is clearly a benefit to the Commonwealth.

CEC/DOER's 2017 *State of Charge* report addresses job creation as a non-energy benefit of increased investment in energy storage, noting that "growing [the] energy storage industry can expand on the success of the clean energy industry, bringing in new business to Massachusetts and creating new jobs."[51] The report found that deploying 1,766 MW of energy storage in the Commonwealth could create 6,322 job-years (where 1 job-year is defined as one job for one year) and $591 million in labor

[49] MA NEI Evaluation 2011. p. 1-4.
[50] MA NEI Evaluation 2011. p. 4-16; Woolf et al., 2014. p.25
[51] MA CEC/DOER 2017. *State of Charge*. p.23.

income over the ten-year study period (2016-2025) (see Figure 3 below).[52] Per year, these benefits are equivalent to an average of approximately 700 jobs and $66 million; equivalent to 3.3 jobs per MW and $310,000 per MW over the battery storage deployment period (2017-2020) and 0.05 jobs per MW and $4,500 per MW over the storage maintenance period (2021-2025).[53] For context, according to a Massachusetts Clean Energy Center employment report, in 2017, clean energy industry employment in the Commonwealth grew by 4,014 jobs.[54]

Figure 3. *State of Charge* Massachusetts employment and labor income impacts, 2016-2025



Source: Reproduced from MA CEC/DOER 2017, State of Charge. Available online: https://www.mass.gov/files/2017-07/state-of-charge-report.pdf. Figure Appendix B-3, p.222.

CEC and DOER note that the employment and labor income impacts shown in Figure 3 are the result of anticipated levels of spending. Currently, Massachusetts has allocated $10 million in spending on energy storage initiatives from 2017 through 2020 only, resulting in a sharp decrease in employment and labor income impacts in 2021. In order for employment and labor income impacts in 2021 and beyond to be at the levels expected between 2017 and 2020, more spending would need to be allocated to additional storage deployment in those years.[55]

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[52] MA CEC/DOER 2017. *State of Charge*. p.103.
[53] MA CEC/DOER 2017. *State of Charge.* p.222-3.
[54] Massachusetts Clean Energy Center (CEC). 2017. *Massachusetts Clean Energy Industry Report*. Available online: https://www.masscec.com/2017-massachusetts-clean-energy-industry-report.
[55] MA CEC/DOER 2017. *State of Charge.* p.223.

The *State of Charge* report finds that investing in energy storage systems in Massachusetts will provide: 1) direct benefits from employment created from activities such as planning, developing, constructing, installing and maintaining battery storage;[56] 2) indirect benefits created in industries that support battery storage, such as necessary inputs to manufacture batteries—like lithium ion—or facilities needed to facilitate the manufacture, maintenance or operation of battery storage;[57] and 3) induced benefits (that is, ripple effects through the economy) from, for example, battery storage employees spending money near their place of work in restaurants and shops, signing up for health care services, signing up for retirement accounts, etc.[58]

To estimate a value to this non-energy benefit, we used the results of the *State of Charge* report, presented in Figure 3 above, calculating the number of job years created per MW of battery storage and the associated labor income generation per MW. During the construction period between 2017 and 2020, for each MW of installed battery storage capacity, CEC and DOER expect approximately 3.3 job years and $310,000 of labor income. *State of Charge* projects an average annual income plus benefits of approximately $93,000 per job year.

Increasing battery storage in Massachusetts holds the promise of job creation, which will serve to strengthen local communities by providing Massachusetts families will valuable sources of family income.

7. Less land used for power plants

More battery storage reduces capacity reserve margins and the need for power plants that supply energy exclusively at times of peak demand. Reducing the number of peaker plants needed to maintain reliability (which is an energy system benefit) results in an additional non-energy benefit for society as a whole: less land need be devoted to power plants and instead could be used for other purposes such as recreation, conservation, commercial or residential buildings, cropland or pasture.

State of Charge explains, "[A]dvanced energy storage projects require a much smaller footprint than conventional power plants."[59] The report goes on to discuss the comparative land requirements of storage measures and new power plants:

> *With impending power plant retirements in local load pockets, building new power plants or transmission lines is an extensive undertaking with large land requirements. Advanced energy storage, in contrast, can easily be added to local areas to provide grid stability, eliminating the need for new gas-fired generation or transmission to solve these local reliability needs.* [60]

[56] MA CEC/DOER 2017. *State of Charge.* p.223.
[57] MA CEC/DOER 2017. *State of Charge.* p.223.
[58] MA CEC/DOER 2017. *State of Charge.* p.223-4.
[59] MA CEC/DOER 2017. *State of Charge.* p. 9.
[60] MA CEC/DOER 2017. *State of Charge.* p. 9.

According to a report commissioned by the U.S. Department of Energy's Storage Systems Program, "society at large has a significant stake in the storage opportunity because some of the key benefits accrue, in part or in whole, to society at large (e.g., reduced air emissions and reduced land use impacts from reduced need for new infrastructure)".[61] Increasing battery storage capacity in Massachusetts provides benefits beyond those directly experienced by electric distributors or ratepayers; there are broader societal benefits including making more land available for alternative uses.

Neither the MA NEI Evaluation 2011[62] nor the MA NEI Evaluation 2016 address reduced land use as a non-energy benefit, although many energy efficiency measures lessen the need for new power plants in the same way that battery storage does, shrinking the electric sector's land use footprint.

As a preliminary estimate of this non-energy benefit based we compare the land use footprints of conventional natural gas combustion turbines and utility-scale battery storage (see Table 8). The vast majority of storage measures offered to ratepayers by the program administrators, however, can be expected to have much smaller per MW land footprints than would a utility-scale battery storage facility. Many behind-the-meter battery storage installations have no land-use footprint whatsoever. (For example, Tesla's Powerwall 2 battery is 45"x30"x6" and is typically installed within an existing building.[63])

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[61] Eyer, J. and Corey, G. February 2010. *Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide: A Study for the DOE Energy Storage Systems Program*. Prepared by Sandia National Laboratories, SAND2010-0815. Available online: https://www.smartgrid.gov/files/sandia_energy_storage_report_sand2010-0815.pdf. p. 152.

[62] MA NEI Evaluation 2011 does include a consideration of a related non-energy benefit, namely, avoided landfill space due to appliance recycling programs.

[63] Energy Matters. "Buy Tesla Powerwall 2 Home Battery." Available online: https://www.energymatters.com.au/residential-solar/tesla-powerwall-battery/.

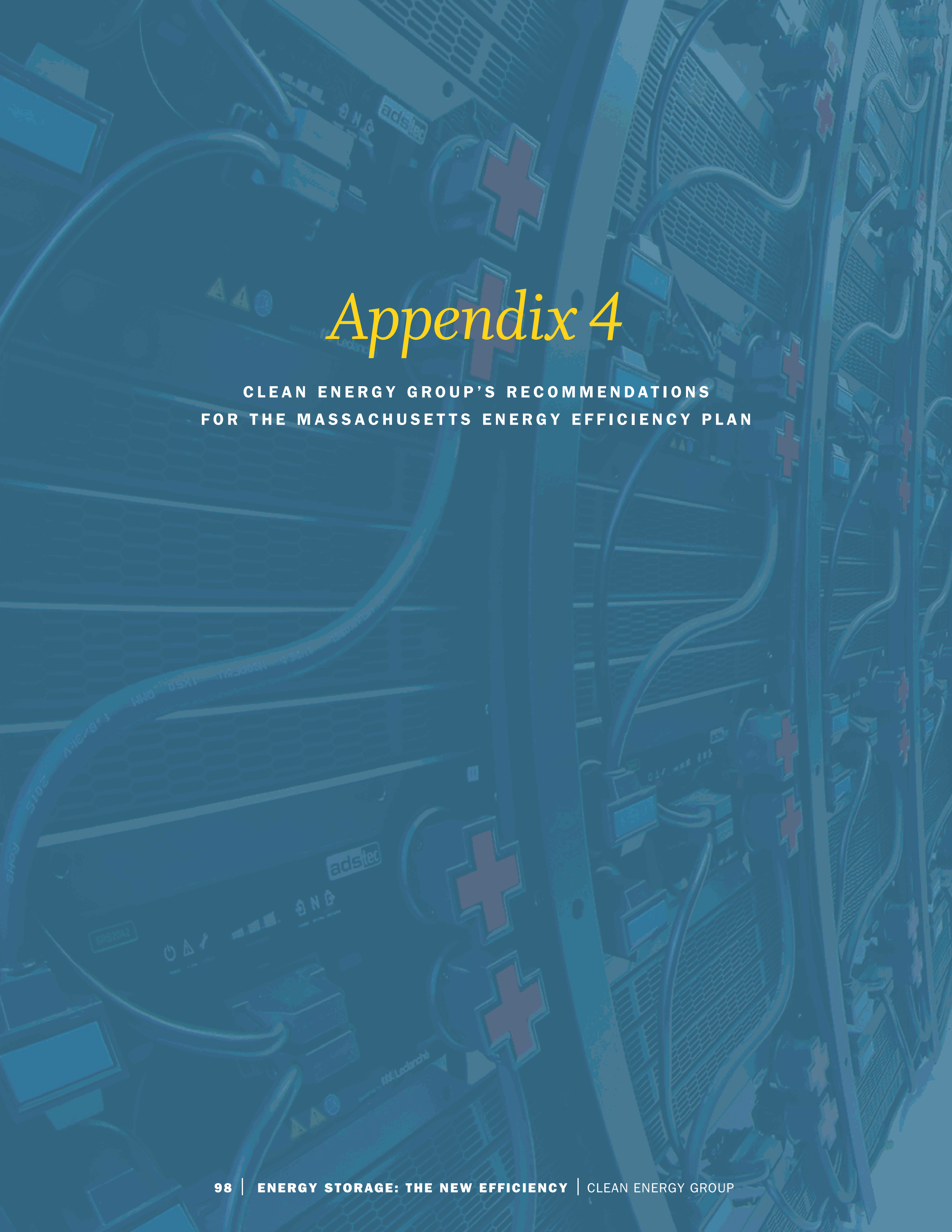
Table 8. Average land use of U.S. natural gas plants and utility-scale battery storage installations

Energy Type	Land Use Footprint (Acres/MW)	Location	Source
Natural gas	**12.4**	U.S.-wide estimate	Eyer, J. and Corey, G. February 2010. Energy Storage for the Electricity Grid: Benefits and Market Potential Assessment Guide: A Study for the DOE Energy Storage Systems Program. Prepared by Sandia National Laboratories, SAND2010-0815. Available online: https://www.smartgrid.gov/files/sandia_energy_storage_report_sand2010-0815.pdf.
Utility-scale battery storage	**0.017**	Average of three cases provided below	AEC calculation
Utility-scale battery storage	0.004	Duke Energy wind and battery storage project (TX)	International Renewable Energy Agency (IRENA). 2015. Case Studies: Battery Storage. Available online: http://www.irena.org/documentdownloads/publications/irena_battery_storage_case_studies_2015.pdf
Utility-scale battery storage	0.007	Solar Grid Storage solar and battery storage project (MD)	International Renewable Energy Agency (IRENA). 2015. Case Studies: Battery Storage. Available online: http://www.irena.org/documentdownloads/publications/irena_battery_storage_case_studies_2015.pdf
Utility-scale battery storage	0.04	AES Energy Storage 50 MW lithium-ion configuration	Leslie, P. 2014. Battery Storage Projects. Puget Sound Energy Presentation. UW Energy and Environment Seminar. Available online: https://class.ece.uw.edu/500/2014aut-e/11-13-14%20Pres%20(PSE%20Storage).pdf

While natural gas plants use a substantial amount of land, residential battery storage typically involves little or no additional use of land. The difference between the land use footprint of a typical natural gas combustion turbine and behind-the-meter battery storage is approximately 12.4 acres per MW of capacity—meaning that for each MW of battery storage installed, 12.4 acres of land is available to be utilized for non-energy purposes. While we do not have access to data on the land value of existing gas plants, nor are we able to predict the land value of plants yet to be built, recent research has found that the average value of urban land in Boston is $600,000 per acre.[64] If, for example, a 60 MW gas peaker plant in urban Boston were avoided by installing battery storage instead—the total value of land available for other uses would be approximately $446 million. It is important to conclude with a caveat: land values are highly location-dependent, and the numbers presented above should be interpreted with care as an illustration only.

[64] Albouy, D., Ehrlich, G. and Shin, M. 2018. Metropolitan Land Values. *The Review of Economics and Statistics, MIT Press*, 100(3), 454-466. Available online: http://davidalbouy.net/landvalue_index.pdf. p.460.

Full valuation of an energy project that was 12 acres of land per MW more efficient than its alternative would include benefits to the utility—for example, reduced operations, maintenance, and property taxes—as well as benefits to society—for example, land that might have been designated for a power plant could be used for mixed-use development instead.



Appendix 4

CLEAN ENERGY GROUP'S RECOMMENDATIONS FOR THE MASSACHUSETTS ENERGY EFFICIENCY PLAN

Appendix 4

CLEAN ENERGY GROUP'S RECOMMENDATIONS FOR THE MASSACHUSETTS ENERGY EFFICIENCY PLAN

The Massachusetts 2019–2021 Energy Efficiency Plan included some important advances in the inclusion of energy storage as a peak demand reducing technology. However, there are several ways to improve the plan to make it more proactive in supporting energy storage and clean energy equity. We offer the following suggested improvements for Massachusetts' 2022–2024 Three-Year Energy Efficiency Plan:

- **Low-income provisions.** Typically, it is more difficult to provide clean energy options to low-income communities, which need clean, resilient and low-cost energy the most. This is why the Commonwealth of Massachusetts has established a multi-agency initiative to ensure that low-income communities do receive clean energy services and programs.[1] The Commonwealth's energy efficiency plan includes "income-eligible" measures for these underserved communities, however, the program administrators did not include any storage incentives in the income-eligible category for the 2019–2021 plan. To correct this omission, Massachusetts should focus on developing specific low-income provisions as it begins the process to develop the next three-year energy efficiency plan, which will commence in 2022. These could include an added low-income incentive, more favorable financing, a carve-out guaranteeing a certain percentage of low-income participation, an up-front rebate, or (preferably) a combination of these.

- **Lack of transparency.** Numerous stakeholders have noted a lack of transparency in the way the energy efficiency plan was developed, as well as in the resulting plan. The plan as approved by the DPU still includes vague and undefined elements that make it difficult to understand exactly what is being offered to storage customers by the program administrators. Improved transparency is essential, both to enable stakeholder participation in the process, and to enable developers to effectively market the plan.

- **Stacking incentives/applications.** Stacking applications and incentives (such as net metering, SMART incentives, and efficiency incentives) can be important to allow customers to defray battery storage system costs. Because the Massachusetts energy efficiency plan does not prohibit the stacking of incentives and applications, it is assumed that this practice will be allowed. However, it would be preferable to make this clear in the language of the energy efficiency plan itself.

- **Size of investment.** The investment in incentives that could be applied to energy storage is small ($13 million/34 MW) relative to both the size of the state's peak load, and to the size of the efficiency budget. Future plans should expand the energy storage offering.

- **Daily Dispatch program.** The Massachusetts Department of Public Utilities (DPU) should allow the utilities to go forward with their proposed Daily Dispatch energy storage incentive as a full program offering, rather than a pilot program.

- **Energy Storage System and Performance program.** The MA DPU should allow Cape Light Compact (CLC) to go forward with its proposed Storage System and Performance program, which would, if approved, provide free batteries to 1,000 residential and commercial customers of CLC, including low-income customers. CLC's proposed program was the only part of the plan that included income-eligible customers in any way. It also set forth a different approach to incentivizing battery deployment, that would have provided the state with an alternative model to compare with the statewide offering.

1 The MA governor announced the Affordable Access to Clean and Efficient Energy Initiative in 2016. For more information, see *https://www.mass.gov/service-details/affordable-access-to-clean-and-efficient-energy-initiative*.

- **Energy storage benefits omitted/undervalued.** Due to numerous omissions, notably the absence of any consideration of non-energy benefits, energy storage was likely undervalued in the utility program administrators' benefit/cost ratios (BCRs). In addition to the omission of non-energy benefits, there are a number of other omissions and errors in the valuation of energy storage in the 2019–2021 Massachusetts energy efficiency plan. The most important of these are listed below (these issues are discussed in more detail in Applied Economics Clinic's reports in Appendices 1–3):

  - Non-energy benefits valued at zero
  - Summer discharge generally not included in targeted discharge
  - Winter reliability benefits valued at zero. The MA Energy Efficiency Advisory Council (EEAC) and the program administrators should together work to value the winter reliability benefits of energy storage, as called for by the EEAC and DOER.
  - Emissions benefit under-counted (CO_2 emissions assumed higher in off-peak hours than on-peak hours, contrary to ISO-New England data)
  - Energy prices use assumed averages rather than actual, granular prices by time period
  - Summer capacity undervalued—assumption that storage only operates during 10 percent of peak hours (based on Maryland study)

In addressing the above issues, additional analytical work may be needed. Recommended future analytical work in Massachusetts includes:

- Analysis of additional non-energy benefits of energy storage (beyond the seven included in this report)
- Evaluation of the value of winter reliability benefits of energy storage (as called for by DOER and the EEAC)
- Analysis of assumptions that New England generators' CO_2 emission rates are higher during off-peak than peak hours (contrary to ISO-New England historical data), and the impact of this on storage BCRs Revision of storage BCRs using hourly price data rather than average seasonal on- and off-peak prices, as the program administrators did for the 2019 MA energy efficiency plan
- Analysis of the value of shaving peak demand in New England
- Analysis of the value of health benefits resulting from replacing fossil fuel generation with renewables and energy storage

ABOUT THE AUTHOR

Todd Olinsky-Paul is a project director for Clean Energy Group (CEG) and Clean Energy States Alliance (CESA). He conducts policy work for Clean Energy Group's Resilient Power Project, supporting state policymakers and regulators in integrating behind-the-meter battery storage into state policy and programs. He also directs CESA's Energy Storage and Technology Advancement Partnership (ESTAP), a federal-state funding and information sharing project that aims to accelerate the deployment of electrical energy storage technologies in the United States. Todd's recent work has focused on energy storage policy and economics, including work with federal and state energy agencies, utilities, non-governmental organizations and national laboratories. He holds a Master of Science in Environmental Policy from Bard College and a Bachelor of Arts from Brown University.
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ABOUT CLEAN ENERGY GROUP

Clean Energy Group (CEG) is a national, nonprofit organization that promotes effective clean energy policies, develops low-carbon technology innovation strategies, and works on new financial tools to advance clean energy markets that will benefit all sectors of society for a just transition. CEG works at the state, national, and international levels with stakeholders from government, the private sector, and nonprofit organizations. CEG promotes clean energy technologies in several different market segments, including resilient power, energy storage, solar, and offshore wind. CEG created and now manages a sister organization, the Clean Energy States Alliance, a national nonprofit coalition of public agencies and organizations working together to advance clean energy through public funding initiatives. Neither organization accepts corporate contributions. *www.cleanegroup.org*

Energy Storage: The New Efficiency

HOW STATES CAN USE ENERGY EFFICIENCY FUNDS TO SUPPORT BATTERY STORAGE AND FLATTEN COSTLY DEMAND PEAKS

Clean Energy Group (CEG) is a leading national, nonprofit advocacy organization working on innovative policy, technology, and finance strategies in the areas of clean energy and climate change.

CEG's energy storage policy work is focused on the advancement of state, federal, and local policies that support increased deployment of energy storage technologies. Battery storage technologies are critical to accelerate the clean energy transition, to enable a more reliable and efficient electric power system, to promote greater energy equity, health, and resilience for all communities.

Learn more about Clean Energy Group and its Energy Storage Project at *www.cleanegroup.org/ceg-projects/energy-storage-policy*.

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October 30, 2019

Aida Camacho-Welch
Board of Public Utilities
44 South Clinton Avenue, 9th Floor,
Post Office Box 350,
Trenton, New Jersey 08625-0350

Re: SDK Greenbrook Gardens LLC, 1275 Rock Ave., North Plainfield, NJ 07060

Dear Ms. Aida Camacho-Welch:

In this day and age, given all the environmental challenges our planet and our society face, it is imperative that each one of us makes an effort to be energy efficient. In that spirit I truly appreciate the collaboration with PSE&G.

SDK has worked with PSE&G for the past several years in exploring projects to retrofit older buildings with new and improved technologies bring energy efficiency in air sealing and weatherization, lighting, water consumption and heating & cooling.

Just this past year we worked together on improving heating systems, lighting and water conservations on a 407-unit apartment complex built in 1970's. It was not a small undertaking. The team has been instrumental in getting this project successfully completed. Just like any project this one had its own challenges. Starting with getting an energy audit completed to planning and explaining the project to SDK was executed flawlessly. It was a serious dollar commitment both on PSE&G and SDK's part. Given that PSE&G helps fund the core project entirely and provides 40%-50% incentive to implement the energy saving measures was a key to getting this work approved. It has been over a year since we started working on this project. PSE&G along with McGrann Associates, the engineers on this project, have played a critical role.

The design of this program was critical to overcome our barriers to participating in energy efficiency, including the access to PSE&G's expertise in the audit, engineering, and construction phases of the project, as well as the access to upfront capital. I hope that PSE&G continues its effort on similar projects in the future.

Thank you.

Warm Regards,

Raman Khosla
CFO & COO
SDK Apartments

Jewish Community Center
Of Middlesex County
"Community Is Our Middle Name"

November 5, 2019

Secretary
New Jersey Board of Public Utilities
44 South Clinton Ave., 9th Floor
P.O. Box 350
Trenton, NJ 08625-0350
Attn.: Aida Camacho-Welch

RE: PROGRAMS
PSE&G ENERGY EFFICIENCY DIRECT INSTALL PROGRAM

Dear Ms. Camacho-Welch:

I am the Director of Development for the Jewish Community Center of Middlesex County, a New Jersey 501C3 nonprofit organization providing social services to several thousand residents of Middlesex and Monmouth Counties and surrounding communities. We have recently had experience working with PSE&G and their authorized contractor, Willdan Energy Solutions, to provide the Jewish Community Center of Middlesex County (JCC) with significant benefits by way of important upgrades to our lighting and HVAC systems in our facility in Edison.

As a nonprofit agency every dollar we spend and every dollar we save directly impacts the programs and services we provide to our community, including children, seniors, people with special needs, vulnerable communities and those needing socialization and other programs and services.

The programs provided by PSE&G, specifically the Energy Efficiency Direct Install Program, provided the JCC with an opportunity to improve our lighting and HVAC systems, projects that we would not have otherwise been able to complete with our own resources. Additionally, the energy savings being realized as a result of the upgraded lighting and HVAC systems will have a significant positive budgetary impact for the JCC and as such enabled the JCC to allocate those resources to our programmatic endeavors, thus improving the ability of the JCC to offer programs and services to our constituencies, in a facility that is improved by the upgrades provided through this program. The JCC, like other similar nonprofits needs and uses every available dollar to provide the programs and services that improve the lives of our members and program participants.

Morris & Lydia Goldfarb Building
1775 Oak Tree Road, Edison, New Jersey 08820 TEL: 732.494.3232 FAX: 732.548.2850 www.jccmc.org
A Beneficiary Agency of the Jewish Federation in the Heart of New Jersey

If the funds do not exist, the programs and services are simply not provided and those in need are unable to receive the vital and impactful services. It is as simple as that.

What made the Energy Efficiency Direct Install program benefits that the JCC received even more important and positive was the ease of the process, and the expertise and abilities of the PSE&G representatives in explaining the program, guiding us through the process, working and coordinating with us and the implementation and supervision of the project in a manner that had the least adverse impact on our operations and members.

Simply put, without this program the JCC and other nonprofit agencies and organizations would be unable to and without the resources to improve our facilities, have access to the current technologies and environmental enhancements that create a cleaner, safer and more accessible facility, while providing economic and financial benefits that we would otherwise be out of our reach.

This program and the work of PSE&G and their vendor partners, clearly and directly improves our community by enabling us to better do our work which impacts the communities we share.

We implore the New Jersey Board of Public Utilities to provide PSE&G with the ability to create and to continue to implement programs, like the Energy Efficiency Direct Install program, that are vital to the ability of nonprofits like the Jewish Community Center of Middlesex County to improve and transform our communities and the residents of New Jersey. We all benefit from these programs and transfer those benefits to the people we serve.

Very truly yours,

ADAM GLINN
Director of Development

/arg
Via electronic mail – EnergyEfficiency@bpu.nj.gov

State of New Jersey
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PHIL MURPHY
Governor

SHEILA OLIVER
Lt. Governor

STEFANIE A. BRAND
Director

November 6, 2019

VIA ELECTRONIC MAIL (EnergyEfficiency@bpu.nj.gov)
AND HAND-DELIVERY
Honorable Aida Camacho-Welch, Secretary
New Jersey Board of Public Utilities
44 South Clinton Avenue, 9th Floor
Trenton, New Jersey 08625-0350

Re: Clean Energy Act – Energy Efficiency Transition
BPU Docket No.: Undocketed Matter
Stakeholder Meeting – Program Structure
Comments of the Division of Rate Counsel

Dear Secretary Camacho-Welch:

Enclosed for filing please find an original and ten copies of the comments of the New Jersey Division of Rate Counsel ("Rate Counsel") submitted pursuant to the Board of Public Utilities' Notice dated October 15, 2019 ("Notice"). In accordance with the Notice, an electronic copy will be emailed to EnergyEfficiency@bpu.nj.gov.

We have also enclosed one additional copy of the materials transmitted. **Please stamp and date the copy as "filed" and return to our courier.**

Thank you for your consideration and attention to this matter.

Respectfully submitted,

STEFANIE A. BRAND
Director, Division of Rate Counsel

By: Felicia Thomas-Friel
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Clean Energy Act
New Jersey Energy Efficiency Transition
Stakeholder Process
Energy Efficiency Stakeholder Meeting – Programs

BPU Docket No.: Undocketed Matter

Comments of the Division of Rate Counsel

November 6, 2019

Introduction

As part of the process to implement the Clean Energy Act[1], the Staff ("Staff") of the Board of Public Utilities ("Board", "BPU") convened a Stakeholder Meeting on October 30, 2019 and invited stakeholders to comment on energy efficiency ("EE") programs in New Jersey. The within comments are being submitted by the New Jersey Division of Rate Counsel ("Rate Counsel") pursuant to the Notice dated October 15, 2019 ("Notice") in this matter and the meeting agenda ("Agenda"), which set forth five questions for comments:

Questions for Comments

1. Which New Jersey programs are considered the most successful? How do you define "success"?
2. What programs will achieve the most energy and/or cost savings?
3. How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?
4. What market barriers are prevalent in specific New Jersey programs?
5. How do we ensure equitable access?

In the following sections, Rate Counsel provides its responses to these questions.

[1] P.L. 2018, c. 16 (C.48:3-87.3-87.7) ("Clean Energy Act" or "CEA").

Responses to the Five Questions

1. Which New Jersey programs are considered the most successful? How do you define "success"?

Success of New Jersey's EE programs can be evaluated in various metrics. Among others, key performance metrics for evaluating successful programs include, but are not limited to, the following:

- Cost-effectiveness (e.g., net benefits, benefit-cost ratios);
- Cost of saved energy (e.g., cents per kWh, dollars per therm or Btu);
- Participation rates which could include participation rates for certain customer segments, such as low-income and small business customers.

According to the New Jersey Clean Energy Program ("CEP" or "NJCEP") website, the most recent program cost-benefit evaluation report was conducted and published by Rutgers Center for Green Building in May 2019 ("May 2019 Cost-Benefit Study").[2] However, the latest program year evaluated in this report was FY2017, which was from July 1, 2016 to June 31, 2017. Thus, while the results may not be directly applicable to the current programs, the May 2019 Cost-Benefit Study provides a high-level depiction of costs and benefits of the CEP programs.

The table below (TABLE 1) shows benefit-cost ratios based on the Total Resource Cost test from the May 2019 Cost-Benefit Study. The most successful programs - estimated to produce most benefits relative to costs using the Total Resource Cost test - are four commercial and industrial ("C&I") programs: New Construction, Retrofit, Direct Install, and Pay for

[2] Rutgers Center for Green Building. 2019. "Cost-Benefit Analysis of the NJCEP Energy Efficiency Programs: FY2017 Retrospective and FY2019 Summary Reports." Available at https://www.njcleanenergy.com/files/file/BPU/FY17%20CBA%20Report%20Update%20Final.pdf.

Performance–Existing Buildings. Residential programs are generally much less cost-effective than the C&I programs. Among the residential programs, Energy Star Products and New Construction programs show the highest benefit-cost ratios using this test, although they are only marginally cost-effective.

TABLE 1: Total Resource Cost Test Ratios for FY17

	Benefit-Cost Ratio
Residential Programs:	
Low Income	0.1
HVAC	0.6
Home Performance with ENERGY STAR (HPwES)	0.7
Energy Star Products	1.1
New Construction	1.0
C&I Programs:	
New Construction	2.6
Retrofit	4.9
Direct Install	2.5
Pay for Performance - Existing Building	2.5
Pay for Performance - New Construction	0.9
Large Energy Users Program	n/a

Rate Counsel also reviewed the CEP's program performance data available on the CEP website. The latest performance data available from the CEP website are for FY2018 program preliminary data, provided in the CEP's most recent monthly FY2018 report as of June 2018 ("June 2018 CEP Report").[3] However, the June 2018 CEP Report does not provide any of the

[3] FY18 NJCEP Reporting, as of June 2018. Available at https://www.njcleanenergy.com/files/file/Library/PTG%20June%202018%20-%20FY18%20v3.pdf.

key metrics necessary to evaluate the success of the CEP programs. Rate Counsel recommends that the CEP include cost of saved energy and participation rates in its program reports.

2. What programs will achieve the most energy and/or cost savings?

Energy efficiency programs in New Jersey serve three basic customer sectors: residential, commercial, and industrial. Since the distribution of measures within each program can vary from year to year and savings potential data are not available by program, Rate Counsel reviewed savings and costs by end-use within each sector.

One way to estimate future savings is through potential studies, although many factors can cause actual savings to differ from these estimates. Program administrators may target certain market segments or technologies, new standards could go into effect, or fuel prices could fluctuate. Any of these could impact program success. Absent insight into those possibilities, potential studies are a reasonable starting point.

In 2019, Optimal Energy, Inc. ("Optimal") conducted the "Energy Efficiency Potential in New Jersey" ("Optimal Potential Study") on behalf of the New Jersey Board of Public Utilities.[4] The Optimal Potential Study evaluated the maximum achievable potential for energy efficiency for electric and gas programs between 2020 and 2029. However, the Optimal Potential Study has some shortcomings, as addressed in comments submitted earlier by Rate Counsel.[5] Therein, Rate Counsel expressed a concern about the use of the Societal Cost Test in the Optimal Potential Study and recommended the use of additional cost benefit analysis tests. While Rate Counsel still maintains its earlier concerns, the results in the Optimal Potential Study are useful

[4] Optimal Energy, 2019. *Energy Efficiency Potential in New Jersey.* Draft prepared for the New Jersey Board of Public Utilities.
[5] See Rate Counsel's comments on the Optimal Potential Study, dated May 16, 2019.

to assess the relative amounts of energy savings potential among different end-uses. The Optimal Potential Study breaks down each fuel and sector by end-use potential, which are discussed by sector below.

End-uses that will achieve the greatest cost savings must have high penetration potential and low costs of saved energy ("COSE"). According to a 2018 Lawrence Berkeley National Laboratory ("LBNL") study of ratepayer-funded programs, heating, cooling, and water heating measures have high a COSE. Products (including appliances, refrigeration, and plug loads) and behavior programs have a moderate COSE. Lighting has a low COSE.[6]

With the caveat regarding the Optimal Potential Report noted above, brief summaries of the energy savings potential for the Residential, Commercial, and Industrial sectors are presented below.

Residential Sector

TABLE 2: Residential Electric Potential Energy Savings (MWh)[7]

Electric (MWh)	
Water Heating	1,562,759
Cooling	627,198
Appliances	491,556
Space Heating	441,603
Refrigeration	315,385
Whole Building	299,087
Other	139,376
Plug Loads	139,027
Exterior Lighting	54,888
Interior Lighting	39,151

[6] Lawrence Berkeley National Laboratory, 2018. The Cost of Saving Electricity Through Energy Efficiency Programs Funded by Utility Customers: 2009-2015. Page 65. Available at: https://www.swenergy.org/Data/Sites/1/media/lbnl-cse-report-june-2018.pdf.
[7] Optimal Potential Study, Figure 7.

TABLE 3: Residential Gas Potential Energy Savings (BBtu)[8]

Gas (BBtu)	
Space Heating	12,349
Water Heating	7,393
Whole Building	1,552

For Residential electric programs, the Optimal Potential Study finds that the majority of savings opportunities are from water heating and cooling measures. Appliances, space heating, refrigeration, and whole building end-uses will contribute moderately to future savings. The Optimal Potential Study indicates that residential lighting opportunities will drop to just a small percentage of savings compared to historical program contributions. Residential gas programs, meanwhile, show that the most potential exists for space heating, followed by water heating and whole building end-uses.

The greatest residential electric cost savings will likely come from a combination of HVAC/water heating measures and products. HVAC/water heating measures will lead to portfolio savings but generally have a high COSE. The less expensive measures and products will provide higher cost savings per measure, even if they make up a smaller percentage of the portfolio total. In the case of gas, the vast majority of cost savings will be from space and water heating simply because those two end-uses make up nearly the entire market share.

[8] Id., Figure 8.

Commercial Sector

TABLE 4: Commercial Electric Potential Energy Savings (MWh)[9]

Electric (MWh)	
Interior Lighting	3,331,361
Whole Building	2,958,230
Refrigeration	1,784,588
Ventilation	1,334,715
Cooling	1,113,212
Plug Loads	328,459
Space Heating	299,388
Other	290,366
Exterior Lighting	288,731
Cooking	157,528
Appliances	151,528
Water Heating	90,551

TABLE 5: Commercial Gas Potential Energy Savings (BBtu)[10]

Gas (BBtu)	
Space Heating	20,269
Whole Building	5,804
Cooking	2,661
Water Heating	1,930

In the Commercial electric sector, the Optimal Potential Study shows end-uses with the highest savings opportunities are interior lighting, whole building, and refrigeration, followed closely by ventilation and cooling. The Commercial gas sector follows a similar trend as the residential gas sector, with space heating accounting for approximately two thirds of savings opportunities. Results show whole building has the next largest savings potential, followed by cooking and water heating.

[9] Optimal Potential Study, Figure 9.
[10] Id., Figure 10.

Further, in the Commercial sector, the majority of electric cost savings will likely come from interior lighting measures and products, due to the high penetration and low COSE for the end-use. Meanwhile, consistent with the Residential sector, gas cost savings will likely be driven by the dominant space heating end-use, as shown in Table 5.

Industrial Sector

TABLE 6: Industrial Electric Potential Energy Savings (MWh)[11]

Electric (MWh)	
Interior Lighting	273,822
Motors and VFDs	131,804
Whole Building	72,203
Other	58,136
Drives	34,891
Compressed Air Systems	26,562
Cooling	7,117
Process Heating	6,271
Process Cooling and Refrigeration	6,107
Space Heating	4,760

TABLE 7: Industrial Gas Potential Energy Savings (BBtu)[12]

Gas (BBtu)	
Process Heating	3,002
Whole Building	1,102
Space Heating	741
Other	214
Process Cooling and Refrigeration	11

For the Industrial electric sector, the results show interior lighting accounts for the largest portion of the savings potential. The end-use with the next largest potential is motors and

[11] Id., Figure 11.
[12] Id., Figure 12.

variable frequency drives, followed by whole building, "other," drives, and compressed air. Industrial gas heating end-use potential differs from the other two sectors, with process heating representing more than half of expected future savings. Whole building and space heating have the next largest potential for savings.

Similar to the commercial sector, the Industrial sector will likely see most of its electric cost saving from interior lighting and products. For gas, process heating and whole building typically fall under custom measures, as they vary from facility to facility. Accordingly, COSE varies. Nevertheless, these two end-uses account for over 75 percent of future savings, and they will likely provide the greatest cost savings.

3. How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?

First of all, New Jersey should not allow multiple entities to run the same program in the same service territory. For example, utilities should not offer incentives on top of existing CEP program incentives. Utilities should be encouraged to offer programs that are different from existing CEP programs. For instance, utilities can offer on-bill financing or unique programs that target specific market segments for which utilities can provide highly individual service—namely large commercial and industrial customers.

Where multiple entities are implementing the same or similar programs in different service territories, these programs should have consistency in a number of aspects to avoid or reduce confusion. Such consistency will facilitate smooth program transactions (e.g., rebate application and processing) by customers and contractors that have buildings in more than one utility service territory. Aspects that should be consistent include, but are not limited to, (a) marketing messages, (b) application format and process, (c) eligible energy efficiency measures,

(d) efficiency levels for similar measures or measure types, (e) incentive structures, (f) performance reporting formats, and (g) program related terminologies. Ideally, there should be a single point of contact for the same program across the State over different utility service territories.

As mentioned in Rate Counsel's comments regarding the Clean Energy Act – Energy Efficiency Transition, utilities in Massachusetts coordinate under the Mass Save collaborative. Mass Save enables customers to access efficiency from a single point of contact.[13] While Mass Save is the face of efficiency in Massachusetts, the programs are still operated by the utilities in each service territory.

Lastly, Rate Counsel also notes that many of the areas in need of consistency apply across all programs rather than just to similar programs. For example, the following should be consistent for all programs whether they are similar to each other or not: application formats and process, measure efficiency levels, incentive structure, performance reporting formats, and program terminologies.

With the consistencies described above, program administrators would still have the flexibility to address specific needs and barriers in different geographic areas or market segments. For instance, for certain geographic areas with lower program participation rates or for harder-to-reach customer segments, utilities or the CEP could use a targeted marketing campaign or enhanced incentives to increase participation rates and energy savings. As another example, for a certain constrained distribution area, utilities could provide additional incentives to encourage targeted peak load reductions in order to alleviate the constraints and defer or avoid any future needs to expand the distribution system.

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[13] See Rate Counsel's comments, dated October 4, 2019.

4. What market barriers are prevalent in specific New Jersey programs?

Regulatory uncertainty poses a barrier to maintaining current participation levels, and also to scaling up programs. Selling and providing services, particularly those with a long time period from sale of efficiency services to project completion, is difficult when funding is interrupted recurrently (e.g. funding runs out in the middle of the program year). Energy efficiency programs are most successful when financial and regulatory support is sustained over time. Funding consistency will need to be addressed to meet the targets established in the Clean Energy Act.

Another notable barrier is the CEP's historically low marketing budget. This issue is generally applicable to all CEP programs. Rate Counsel has repeatedly raised its concern about the low level of marketing budget by the CEP, which is just about 1 percent of the total program budget while the industry average is between 3 to 5 percent.[14] Rate Counsel notes that the 2016 ERS process evaluation also found the low level of marketing expenditures to be problematic.[15]

In addition to the level of the budget, the CEP's marketing activities appear to lack any targeted approaches. Community-based targeted marketing or customer-segment focused marketing can be used to promote increased program participation. These strategies are likely to be particularly helpful where customer acquisition costs are high.

Program delivery mechanisms also lack effective approaches to increasing adoption of efficiency HVAC measures by consumers when existing, old HVAC systems fail. Such customers need to have contractors install new systems as soon as possible. In such situations,

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[14] ERS 2016, "Review and Benchmarking of the New Jersey Clean Energy Program." Available at
http://www.njcleanenergy.com/files/file/Library/NJCEP%20Process%20Evaluation%20Final%20Report%20and%20Memo%2002152017.pdf.

[15] Id.

contractors can only offer products already stocked at local distributors, which typically might not stock high efficiency systems. By offering financial incentives to distributors to reduce the cost of qualifying products, the CEP can encourage them to stock higher efficiency systems so that these products would be readily available for consumers when old systems suddenly fail.

The recently launched Multi-Family program seeks to address the split incentive problem. This problem occurs when landlords have little incentive to invest in energy efficiency improvements to rental properties because tenants pay their own energy bills, and tenants have limited ability and muted incentives to make these improvements on their own. Rate Counsel is not aware of any updates on the new Multi-Family program's performance. Rate Counsel notes that the structure of the Multi-Family program is complicated. Thus, it is critical to provide timely updates on the performance to identify problems early.

Finally, the lack of access to low-cost financing is another market barrier to energy efficiency in New Jersey. To address lack of access to capital, some utilities (New Jersey Natural Gas, Elizabethtown Gas, and South Jersey Gas) offer financing services. However, those that offer financing do not necessarily provide on-bill financing. Where utilities currently offer on-bill financing, they should consider options for making this service more accessible to the low-income customer segment. Utilities that do not provide any form of financing should consider making such an offering, preferably via on-bill financing.

5. How do we ensure equitable access?

Accessibility and affordability are paramount to ensuring that all residents and businesses see benefits from achieving the targets set forth in the Clean Energy Act. The state must work to ensure energy efficiency is delivered equitably by identifying the market barriers faced by different participant groups and developing strategies to overcome those barriers. One segment that has historically been underserved, in New Jersey as elsewhere, is the low-income population.

Comfort Partners provides critical energy efficiency and energy education services for income-qualified households in the state.[16] Administered jointly by New Jersey's electric and natural gas utilities, Comfort Partners works with the Weatherization Assistance Program ("WAP") to cover a larger population than each program could cover on its own. However, these programs are not able to address the needs of all low-income customers in the State.

Income eligibility for Comfort Partners is up to 250 percent of the federal poverty level ("FPL"). The population at or below 250 percent of the poverty level, aligned with the Comfort Partners income eligibility requirements, is around 2.6 million people.[17] Comfort Partners claims to have served over 114,000 families since it was launched in 2001.[18] Assuming New Jersey's current average of 2.74 persons per household,[19] Comfort Partners has covered a population of more than 312,000 people *over the 19 years it has operated.* That is equivalent to only about 12 percent of the current population eligible for Comfort Partners, based on income eligibility requirements alone.

Income eligibility for WAP is up to 200 percent of the FPL. New Jersey's population below 200 percent of the FPL - reflecting WAP's more restrictive eligibility requirement - is over 2.1 million. This is roughly a quarter of the total statewide population of 8.7 million.[20]

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[16] Rockland Electric Company does not participate in the Comfort Partners program.

[17] O'Dea, Colleen. "Incomes Rose in NJ Last Year but Significant Number of Residents Remain in Poverty." Sept. 13, 2018. https://www.njspotlight.com/2018/09/18-09-12-incomes-rose-in-nj-last-year-but-significant-number-of-residents-live-in-poverty/.

[18] https://www.njcleanenergy.com/residential/programs/comfort-partners/comfort-partners.

[19] See US Census data at https://www.census.gov/quickfacts/NJ.

[20] State of New Jersey Department of Community Affairs. U.S. Department of Energy Weatherization Assistance Program: New Jersey State Plan and Application. Available at: https://www.nj.gov/dca/divisions/dhcr/offices/docs/wap/2019_DOE_State_Plan.pdf.

WAP has weatherized a total of 42,441 housing units in the state since 2009.[21] Assuming 2.74 persons per housing unit,[22] WAP has covered roughly 116,000 people, or 5.5 percent, of the population at or below 200 percent of the FPL, over a 10-year period.

Importantly, a significant portion of the population that meets Comfort Partners income requirements is not eligible for other reasons. For instance, the customer may not be listed as a current electric or gas account holder. Another possible reason is that the home is in foreclosure or for sale, is not a primary residence, or is not individually metered. Based on a previous evaluation, the ineligible population is about 40 percent of those who meet the income requirements.[23] Nonetheless, there appears to be a large, unmet need.

The 2014 evaluation of Comfort Partners is five years old and should be updated. Comfort Partners' eligibility requirement for income in 2014 was up to 225 percent of the FPL, as opposed to the current requirement of a maximum income of 250 percent of the FPL. Nonetheless, Rate Counsel believes that some of the insights provided by the 2014 report could be helpful in improving access and reducing energy burdens of the state's low-income population. The following findings of the APPRISE Report are particularly pertinent here:

- Word of mouth has been the primary means of participants getting information about Comfort Partners.[24] This might indicate that more efforts should be put into marketing, but it also may mean that there are trust issues that impede participation in the program. Making partnerships with trusted local organizations to spread the word about the program could be helpful.

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[21] State of New Jersey Department of Community Affairs. "State Agencies Collaborate to Help Low-income Residents Save Money and Energy," Oct. 23, 2018. https://www.nj.gov/dca/news/news/2018/approved/20181023.html.

[22] Rate Counsel assumes the number of persons per household as a proxy for the number of persons per housing unit. See US Census data at https://www.census.gov/quickfacts/NJ.

[23] According to the 2014 APPRISE evaluation of the Comfort Partners Program ("APPRISE Report"), roughly 62 percent of the income-eligible households had housing and energy bill characteristics that made them eligible for Comfort Partners. In 2014, Comfort Partners' income eligibility was up to 225 percent of the FPL, APPRISE Report, p. v.

[24] Id., p. 85.

- A large portion—39 percent of households—do not speak English in the home. This suggests that providing marketing materials in multiple languages and engaging multi-lingual community organizations may help with increasing the program's reach.[25]

- A solid majority of households meeting the income requirement, over 60 percent, do not own their homes.[26] In order to serve renters, landlord permission must be obtained, and landlords may not have adequate motivation to make energy efficiency improvements in their properties. Approaches to address split incentive problems, such as targeted low-income multi-family programs, should be considered.

- Comfort Partner contractors provide up to two hours of education on energy use and bills.[27] Other program types could be helpful in educating and prompting behavior change in low-income communities. For example, community-based social marketing ("CBSM") campaigns can influence a targeted behavior (e.g., energy consumption) through social and behavioral factors and achieve much greater participation and deeper savings than those achieved by programs that only use economic and attitudinal traits as motivation.

In addition to these points, Rate Counsel notes that low-income customers are much less likely to have capital to invest in efficiency than market rate customers. To address this barrier, more utilities can offer an on-bill financing service in which energy efficiency improvements are repaid through a customer's energy bills. Where utilities currently offer on-bill financing, they should consider options for making this service more accessible to the low-income customer segment.

Besides low-income customers, there are other customer segments that are likely underserved (for example moderate-income customers, multi-family properties and renters, as noted above, and small commercial and industrial businesses). Without more information on who is participating in energy efficiency programs, or even up-to-date information on the numbers of participants in current programs, it is difficult to make conclusions about how well ratepayers as a whole are being served. To this end, the Office of Clean Energy should review,

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[25] Id., p. 40.
[26] Id., p. 42.
[27] Id., p. iii.

monitor, and report on participation by low-income, moderate-income, multi-family, and small business customers periodically to increase transparency and reveal trends that can inform future programs. Rate Counsel recommends using a "dashboard" to increase transparency and reporting frequency, and to promote timelier course-correction if costs, participation, savings, or other important metrics are out of line with the state's goals.

New Jersey should identify the existing barriers to participation in energy efficiency programs and develop cost-effective ways to address these barriers in program administration and design. Program administration and design should consider access to programs as well as cost-effectiveness. Energy efficiency programs should be delivered in a manner that does not render energy efficiency measures unaffordable for ratepayers and the overall cost of such programs should not unduly burden ratepayers.

As noted in previous comments, low- and moderate-income households have different energy needs and will require separate programs and goals to better serve each community. It is critical that low-income programs not be simply broadened to include moderate-income customers, as pressures to keep costs down may cause programs to favor moderate-income customers, who are likely to need lower incentives for the same amount of energy saved relative to low-income customers.

New Jersey Natural Gas

VIA ELECTRONIC MAIL (energyefficiency@bpu.nj.gov)

November 6, 2019

Honorable Aida Camacho-Welch, Secretary
New Jersey Board of Public Utilities
44 South Clinton Avenue, 3rd Floor
Suite 314
P.O. Box 350
Trenton, NJ 08625-0350

Re: IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, c. 17 REGARDING THE ESTABLISHMENT OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS DOCKET No. QO19010040

Dear Secretary Camacho-Welch:

New Jersey Natural Gas Company ("NJNG") looks forward to working with the Board of Public Utilities' ("BPU") on the implementation of P.L. 2018, c. 17 regarding the establishment of energy efficiency and peak demand reduction programs ("Clean Energy Act"). NJNG has already shared significant input within this proceeding through our remarks at the February 1, 2019 public hearing and through written remarks submitted on February 15, 2019, as well as expressing significant support for the remarks and comments submitted by the New Jersey Utility Association on the same dates. NJNG also provided significant input through my participation in the panel discussion at the September 25, 2019 Energy Efficiency Stakeholder Meeting, in this proceeding and additional written comments submitted on October 4, 2019. Since these elements are already part of the record within this Docket, we will not repeat that content within this letter; however, we are providing relevant excerpts as appendices for your convenience. However, we would like to share a few highlights of our perspective on the questions included in the agenda for the October 30, 2019 stakeholder meeting and our reactions to comments from the panelists.

Successful Programs

NJNG appreciates the Board's interest in soliciting stakeholder feedback on which New Jersey programs are the most successful but notes that most stakeholders don't have sufficient information regarding the performance of the programs offered by New Jersey's Clean Energy Program ("NJCEP") to make definitive recommendations. The Public Reports and Library section of the NJCEP website does not have any NJCEP Financial & Energy Savings Reports posted for the period beyond July of 2018, and due to timing, that report only reflects one month of activity for that fiscal year. Further, the NJCEP Energy Efficiency Committee has not held a meeting since September of 2018, so nearly all stakeholders are at a loss to opine on current NJCEP program performance.

Successful programs reflect features that address market barriers that may be common across market segments or unique to a segment (see pages 3 to 5 of Appendix A for comments about market segments from NJUA February comments and discussion below). They consider the role of trade allies and ensure sufficient attention is dedicated to outreach and training to help these entities understand the business proposition and be ambassadors for growing the clean energy economy. Successful programs raise customer awareness of the full range of benefits of energy efficiency and provide strong incentives that inspire customers to participate in the programs. As stated in our comments as a panelist at the September 25th stakeholder meeting, achieving these targets will create significant personalization of information to ensure customers are being presented with actionable information, including solutions like On-Bill Repayment Program that make participation more accessible.

It is also critical to remember that the energy savings targeted by the Clean Energy Act are looking for an incredibly aggressive increase in energy savings achieved in comparison to what is currently being reported for NJCEP. New Jersey will need to look beyond our borders to consider innovative program approaches being implemented across the country. We must be active participants in national organizations that help share success stories and failures so that we can build off those experiences rather than learn each lesson on our own. Further, New Jersey must establish a structure that encourages the utilities to pursue market transformation strategies that have the potential to transform the market from a long-term perspective but could present some short-term risk because experience has shown that some initial market transformation efforts are not successful.

Achieving Energy Savings

NJNG strongly believes that the state will benefit from pursuing a broad mix of programs. It is very important to have programs that serve the interests of large commercial customers and can deliver some of the best value in achieving energy savings. However, the state has also clearly demonstrated an interest in ensuring that all customers have an opportunity to participate so it must also focus on programs to serve customer classes beyond just the large commercial and industrial customers, including low-to-moderate income customers, underserved and utilized markets. Similarly, the state should ensure that there is a diversity of measures considered and understand the trade-offs in pursuing strategies. For example, lighting programs have historically delivered some of the most cost-effective savings, but aggressive commercial lighting programs could jeopardize the ability of customers to participate in more comprehensive whole building savings programs. Those comprehensive programs often need some cost-effective lighting measures to help balance out the cost of more expensive high efficiency HVAC equipment.

Additionally, it will be critical to implement an Emerging Technology program to ensure that the state is positioned to bring new technologies to customers as soon as possible and have a pipeline of new measures to promote as codes and standards advance. Refer to the NJUA February comments for a more detailed discussion of this point (see pages 5 and 6 of Appendix A).

Balancing Consistency and Flexibility

The NJUA February comments (Appendix A pages 3 to 5) noted that the utilities had initiated preliminary discussions regarding the key market segments and expressed a willingness to engage in more detailed discussions regarding coordination and alignment of programs, including coordinated efforts for some functions and markets. Those comments listed the market segments and expressed a desire for clarity regarding the longer-term role for NJCEP before investing significant utility resources in those more detailed discussions. Those same comments also highlighted elements where relying on utility branding, channels, and direct relationships with customers may be more effective than a mandate to deliver identical, joint programs.

NJNG also provided examples of current utility collaboration as part of our February comments (see pages 1 and 2 of Appendix B) and through our participation as a panelist at the September 25th Stakeholder meeting.

Market Barriers and Equitable Access

NJNG's February comments (see pages 3 to 5 of Appendix B) included a discussion of market barriers, including significant upfront costs for energy efficiency investments, the need for timely payment of incentives, the need to provide extra incentives for low- and moderate-income customers, and the challenges reaching small business customers.

NJNG's May 2019 comments (see pages 4 to 5 of Appendix C), filed in response to the draft Market Potential Study, also highlighted significant health and safety issues that are creating barriers for low income customers interested in moving ahead with improvements. These health and safety issues (examples include asbestos, lead paint, mold, roof leaks, moisture in basements, open sewer lines or drainage issues, leaky plumbing and infestation issues) must be addressed before some energy efficiency measures can be implemented. Unfortunately, the expense to remediate these health and safety issues can run far beyond existing program allowance and could exceed the cost of the energy efficiency measures themselves. The state must work with stakeholders to identify a set of solutions to fund the remediation of these issues or we will continue to walk away from available energy savings and frustrate our most vulnerable customers. Without a solution, it will be impossible to achieve equitable participation in the clean energy economy.

NJNG and many other stakeholders have repeatedly cited the benefits of On-Bill Repayment Programs. By removing the upfront cost barrier, this program makes participation more accessible. NJNG has been offering this feature for certain programs since 2011 and have seen it strongly embraced by both customers and trade allies. Our approach screens eligibility based on a customer's utility payment history and lack of recent bankruptcy instead of relying upon traditional credit ratios. This makes outreach more effective because most customers instinctively know if they should qualify for the OBRP. In addition, customers appreciate the convenience of a single bill and being able to repay the obligation at the same time they are experiencing the energy savings. Earlier this year, the program was expanded to provide more generous terms for moderate income customers.

NJNG appreciates the listing of barriers that Rutgers presented at the October 30th stakeholder meeting. Since many of these barriers are not unique to New Jersey, we should be able to leverage strategies that have been explored in other jurisdictions.

Timing

NJNG's September comments identified inconsistencies in the referenced timing for BPU decision in this matter and the related utility filings. NJNG noted that the October meeting referenced a BPU decision in Spring 2020 with utility filings due in Summer 2020. We would like to repeat our suggestion that the Board to consider a phased approach that supports a thorough review of the topics but reaches decisions on key elements earlier in 2020. Prioritization of the most important topics related to planning and preparing filings will allow for utilities to submit more thoughtful and comprehensive filings. Early guidance on programs that may still be served by New Jersey's Clean Energy Program ("NJCEP") for any period beyond fiscal 2021 should also be helpful to the Office of Clean Energy ("OCE") as they plan NJCEP programs for fiscal 2021.

NJNG appreciates the opportunity to provide comments on these topics. We look forward to working with the Board and other stakeholders as the State considers how to restructure the approach to energy efficiency as to enable the utilities to reach the aggressive clean energy goals established by Governor Murphy's administration. Please feel free to contact me if you need any additional information regarding these issues.

Respectfully submitted,

Anne-Marie Peracchio

Anne-Marie Peracchio
Director- Conservation and Clean Energy

Appendix A
NJUA Comments

February 15, 2019

VIA ELECTRONIC MAIL
Aida Camacho-Welch
Secretary of the Board
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Re: IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, c. 17 REGARDING THE ESTABLISHMENT OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS DOCKET No. QO19010040

The New Jersey Utilities Association (NJUA) represents investor-owned utilities that provide electric, natural gas, telecommunications, water, and wastewater services to residential and business customers throughout the state. I am writing on behalf of our electric and natural gas members ("the utilities") in response to the January 22, 2019 Notice that initiated the Board of Public Utilities' ("BPU") request for comments on the implementation of P.L. 2018, c. 17 ("Clean Energy Act"). Since our input addresses multiple questions, we have framed these comments around key themes. Also, please note that each of our members reserve the right to submit comments on an individual basis.

Clarity regarding the role of New Jersey's Clean Energy Program

The utilities are uniquely positioned to support Governor Murphy's Administration in implementing the Clean Energy Act. Each of our energy members have experience running energy efficiency programs and they recognize the magnitude of the effort required to develop and offer cost-effective energy efficiency programs for their customers.

Our members have initiated informal discussions regarding a portfolio of programs that they believe would be necessary to achieve the mandated reductions of the Clean Energy Act, sharing their experiences and perspectives regarding program design, delivery and specific features that will allow for effective programs and provide the opportunity for all customer segments to participate. This effort includes consideration of the best opportunities to coordinate and collaborate, and working to identify areas where coordination may not deliver any improvements to the program and could, in fact, increase the cost of securing energy reductions.

While the utilities see the opportunity to explore coordination and collaboration, our discussions inevitably and repeatedly return to a fundamental problem. It is impossible for our members to determine the optimal approach or progress very far without a clear understanding of the role of New Jersey's Clean Energy Program ("NJCEP"). In May of 2018, NJUA testified on concerns about language in NJCEP's Draft Strategic Plan. That Draft Strategic Plan repeatedly called for utility programs to be designed so as to not compete with NJCEP programs. However, NJCEP programs span nearly every market segment. The approach suggested in that Draft Strategic plan would therefore restrict the utilities from offering programs to obtain energy efficiency savings in the most cost-effective manner.

The utilities respectfully note that last year's Draft Strategic Plan, the last known public information shared regarding the energy savings achieved by NJCEP, clearly shows that significant efforts will be needed in addition to what is projected under the current path of NJCEP programs.

New Jersey's Clean Energy Program FY19-FY22 Strategic Plan (excerpt from tables on pages 10 and 11)			
	Clean Energy Law Target	Estimated NJCEP Savings for Fiscal 2018	Aspirational NJCEP Savings for Fiscal 2022
Electric	2.00%	0.36%	0.62%
Gas	0.75%	0.16%	0.22%

The Clean Energy Act is clear. It holds the utilities accountable for achieving energy reductions. The utilities cannot face a mandated responsibility to deliver energy savings as set forth in the law and then effectively be told that they cannot operate in the market segments where the most cost-effective opportunities exist. Niche programs alone will not position the utilities to meet the targets.

If NJCEP continues to exist with a broad suite of programs, a significant amount of stakeholder resources are likely to be expended each year debating whether new program offerings should reside with NJCEP or with the utilities. In addition, significant coordination efforts would be required on an ongoing basis to ensure the NJCEP and utility programs are complimentary and not creating market confusion with customers and trade allies. It would be more efficient to focus our collective resources on policy objectives, assessing how we can improve the experience for customers and trade allies, and determining whether the structure is helping to advance the clean energy economy in New Jersey.

Further, the current structure of the NJCEP as the statewide program allows ratepayer funding to migrate across fuel and utility service territories. So, theoretically, a dollar collected from a gas customer in Cumberland County could be spent on energy-efficient lighting in Bergen County. Ratepayer funding migration and the companion demand reductions is a dynamic that is fundamentally at odds with the new statutory mandate that will establish demand reductions by utility service territory.

Unique Role of the Utilities, Portfolio of Programs, and Opportunities for Utility Collaboration

The Clean Energy Act directs the utilities to advance energy efficiency. As part of that effort, the utilities can leverage their ongoing relationship and frequent communication with customers.

Customers recognize their utility brand, and studies consistently show that they turn to their utility for conservation advice and resources. Routine utility interactions like inquiries regarding a high bill or new customer connections can be leveraged into opportunities to participate in our energy efficiency programs. Leading programs across the country are focused on personalization of customer communications to identify the best opportunities for customers to save energy and for improving the targeting of customer participation through propensity modeling. New Jersey's efforts to implement the Clean Energy Act should include recognition of the opportunity to leverage the strengths of the utility-run programs.

The utilities recognize there needs to be a diversified portfolio of programs to ensure that all customer classes have the ability to participate and realize energy savings. It is important that special attention is given to programs and features to support participation by low to moderate income residential customers. It is also important to develop distinct approaches for the residential market segments that include renters and seniors. For commercial and industrial customers, there is an opportunity to expand efforts to serve commercial customers by industry segment, leverage insights from national efforts (e.g. CEE, DOE Better Buildings Network) to learn from others, and share best practices in program administration. All of our member companies have experience with providing programs and can leverage their knowledge to target or maximize participation across customer segments through both program design and implementation.

Preliminary utility discussions identified the key segments listed below for program delivery to ensure that a broad range of strategies are used to meet customer needs and allow for equitable participation in the energy efficiency programs. The utilities recognize that NJCEP currently runs programs for many of these market segments, so insights into the long-term role for NJCEP will set the foundation for more detailed discussions among the utilities for coordination and alignment of programs, including coordinated efforts for some functions or market segments. The key segments are listed as follows:

- Residential Markets
    - Behavioral
    - Efficient Products
    - Mechanical Systems
    - Whole Homes
    - New Construction
    - Direct Assessment (entry level home audit program)
    - Low Income
    - Moderate Income
- Commercial Markets
    - Prescriptive
    - Custom
    - Direct Install
    - New Construction
    - Energy Management (Retro-commissioning and Strategic Energy Management)
    - Comprehensive Whole Building
    - Combined Heat & Power
    - Benchmarking

- Other/Cross-cutting
  - Multi-family
  - K-12 Education and Behavioral Program
  - Emerging Technology and Approaches
  - Pilots

Based on our extensive experience both in and outside of New Jersey, the utilities quickly realized that there are some types of programs where there would be no direct benefit if the utilities were forced to embark on a joint program. Utilities know their individual customers and systems best and are uniquely positioned to deliver cost effective energy efficiency programs within their territories. Thus, mandated coordination of some programs would inhibit the utilities from identifying and personalizing opportunities for customers to participate. The clearest example of this circumstance is the administration of behavioral programs. Across the country behavioral programs have benefitted from incredible innovation in the past few years. The industry is trending towards efforts that are broader than just the traditional Home Energy Reports. There are many more behavioral vendors in the space today than there were a few years ago. These vendors offer greater customization (e.g. specific tips for individual customers based on knowledge of customer profile or demographic information), extra program elements (e.g. high usage alerts) and deeper analytics to target customers for participation in other programs.

To make behavioral programs more engaging to customers and increase energy savings, it is very important to link information from other energy efficiency programs. A customer who purchased a smart thermostat through an energy efficiency program should get tips about the best way to use its features to maximize savings, especially during peak usage times. Customization allows for a focus on demographics (e.g. low income, senior) that may align with other policy objectives. Also, there are many emerging opportunities to integrate with home energy management systems and voice enabled assistants.

In order to offer these personalized, effective experiences, the behavioral programs must integrate with each utility's unique billing system. Forced delivery of a joint program would not achieve economies of scale because billing system integration would occur at each utility, and it would be a costly, time consuming and burdensome task of integration. It is also an example of where multi-state utilities may be able to secure efficiencies by working with a vendor that has already successfully completed integration with their billing system in other jurisdictions. These programs prompt customers to contact their respective utility regarding underlying billing information. A third-party administrator would not have the same core understanding of the utility billing system that utility representatives can provide.

Further, allowing utilities to work with different vendors to deliver behavioral programs provides the opportunity to evaluate the experience with multiple vendors and program designs and for utilities to share their experiences. This would effectively test different program designs and approaches and support utility efforts to maximize the performance of their program portfolios, a benefit that would be lost with a single statewide approach. This could lead to utilities migrating to other vendors at contract renewal if evidence shows that another vendor can deliver stronger energy savings.

On the other hand, the utility discussions are already identifying specific functions where consistency is important, and which may benefit from joint administration. One example here is tied to quality control for both new construction programs and installation of HVAC equipment and mechanical systems. The utilities recognize contractors, building raters, and other trade allies need to have a clear set of standards for participation in the programs and to ensure that they meet the specified requirements of the quality control process.

While the utilities know it will be important to work together, they think there is an even greater opportunity to advance the market by working closely with the Department of Community Affairs and through direct outreach to code officials. The annual American Council for an Energy Efficient Economy (ACEEE) State Energy Efficiency Scorecard consistently reflects an opportunity for New Jersey to improve code compliance. Shifting the outreach and education strategies to compliance with all installations could alleviate some of the perceived burden for participation in energy efficiency programs. Using equipment sizing requirements as an example, there should be a shift from requiring documentation of such sizing calculations to earn a rebate for high-efficiency equipment installations to ensuring these techniques are performed on all installations. With this approach, New Jersey customers would benefit from lower bills even with the installation of standard HVAC equipment and this would achieve more energy savings. This is just one example to show that there is a need for a broader approach to tackling existing barriers.

Opportunity for Multi-State Utilities

It is worth noting that our multi-state companies may be able to reference their experience in other states to inform opportunities to build efficiencies here in New Jersey. This is not intended to suggest cross-subsidization between states. It is simply noting the potential for opportunities for multi-state utilities to find efficiencies across systems, processes and programs, where possible. We ask the Board to consider the potential benefits of those opportunities.

Importance of Emerging Technologies

The utilities believe it is important for energy efficiency programs to have a dedicated Emerging Technologies (ET) program. An ET program would fund investments that develop critical insights that can help the State with developing longer term strategies. This program is key to gaining technical and market understanding on installation, performance, reliability, and serviceability considerations for new customer energy-efficiency solutions. Funding would support new technologies and program solutions to allow us to meet tomorrow's energy-efficiency goals with less risk and more certainty.

Leading states in energy efficiency have made this commitment. They recognize the importance of an ET program when pursuing aggressive energy reduction targets and the ability to draw in new technologies or approaches as codes and standards advance. It is a reasonable investment to ensure that New Jersey can develop an understanding of the potential for innovative technologies that may transform the approach to energy efficiency. An ET program should support new technologies and approaches that are ready for broader adoption but need enhanced contractor training, customer incentives, or other key elements to help the marketplace understand the value proposition. When pursuing ET programs, it is important to consider support for educating existing workers and our next generation of engineers and technicians.

ET is also a prime example of a program that can be coordinated across the utilities to ensure that all stakeholders benefit from the insights gained through this program. Recent utility filings have proposed a structured program that would include the involvement of a single New Jersey based university. The university would serve as an independent facilitator to enable utilization of ET and lead an effort to draw in the input of all stakeholders through a stakeholder advisory committee. The committee would review findings and broadly consider how to identify and address relevant barriers in order to leverage market opportunities in a timely manner. This is a critical component to developing a robust clean energy economy in New Jersey.

Market Potential and Cost Benefit Analysis

The utilities look forward to the outcome of the Market Potential Study. Several of our companies have recently participated in Market Potential Studies in other jurisdictions that have taken 12 to 18 months to complete. The utilities are ready to provide supporting data that is available in this compressed time frame. In our experience, the term "full economic cost-effective potential" encompasses everything that is cost-effective, assuming limited or no market barriers. Since barriers do in fact exist, the utilities are hopeful that the Market Potential Study will lead to a meaningful discussion of achievable market potential in establishing the Qualitative Performance Indicators for each measurement period. The Market Potential Study should identify what is achievable through individual utility run programs, as well as from other sources. The state should also consider the costs of programs and the customer bill impacts that will result when establishing the energy savings targets.

Further, the utilities see a need to review the approach to Cost Benefit Analysis screening. Several states have taken a closer look at their program screening processes and determined that their approaches to Cost Benefit Analysis were not balanced. Current tests do a better job of quantifying program costs than they do of capturing program benefits (because those are harder to quantify and more variable) and therefore do not always effectively recognize the total value of energy efficiency offerings. As the State shifts to a policy seeking all cost-effective energy efficiency, and recognizing costs to customers, it must ensure that it fairly measures the true costs and benefits.

Savings Contributions from Other Sources

The process to determine savings from non-utility sources should be clearly defined and calculated in advance of each program year. With that, the value of the contributions from other sources should be presented to each utility with sufficient time to allow the utility to consider how to administer a cost-effective portfolio or program to achieve or exceed remaining energy and demand reduction targets. The utilities should not be penalized for the potential failure of other sources to deliver anticipated savings contributions.

Use of Consumer Data

The utilities recognize that customer usage data is critically important in helping customers and trade allies understand the potential savings from participating in energy efficiency and demand reduction programs. They also recognize that customer usage information is confidential, and that they have an obligation to ensure customer information is protected. In general, customer consent is required prior to release of customer-specific data to third parties. The utilities also recognize that there it is important to ensure that any third-party receiving customer data has proper protocols in place to secure such data from cyberthreats. The utilities will participate in further stakeholder discussions that consider how to properly balance the need to provide data to support the marketplace while also preserving consumer protections.

Advisory Committee

The utilities note that the Clean Energy Act clearly provides that the utilities will participate as members of the advisory committee. Each utility looks forward to participating to share the experiences regarding the administration of the programs within their service territory and to hear constructive input from other key stakeholders. This advisory committee can help review the performance of the energy efficiency programs and provide recommendations for improvements as called for the in Clean Energy Act. That said, it will be important for the structure and the timing of this feedback to support refinements on a timely basis while not creating any additional barriers to the timely launch of new programs or refinement of existing programs.

Alignment of Utility Interests

New Jersey's utilities primarily recover the cost of their investments in the distribution system through volumetric rates, charged per kWh or per therm for the energy utilities. There is thus a fundamental disincentive in New Jersey's ratemaking process and designs to investment in energy efficiency programs. Energy efficiency programs result in lower throughput (sales) on the distribution system, while the costs of providing electric and gas distribution service (*e.g.* capital investment, and operation and maintenance expense) of the electric and gas distribution systems do not decrease.

The Clean Energy Act does in fact recognize this conflict, as it explicitly states:

> Each electric public utility and gas public utility shall file annually with the board a petition to recover on a full and current basis through a surcharge all reasonable and prudent costs incurred as a result of energy efficiency programs and peak demand reduction programs required pursuant to this section, including but not limited to recovery of and on capital investment, **and the revenue impact of sales losses resulting from implementation of the energy efficiency and peak demand reduction schedules…**[1] (Emphasis added)

[1]Subsection e., P.L. 2018, c. 17. (emphasis added).

We ask that the Board recognize and encourage rate mitigation options that can help bridge the gap between lost sales and insufficient cost recovery as a result of incentivizing these important programs. We also ask that the Board recognize the need to continue to explore appropriate rate design and/or financial incentives for utility participation and support of energy efficiency programs. Such exploration will serve to enhance utility participation and alignment with the goals of the Clean Energy Act, including full and timely recovery of program costs and performance incentives.

Transition Period

The utilities recognize the importance of meeting the expectations of customers and properly supporting trade allies. Customers who have unsatisfactory experiences during a transition period may develop a negative association with energy efficiency investments that could reduce their interest in participating in future programs or lead them to share their bad experience with other customers. Either of those customer outcomes would make it more challenging to meet long term goals. Similarly, the utilities want to ensure that contractors and other trades allies understand and can plan for how any shift or expansion of program administration will impact their business, including the potential for improvements that encourage them to play a greater role in the clean energy economy. For example, if utility programs can improve the timeliness of incentive payments it would provide a significant benefit to contractor working capital. Accordingly, the utilities encourage thoughtful consideration of the time frame and approach for the transition of any program that includes the opportunity for stakeholder input.

The utilities appreciate the opportunity to share our comments and look forward to working with the BPU and other stakeholders to determine the best path for securing the mandated energy reductions. The utilities are confident that after the future role of NJCEP is addressed, they can engage in meaningful discussions on the best path forward to develop effective programs that serve the needs of all customers and help build a robust clean energy economy for New Jersey.

Thank you for providing this opportunity to comment.

Respectfully,

Andrew Hendry
President and Chief Executive Officer
New Jersey Utilities Association

Appendix B.

New Jersey Natural Gas

VIA ELECTRONIC MAIL (energyefficiency@bpu.nj.gov)

February 15, 2019

Honorable Aida Camacho-Welch, Secretary
New Jersey Board of Public Utilities
44 South Clinton Avenue, 3rd Floor
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Re: IN THE MATTER OF THE IMPLEMENTATION OF P.L. 2018, c. 17 REGARDING THE ESTABLISHMENT OF ENERGY EFFICIENCY AND PEAK DEMAND REDUCTION PROGRAMS DOCKET No. QO19010040

Dear Secretary Camacho-Welch:

New Jersey Natural Gas Company ("NJNG") has reviewed the questions posed in the January 22, 2019 Notice that initiated the Board of Public Utilities' ("BPU") request for comments on the implementation of P.L. 2018, c. 17 regarding the establishment of energy efficiency and peak demand reduction programs ("Clean Energy Act"). Through this letter, NJNG would like to share some key points relevant to the discussion questions.

Support for Joint Utility Efforts

As noted at the February 1, 2019 Public Meeting, the New Jersey utilities have initiated discussions to consider the implications of the Clean Energy Act, as well as potential opportunities to collaborate on program design and administration. NJNG strongly supports the written comments that are being submitted separately on behalf of the utilities through the New Jersey Utilities Association ("NJUA"). Since that document addresses utility agreement on many of the policy questions posted in the January 22, 2019 Notice, NJNG will not address the same points within this response.

NJNG would like to note that the efforts to collaborate and strive for consistency are already underway in the delivery of programs. NJNG's new Engineered Solutions program is modeled after the award-winning hospital program that Public Service Electric & Gas (PSE&G) has run for nearly a decade. PSE&G staff has been generous with both their time and their willingness to share supporting documentation. This is enabling NJNG to launch the program significantly faster and to build off the lessons learned from their experience. It is also making it easier for the trades allies and customers to participate in the program because they understand the approach and it will expedite their review of key program documents. Similarly, NJNG has been sharing insights from our experience in the residential market, including our approach to On-Bill Repayment Programs, with staff from PSE&G and other utilities.

NJNG would like to take this opportunity to share some relevant insights based on our experience working with customers and trade allies and our participation in national energy efficiency organizations.

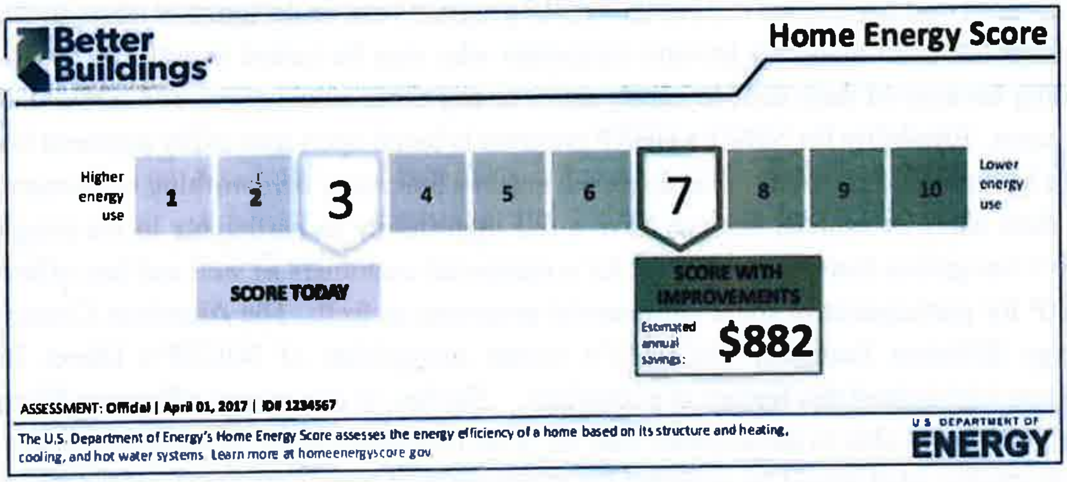
NJNG Background in Energy Efficiency

NJNG has proven our commitment to helping customers reduce their energy bills and advancing state energy efficiency programs through our SAVEGREEN Project. SAVEGREEN recently reached key milestones that help illustrate NJNG's impact on the marketplace.

- More than 53,000 customers have participated
- More than $166 million invested in energy savings measures
- More than 2,600 contractors have participated
- More than $350 million in economic activity

To put these customer participation numbers in perspective, that's more than 1 out of every 10 of our customers. Given the fact that SAVEGREEN is less than 10 years old and our core programs have been tied to significant customer investment in HVAC systems, this is a meaningful accomplishment that illustrates SAVEGREEN is motivating more customers to pursue high-efficiency investments. The investment and contractor participation milestones underscore how the SAVEGREEN program is helping advance the clean energy economy.

NJNG has performed more than 20,600 Home Energy Scores, a national standard for rating the efficiency of a home (see image below). That's approximately 19% of the total scores generated across the country. We are one of the longest serving partners for this U.S. Department of Energy ("DOE") initiative and are very proud of our contributions helping DOE refine this rating scale. Some states have adopted the Home Energy Score as a standard for audits and some progressive cities have implemented mandates for homeowners to disclose a Home Energy Score as part of their real listing. We believe that to reach the Clean Energy Act mandates, New Jersey must not limit the utilities ability to propose programs and must encourage the utilities to take leadership roles in innovative new approaches like the Home Energy Score.



NJNG has strongly embraced educating our customers about energy efficiency and energy conservation since 2006, when our Conservation Incentive Program was first approved. This structure has undergone a thorough regulatory review many times over the past 13 years and has maintained support from both the BPU and the Division of Rate Counsel. We can attest that this regulatory mechanism has helped transform our corporate culture. We have embraced a new way of doing business that actively enables and encourages our customers to use less energy. As a result of this change, our call center staff has proactively provided nearly 3.3 million energy conservation tips since 2008 and our E-tips service has more than 145,000 subscribers who receive monthly emails with helpful seasonal tips and the latest information on program updates and events. We are happy to share more about our experience as the BPU considers how to align the interests of other utilities with the policy objectives.

Focus on the Barriers

NJNG believes that as the BPU considers how to adjust program administration to ensure New Jersey sets the proper foundation for the utilities to meet the regulatory mandates and help grow the clean energy economy, it is critical to identify and consider how to address existing barriers to energy efficiency. While we are hopeful that this proceeding will generate some stakeholder input regarding barriers, we believe it would be beneficial to host sessions with customers and trade allies that are specifically focused on identifying barriers so we can hear direct feedback from customers. NJNG is providing the following as examples of the types of problems we should be exploring.

Upfront Costs: Industry studies often note that upfront costs are a barrier to participation in energy efficiency programs. NJNG been offering an On-Bill Repayment Program (OBRP) for some of our energy efficiency programs since 2011. In addition to eliminating the up-front cost barrier, we believe the OBRP programs can be designed to allow for strong participation from moderate income customers who may be turned away from traditional funding because of their debt-to-equity ratio, or any other calculations traditional markets rely upon. Eligibility for NJNG's OBRP program is based upon past utility payment history and a bankruptcy screening. This approach ensures that many hardworking customers who pay their share of societal charges have a fair opportunity to participate in the programs. NJNG recognizes that this is a barrier for commercial customers as well and has offered an OBRP for participants in some commercial programs as well. The American Council for Energy Efficient Economy (ACEEE)'s recent recognition of NJCEP's Direct Install program highlighted this feature as exemplary. Further, in our energy efficiency filing last year, NJNG was able to demonstrate that the level of activity in the WARMAdvantage was nearly double what would be expected for the number of customers we serve and was more than 2.5 times what would be expected for the Home Performance with Energy Star Program.

Timely Payment of Incentives: Customers and contractors often express frustration regarding delays in receiving the incentives from NJCEP. NJCEP materials currently advise customers that "Once approved, it may take up to 120 days to issue the rebate…". Waiting months for a rebate that may be worth hundreds or thousands of dollars can be frustrating for customers. Some customers are able to transfer that burden to a contractor who is willing to accept an assignment of proceeds but that can create a burden for contractors that are interested in expanding their business to focus on energy efficient projects. If they offer that feature to multiple customers, it can quickly snowball into thousands or tens of thousands of dollars in accounts receivable that can negatively affect their cash flow, especially for the thousands of smaller contractors. In contrast, NJNG rebate checks are issued within 10 days of approval which creates a more positive experience for customers and trade allies.

Special Incentives for Low to Moderate Income Customers: NJNG recognizes that even with our OBRP functionality many low to moderate income customers may be concerned about their ability to repay their obligations for energy efficiency investments. NJNG is excited about the recent enhancements that the BPU approved for our HVAC incentive program that will help us achieve a stronger, fairer economy. At the beginning of last month, NJNG launched new incentives that allow for these customers to apply for a longer OBRP term and receive rebates to help them offset the incremental upfront costs of installing high efficiency equipment. The combination of these more generous features reduces the monthly payback for participating customers. Customers and contractors are already reacting favorably to this new offer. While it will take a significant amount of time to have enough data to properly evaluate this feature, we are hopeful it will provide a path to ensure all customers will have the opportunity to participate in the clean energy economy and that any evaluation will provide other recommendations to support this market segment.

NJNG is also excited about the opportunities within our recently approved Efficient Products program that supports a new partnership with local foodbanks that will allow us to provide free conservation kits to their clients. In addition to providing these customers with immediate energy savings, these kits will cross promote both the NJCEP Comfort Partners program and the broad range of energy assistance benefits available in New Jersey.

Reaching Small Business Customers: NJNG recognizes that small businesses also face significant challenges in participating in energy efficiency programs. They are focused on their core business leaving little time to understand and investigate energy efficiency options and few financial resources to support the investment. Through our partnership with the NJCEP Direct Install program, where we offer an OBRP for the balance of the project cost not covered by the NJCEP incentive, we have helped some customers in this segment. We are excited for the launch of our recently approved SAVEGREEN on Main program that will provide another pathway to help reach small businesses and can include some measures that are not part of the Direct Install program. SAVEGREEN on Main will include an OBRP component to address the upfront cost barrier and will also test a performance element that will reward customers for achieving energy savings. Our intention is to consult with the customer regarding the needs in their facility and help them determine which program better serves their needs. Plus, we will be able to evaluate and share the insights of a performance based approach for this smaller market with the other utilities, policymakers and interested stakeholders.

NJNG appreciates the opportunity to provide comments on these topics. We look forward to working with the Board and other stakeholders as the State considers how to restructure the approach to energy efficiency as to enable the utilities to reach the aggressive clean energy goals established by Governor Murphy's administration. Please feel free to contact me if you need any additional information regarding these issues.

Respectfully submitted,

Anne-Marie Peracchio

Anne-Marie Peracchio
Director- Conservation and Clean Energy

Appendix C

New Jersey Natural Gas

May 16, 2019

Honorable Aida Camacho-Welch, Secretary
New Jersey Board of Public Utilities
44 S. Clinton Ave., 9th Floor
P.O. Box 350
Trenton, NJ 08625-0350

Re: **Energy Efficiency Potential in New Jersey**

Dear Secretary Camacho:

Please accept these comments on behalf of New Jersey Natural Gas Company ("NJNG") in response to the May 9, 2019 draft study "Energy-Efficiency Potential in New Jersey" ("Draft Study") prepared for the New Jersey Board of Public Utilities ("Board") by Optimal Energy, Inc. ("Optimal"). NJNG appreciates the opportunity to offer these comments and take part in the development of a framework for the State's energy-efficiency spending and saving targets.

NJNG recognizes the importance of this type of Draft Study in setting the foundation for the long-term goals for achieving energy efficiency and demand reduction. NJNG remains committed to supporting New Jersey's energy-efficiency goals and appreciates the key role our company plays in achieving the targets contained in the New Jersey Clean Energy Act of 2018 (the "Act"). Beginning well before the promulgation of the Act, NJNG's energy-efficiency programs have saved money for New Jersey customers and generated jobs, while reducing greenhouse gas emissions. NJNG will continue to support programs that encourage energy efficiency, which in turn make energy bills more affordable for our customers.

However, NJNG is quite concerned about the validity of the analysis and fairness of the process relied upon to develop the Draft Study, as well as the soundness of several findings and recommendations (or absence of findings/recommendations) contained in the Draft Study. Our concerns are addressed in these comments; although given the extremely limited time period[1] provided for stakeholder comments, this submission does not represent an exhaustive list of concerns. NJNG respectfully requests the BPU provide for a full and substantive stakeholder process to weigh in on the enormity of the Draft Study prior to

[1] The Draft Study entitled "Energy Efficiency Potential in New Jersey" authored by Optimal Energy, Inc. was publicly released after the close of business on May 9, 2019 and comments were required within seven (7) calendar days, not business days. A weekend was included in the response period. Under the Board's rules of procedure, governed by the Uniform Rules of Procedure, set forth at N.J.A.C. § 1:1-1.4 Computation of time: "In computing any period of time fixed by rule or judicial order, the day of the act or event from which the designated period begins to run is not to be included. The last day of the period so computed is to be included, unless it is a Saturday, Sunday or legal holiday, in which event the period runs until the end of the next day which is neither a Saturday, Sunday or legal holiday. In computing a period of time of less than seven days, Saturday, Sunday and legal holidays shall be excluded," the seven (7) day time period should have commenced on Monday, May 13, 2019 with comments due on May 20, 2019. As a result, the stakeholder's due process rights were violated. Notwithstanding, the Company believes given the magnitude of the proposed Optimal paradigm shift, a longer time period should have been afforded the interested stakeholders to provide meaningful comments to the Draft Study.

implementing any of the recommendations or imposing targets. It is respectfully submitted the Board has violated the due process rights of the affected stakeholders (i.e. the New Jersey natural gas and electric distribution utilities, along with other interested stakeholders). Moreover, the Draft Study does not include any supporting appendices. Without this data, stakeholders are unable to review underlying assumptions and provide meaningful guidance to the Board and its staff. This is another fundamental flaw of the Stakeholder process, as described below.

STAKEHOLDER PROCESS:

The stakeholder process used to develop the Draft Study provides very limited opportunity for the utilities and other stakeholders to give meaningful input and contribute to an informed discussion. Over a four-month period, there were four meetings held with all stakeholders – one with less than three (3) days' notice – with very limited analytical or supporting data disseminated by Optimal to the attendees. Further complicating the lack of data and process transparency is the challenge of providing comments on a Draft Study intended to inform the Board on targets and related information critical to meeting the State's goals — within only a week of issuance.[2] NJNG appreciates the time constraints facing the State; however, we are concerned the compressed review period for submitting comments has compromised our ability, as well as the ability of all interested stakeholders, to appropriately reflect on the analysis and findings contained in the Draft Study. As discussed below, while the process for the adoption of the quantitative performance indicators ("QPIs") and related findings reflected in the Draft Study remains a concern, we respectfully submit that ultimately the Act requires the Board to adopt the QPIs in accordance with the requirements of the "Administrative Procedure Act," P.L.1968, c.410 (C.52:14B-1 et seq.).

Turning to our concerns about some of the findings and recommendations contained in the Draft Study, a critical foundational issue is the responsibility for program administration. Yet, the Draft Study does not clearly indicate whether the utilities or BPU Office of Clean Energy ("OCE") will be responsible for administration of the energy-efficiency ("EE") programs. Fundamentally, where a utility may be subject to a reward/penalty based on the achievement of targets (in this case), the utility at least must have the ability to administer and control its own programs. In other words, if we are responsible for ensuring our programs facilitate the attainment of required savings targets, then we must be empowered to control the administration of our EE programs, and not compete with the OCE. This will allow the State to accomplish its EE goals while also holding each utility accountable for its efforts in support of efficiency. Furthermore, the Draft Study's performance incentive and penalties proposal lacks sufficient detail and definition; thus, it should be further considered in a subsequent stakeholder process. It would be unreasonable to apply a penalty and incentive system that is vague and does not provide clear and well-defined signals for action.

PLANNED INITITAL BOARD ACTION:

The Request for Comments Reminder issued after close of business of May 15 contained some alarming expectations regarding the anticipated actions the Board will take at the May 28 BPU Agenda meeting. Based upon our review of the Draft Study and extensive discussions with a broad range of stakeholders engaged in this effort, we expect the Board will need to consider significant technical limitations and errors, as well as serious legal considerations regarding this Draft Study. Accordingly, it is hard to fathom how the Board could consider the release of the final "Energy Efficiency Potential Study in New Jersey" within less than two weeks of receiving that information.

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[2] The deadline for comments on the May 9, 2019 Draft Study was set for May 15, 2019, less than 7 business days from the date of issuance on May 10, 2019, in violation of N.J.A.C. § 1:1-1.4.

Moreover, the same Reminder Notice appears to suggest the Independent Advisory Group will meet during July and August to discuss issues concerning utility-specific energy usage and peak reduction targets, the program structure, cost recovery, utility filing requirements and timeframe and evaluation and reporting requirements. We recognize these all are incredibly important topics that demand thoughtful consideration to ensure the new direction for energy efficiency in the state is grounded in solid and practical policy. However, the Reminder Notice appears to imply such foundational issues may be resolved within that two-month window. If this is the expectation, and some of the recommendations within the Draft Study regarding utility coordination are proposed, it only would allow for a 10-month period to accomplish all of the following:

- The BPU would address the relative roles of utilities and NJCEP regarding program administration.
- The BPU will establish a process and timeline for utilities to file their program plans and related budgets and evaluation plans.
- The utilities would be asked to develop such plans with a concerted effort to offer consistent incentives and strive for joint/collaborative efforts.
- The regulatory process regarding the review of such plans would occur.
- The BPU would approve the utility plans; and it is reasonable to assume there may be modifications to the original utility proposals based on the regulatory process and stakeholder input.
- Utilities would have to work to implement these plans as appropriate, which is likely to involve hiring new staff, issuing requests for proposals, drafting and executing vendor contractors, qualifying trade allies eligible to participate in programs, developing customer participation agreements, establishing proper internal controls, developing marketing plans, building systems to track results and many more key activities.

Based upon the nuanced policy discussions that occur in many other states regarding the key issues the Independent Advisory Group is charged with considering, as well as the historical experience in New Jersey regarding energy-efficiency programs from a regulatory and implementation perspective, this is an incredibly unrealistic expectation. Programs launched in such an expedited timeframe run a very high risk of unintended consequences, including poor customer experience, flawed program design, unaddressed market barriers to participation, and lapses in internal controls just to name a few. A rushed approach to key issues will miss the opportunity to set the foundation for long and sustained growth in the energy-efficiency markets, and will certainly not generate the "best practices" approach to energy efficiency.

Customers and trade allies must have a strong positive experience with new program offerings to ensure long-term goals are met. We need to ensure quality service is delivered and energy savings are achieved to continue to ensure additional customers and trade allies are willing to participate. Investing resources in setting the proper foundation for a positive customer and trade ally experience will be the most productive way to ensure long-term energy savings goals are met and New Jersey realizes growth in our clean energy economy.

LEGAL INTERPRETATION OF THE ACT:

First and foremost, Optimal is not a New Jersey licensed law firm engaged by the Board to provide a legal opinion of what the Act mandates. The New Jersey Office of the Attorney General is the only authorized entity to provide legal advice to the Board. Notwithstanding, Optimal opines throughout its Draft Study what it perceives to be the legal requirements of the Act. Optimal goes beyond its subject matter expertise by stating the intent of the New Jersey Legislature. To cite an example, Optimal states, "Our interpretation of the law therefore is that incentives can be earned only once a utility achieves 100 percent of the goals …" Draft Study at p. 84.

NJNG respectfully submits the Board not accept Optimal's legal opinions or interpretations regarding the specific requirements of the Act, as the Board has not retained Optimal to provide legal guidance and counsel.

SUBSTANTTIVE COMMENTS:

Limitations in Review of Maximum Achievable Energy Efficiency

NJNG has successfully implemented energy-efficiency programs since 2009, and continues to do so, as part of our energy-efficiency program The SAVEGREEN Project®, and even longer through our work with the New Jersey's Clean Energy Program™ ("NJCEP") New Jersey Comfort Partners ("Comfort Partners") program and others prior to the creation of NJCEP. We recognize the importance of aggressively growing energy-efficiency programs to reach important policy goals, but significant barriers exist that complicate the pursuit of those goals.

The Draft Study suggests utilities may plan to target less than mandated efficiency goals, and would do so at their own risk since they cannot control third-party activities. However, it would be far more cost-effective and conducive with collaborative efforts in place to proactively plan for expected energy savings attributable from other major sources, such as Codes and Standards, Energy Savings Improvement Plans ("ESIP") and more, and only hold the utilities responsible for the balance of energy savings. The assumed savings from these other sources can be subject to independent studies in advance of the program years.

As an example, NJNG has conducted considerable outreach to municipalities and school districts regarding energy efficiency. Frequently, interested customers in these market segments initiate ESIP plans as they consider implementing energy-efficiency measures — as the state continues to aggressively promote this path for financing such improvements. Figure 6 of the Draft Study represents the maximum achievable potential by building type and indicates education is one of the greatest opportunities for natural gas savings. In working with these market segments, we know savings is occurring from projects, and it is critical to gain an understanding as to what degree these projects are currently contributing to energy savings statewide and how much they may be expected to contribute toward proposed target increases.

Points for consideration:

Low-Income Households

A case in point is the ability for utilities to fairly serve low-income customers, and it supports why a detailed review of the Draft Study's assumptions is necessary. Through the Comfort Partners program, NJNG has worked together with other utilities in the state to help more than 114,000 low-income customers since the program's inception, significantly reducing their energy bills and improving the health and safety of their homes. While many customers have benefitted from the program, there are currently barriers to participation for many income-eligible customers because of the premises' health and safety issues, such as:

- Asbestos
- Lead paint
- Mold
- Roof leaks
- Moisture in basements or crawlspaces

- Open sewer lines and drainage problems
- Leaky plumbing
- Insect infestations

While Comfort Partners allows for the improvement of minor health and safety issues to ensure the completion of weatherization measures, it does not have sufficient funding to tackle these more challenging and expensive conditions. A review of 2018 statistics for Comfort Partners found of all enrolled homes visited by a Comfort Partner representative, 1,697 (43.58 percent) were unable to get needed weatherization because the cost of remedying the homes' health and safety conditions was beyond the programs funding scope. The Draft Study indicates approximately 25 percent of New Jersey's single-family homes are low-income. We recognize the current administration places an emphasis on ensuring all customers benefit from a clean energy economy; but in the absence of new funding from other sources to address the significant health and safety issues mentioned above, the utilities are not likely to achieve full energy-saving potential for low-income customers. As the Draft Study provides no supporting information or data sources on the assumptions regarding New Jersey's low-income households, it is not possible to assess the accurate maximum achievable value for this market.

Similarly, there should be strong stakeholder input on the assumptions made for the barriers of each market segment specific to New Jersey conditions, including the level of building code enforcement, and variables such as prevailing wage requirements.

Concerns with Assumptions about Top Energy-Saving Measures

Inaccurate assumptions and modeling methodologies, or inconsistencies with New Jersey policies, can lead to significant overstatement of the market potential for specific measures and for the state as a whole. Both measure-level assumptions and overall modeling methodologies require further review to more accurately reflect the New Jersey marketplace. Tables 10 to 15 of the Draft Study present the current draft top 10 energy-savings categories by fuel type and market segment. Discussions with other stakeholders indicate serious concerns regarding the presumption that these accurately reflect the top potential measures in New Jersey. A few examples include:

- Table 12 of the Draft Study presents the top residential natural gas saving measures and lists two separate line items for natural gas furnaces. While Table 12 does not show the assumed efficiencies, the April 23 stakeholder meeting listed a second furnace category as high efficiency (90% to 94% AFUE). New Jersey has not provided incentives for furnaces in this efficiency range since 2015 due to the evolution of the New Jersey marketplace and maturity of DSM programs. Unless New Jersey amends current policy regarding eligible furnaces, the target for residential savings could be overstated by 2.2 percent. This concern was raised at the May 3 stakeholder meeting. This efficiency- level discrepancy calls into question the efficiency-level assumptions for all measures. The potential exists that multiple measures are currently utilizing assumptions that are not currently eligible for efficiency rebates and potential levels could be significantly overstated.
- Table 12 also shows the combined assumptions for low-flow showerheads in residential single and multi-family homes account for 11.4 percent of the total residential energy savings. These warrant further discussion given the experience in other states, and the generally acknowledged negative customer reactions to these types of energy-saving products. It again points to the need to understand the assumptions behind the analysis that led to this measure accounting for such a large share of the energy savings. To fully assess these measures, stakeholders need access to Appendix E of the Draft Study and adequate time to review and comment on these assumptions. The Impact Factors used by Optimal in the Draft Study are key drivers to the potential results. It is imperative these factors are

based on the best available information applicable to New Jersey, and best reflect the market conditions in New Jersey.

- It is very surprising seal up and insulation does not appear in Table 12 as one of the top 10 energy-saving measures. These measures are typically large contributors to natural gas potential study savings estimates. It is unclear how the potential for seal and up and insulation is being treated since it is not present in the top measures. Based on the NJCEP's experience within the Home Performance with ENERGY STAR® programs at the Tier 2 incentive level, there is significant evidence of seal up and insulation energy-savings potential in homes. While it may be challenging to get a significant amount of energy savings from seal-up and insulation in the short-term due to the limited engagement of those trade allies, the Draft Study tracks potential savings through 2029. Given NJNG's experience in performing more than 45,000 home audits, it seems unlikely a focused effort on educating customers and workforce development initiatives would not be a visible share of the potential energy savings.
- Additionally, there appears to be a mathematical error within Table 12 since the total of the percentages exceeds 100 percent. It is not possible to determine whether an error is limited to the presentation within this table, or an error that affected the outcome of the overall Draft Study.
- Table 15 of the Draft Study presents the top 10 commercial and industrial natural gas measures, and there are similar concerns about the potential for measures potentially being overstated as in the residential sector. ENERGY STAR griddles and ovens collectively account for an estimated 6.5 percent of total commercial and industrial energy savings. Given the majority of commercial and industrial customers may not even own these pieces of equipment, it is very surprising to see them account for this large a share of the energy savings for this market. NJNG reached out to several other program implementers and did not see evidence of savings exceeding 1 percent of the portfolio for the commercial and industrial market. The market share assumptions for these measures is needed to fully review them. Assumed baseline conditions and equipment for the entire market, otherwise known as a Market Profile, is needed to assess whether Optimal has accurately characterized the baseline market conditions from which potential projections are based upon.
- Based on our experience as members of several energy-efficiency organizations with significant participation by program implementers, we were surprised the water heaters did not show up as one of the top 10 measures for the commercial and industrial market.
- Additionally, NJNG is pleased to see furnaces and boilers as a significant source of savings within Table 15; however, we would like to share the practical experience regarding our program supporting the NJCEP Direct Install program. We have frequently encountered instances where natural gas equipment could not pass the cost-effectiveness tests embedded within the Direct Install screening tool. If these natural gas measures are expected to account for a significant share of the energy-savings potential used to build the energy-savings targets, we must ensure the same cost effectiveness screening lens is used for program implementation. If not, all the natural gas utilities will struggle to achieve the established goals.
- For comparison purposes, NJNG has pulled together results from other recently completed energy efficiency natural gas potential studies. This is not a comprehensive or exhaustive list of all studies across the country, but the purpose is to put the draft New Jersey potential study results into context of other studies across the country. As the table below shows, New Jersey has an average yearly maximum achievable potential significantly higher than the other potential studies, especially in the latter years. In many cases, savings decrease over time due to saturated markets and increased baseline conditions, the doubling of potential between 2020 and 2024 in the New Jersey Energy Efficiency Potential study is troubling because New Jersey is already a mature energy-efficiency market – so the doubling of savings within 5 years is highly unlikely, if not impossible.

Year	Yearly Maximum Achievable Potential per Study New Jersey (2019)	Vectren Ohio (2017)	Central Hud (2015)	Ameren (2015)	Vectren Gas (2014)
2020	0.8%	0.8%	0.8%	0.5%	0.9%
2021	0.9%	0.8%	0.8%	0.5%	0.8%
2022	1.3%	0.9%	0.8%	0.5%	0.8%
2023	1.4%	0.9%	0.8%	0.5%	0.8%
2024	1.6%	0.9%	0.8%	0.5%	0.8%
2025	1.6%	0.9%	0.8%	0.5%	0.9%
2026	1.6%	0.9%	0.8%	0.5%	0.8%
2027	1.6%	0.9%	0.8%	0.4%	0.8%
2028	1.7%	1.0%	0.8%	0.4%	0.8%
2029	1.7%	n/a	0.8%	0.4%	0.7%
Average	**1.4%**	**0.9%**	**0.8%**	**0.5%**	**0.8%**

Proposed Target Increases

The Draft Study proposes set energy savings targets that exceed the legislative minimums based on the determination of Maximum Achievable Energy Efficiency — defined as "the maximum level of program activity and savings that is possible, given the market barriers to adoption of energy-efficient technologies, with no limits on incentive payments, but including administrative costs necessary to implement programs." The Draft Study references a 2013 study from the American Council for Energy Efficient Economy ("ACEEE") as an overview of general market barriers. But it does not identify the assumed barriers that exist in New Jersey, and what must be done to overcome such barriers to achieve the proposed savings targets. This is critical information to assess whether the proposed targets are "aggressive but reachable" — a standard proposed with the discussion of performance incentives.

Furthermore, as the Draft Study notes, according to ACEEE's recent State Energy Efficiency Scorecard, only six states currently achieve natural gas savings higher than the targets mandated by the Act. It is important to note only Minnesota is currently performing above the target proposed for year five, and it has a significantly higher heating load than New Jersey. While the Draft Study provides no insights into the savings assumptions from other sources, all stakeholders can see how aggressively the targets for natural gas increase. The savings target doubles between year one and two, and by year five it is more than five times the current level of natural gas savings reported by ACEEE. Many natural gas utilities across the country struggle to meet the energy-saving targets as the low cost of the commodity makes it challenging for individual pieces of equipment to pass some screening tests for cost effectiveness. It is important all stakeholders understand it is not appropriate to apply the results from other states when there are significant varying factors like commodity costs, labor costs and climate.

Proposed Quantitative Performance Indicator (QPI) Structure

Regarding the QPIs presented within the Draft Study, it is incredibly challenging to consider whether some are appropriate given the uncertainty regarding program administration. NJCEP currently administers the Direct Install program, which is generally regarded as the primary path to energy efficiency for small businesses. If the utilities are not playing a central role in the administration of programs that meet the needs of these customers, it is unreasonable to hold the utilities accountable for meeting specific targets for this market. Similarly, the optional metric outlined is presented as accounting for 6 percent of the goal, but it is completely undefined. If it is optional, the proposed percentages should equal 100 percent with adjustments as necessary when the optional metric may be included.

While the Draft Study does provide utility specific tables for the energy-savings targets, those targets do not reflect a thoughtful consideration of the differences between service territories. As an example, NJNG does not have a significant industrial customer load so it may be challenging to secure savings from measures common to the industrial market. Formal targets should reflect a more robust analysis of service territory demographics.

Additionally, NJNG does not agree with the strict interpretation of the word linear for the performance incentives or penalties. We believe based on the experience of other states, it is worth considering a deadband that would result in neither a penalty nor an incentive. Results that fall within that deadband can avoid an excessive drain on regulatory resources of all parties. Greater attention would be warranted when targets are falling below the deadband to assess a penalty as appropriate and, more importantly, to understand what corrective action can be taken to get energy savings back on track. Similarly, when results indicate savings were achieved in excess of the deadband, further review would be warranted to award an incentive and consider what best practices may be applied to other programs to ensure outstanding performance continues.

COST RECOVERY:

Regarding cost recovery, the Draft Study indicates a lower return might be appropriate for energy-efficiency investments rather than traditional supply-side investments by stating "efficiency programs carry much lower risks to shareholders than do most supply side investments." See, Draft Study at p. 81. However, the Board historically has taken the position utilities should be allowed to earn the same return on investments for energy efficiency as its other investments. The return on investments in energy efficiency should be commensurate with other utility investments to further encourage ongoing and future investments in energy efficiency. The Act clearly authorizes utilities to earn a recovery on its energy-efficiency investments, and nowhere indicates this return should be different from the return earned on other traditional (i.e. pipes and wires) utility investments.

The language and structure of the Act and Section 13 of the Regional Greenhouse Gas Initiative ("RGGI") Act, along with the historic treatment of public utility energy-efficiency investments in New Jersey, are clearly consistent with the utilities earning a rate of return on these investments. In addition, it is NJNG's position an artificially low amortization period or, for that matter, no amortization period will result in inter-generational inequity regarding the costs and benefits of EE investments, as well as rate shock if the EE expenditures were recovered on a "pay-as-you-go" basis.

AMORITIZATION PERIOD:

The short amortization period has a lower total revenue requirement over the entire program period on a nominal basis. However, the "real cost" of these revenue requirements to ratepayers must consider the time value of money by applying a discount rate to future revenue requirements. Moreover, the Draft Study does not consider that savings are realized over the life of the equipment, and not in the year of investment. In addition, customers would pay significantly more in the initial years of the program than under the longer amortization period. It is likely many customers would prefer the lower near-term bill impacts associated with the longer amortization period.

RETURN ON EQUITY:

Regarding the return on equity, the Act specifically states pursuant to N.J.S.A. 48:3-87.9.e. (1) that:

> Each electric public utility and gas public utility shall file annually with the board a petition to recover on a full and current basis through a surcharge all reasonable and prudent costs incurred as a result of energy efficiency programs and peak demand reduction programs required pursuant to this section, including but not limited to recovery of and on capital investment, and the revenue impact of sales losses resulting from implementation of the energy efficiency and peak demand reduction schedules, which shall be determined by the board pursuant to section 13 of P.L. 2007, c. 340 (C.48:3-98.1).

Following the subsection quoted above, specifically e. (1), there are two subsections (e. (2) and e. (3)) requiring the Board to establish, respectively, incentive and penalty structures. Then, subsection 48:3-87.9.e. (4) specifically states:

> The adjustments made pursuant to this subsection may be made through adjustments of the electric public utility's or gas public utility's return on equity related to the energy efficiency or peak demand reduction programs only, or a specified dollar amount, reflecting the incentive structure as established in this subsection. The adjustments shall not be included in a revenue or cost in any base rate filing and shall be adopted by the board pursuant to the "Administrative Procedure Act."

This language confirms the utility shall have a return on equity related to its EE programs. Similarly, RGGI section 13 (N.J.S.A. 48:3-98.1) includes the following cost recovery language in subsection b. and definition in subsection d.:

> b. An electric public utility or a gas public utility seeking cost recovery for any program pursuant to this section shall file a petition with the board to request cost recovery. In determining the recovery by electric public utilities and gas public utilities of program costs for any program implemented pursuant to this section, the board may take into account the potential for job creation from such programs, the effect on competition for such programs, existing market barriers, environmental benefits, and the availability of such programs in the marketplace. . . Ratemaking treatment may include placing appropriate technology and program cost investments in the respective utility's rate base, or recovering the utility's technology and program costs through another ratemaking methodology approved by the board, including, but not limited to, the societal benefits charge . . . All electric public utility and gas public utility investment in energy efficiency . . . programs may be eligible for rate treatment approved by the board, including a return on equity, or other incentives or rate mechanisms that decouple utility revenue from sales of electricity and gas.
>
> d. "Program costs" means all reasonable and prudent costs incurred in developing and implementing energy efficiency, conservation, or Class I renewable energy programs approved by the board pursuant to this section. These costs shall include a full return on invested capital and foregone electric and gas distribution fixed cost contributions associated with the implementation of the energy efficiency, conservation, or Class I renewable energy programs until those cost contributions are reflected in base rates following a base rate case if such costs were reasonably and prudently incurred.

Optimal misses a critical point of why distribution utility companies should be allowed the same rate of return on their investments for energy efficiency as other investments. The point is utilities have limited capital to invest. If one investment alternative has a higher return than another, that company will make investments in the opportunities with higher returns. Therefore, the return on investments in energy efficiency must be commensurate with other utility investments to further encourage investments in energy-efficiency projects.

LOST REVENUE:

As it relates to cost recovery for lost revenue, the Act expressly provides utilities to recover "the revenue impact of sales losses resulting from implementation of the energy efficiency and peak demand reduction schedules, which shall be determined by the Board." *Id.* While the Draft Study indicates the Act "… directs some sort of cost recovery mechanism to account for the utilities' net lost revenue," the goals outlined in the Act reflect gross savings, and not net savings. The Act allows utilities to meet goals by counting savings outside of the programs they are administering, including codes and standards. Therefore, it is reasonable to interpret the intent of that statement is to allow utilities to make whole the revenues lost from sales losses due to the targets established by the Board.

In closing, NJNG remains committed to partnering with the State to help achieve its energy-efficiency goals. Thank you, again, for the opportunity to provide these comments and allow us to be a part of the State's energy future.

Respectfully submitted,

Andrew K. Dembia

Andrew K. Dembia

sunrun

November 6, 2019

Aida Camacho-Welch
Secretary
New Jersey Board of Public Utilities
44 S. Clinton Avenue
Trenton, NJ 08625
EnergyEfficiency@bpu.nj.gov

Re: **New Jersey Energy Efficiency Transition - Sunrun Comments on Program Design**

Dear Ms. Camacho-Welch:

Pursuant to the New Jersey Board of Public Utilities' ("BPU" or "Board") October 15 Staff Stakeholder Notice ("Stakeholder Notice") regarding New Jersey's Energy Efficiency Transition, Sunrun, Inc. ("Sunrun") respectfully submits these comments. The Stakeholder Notice requests input on the types of programs needed in order to achieve the required energy reductions in the Clean Energy Act. I attended the Stakeholder Meeting ("Stakeholder Meeting") on October 30 in Trenton and greatly appreciated the insightful and thorough presentations of the speakers.

You may recall that at the Stakeholder Meeting, I raised a question to the panel about the important role of battery storage technology to achieve energy efficiency goals. We believe that battery storage should play a central role in reducing peak demand in New Jersey. Sunrun has spearheaded an innovative policy model that galvanizes customer participation in energy efficiency programs through third-party distributed energy resources ("DER") aggregators – the bring-your-own-device ("BYOD") model. The BYOD model is essentially a tariff structure that enable customers to purchase batteries through any source and receive credits on their monthly bills. Customers can install battery storage at their residences and then share access to the storage with the utility to drive down costs for all ratepayers during peak hours. This approach makes customers true partners with the utility in the effort to reduce costs, shift peak consumption and facilitate greater grid resiliency. BYOD enhances market competition, leverages the customer engagement and education expertise of DER providers, and spurs innovation in the control, management and dispatch of various types of DERs.

Battery storage offers unique operational characteristics that make it particularly well suited to provide energy efficiency and peak demand reduction services for New Jersey consumers. I have attached hereto a copy of the Clean Energy Group's April 2019 report, "Energy Storage: The New Efficiency" which gives a comprehensive assessment of the potential for battery storage to meet states' energy efficiency objectives. Further, Sunrun's BYOD model ensures that customers are allowed to participate in utility programs with non-utility owned DERs, and that competitive market providers, including DER developers that offer aggregation services, are able to work with their customers to manage and dispatch participating DERs to achieve customer and program goals. This is important for customers adopting solar and battery storage in the future, as the BYOD feature provides a scalable design to integrate customer-sited resources into a platform to provide valuable grid services that benefit both participating and non-participating customers. The BYOD model also mitigates ratepayer costs and risk by utilizing non-utility capital to deploy and manage participating resources and allocating the risk of non-performance to private market participants, not utility ratepayers. BYOD models are being adopted for energy efficiency and peak reduction programs in other states and offer a roadmap for implementation in New Jersey.

As one example, in 2018 the Massachusetts Department of Public Utilities ("Massachusetts DPU") approved utility proposals to implement an active demand reduction program, which includes "demonstration offerings to test the daily dispatch of storage . . . to support the potential launch of statewide daily dispatch offerings for residential and/or C&I customers."[1] The Massachusetts program will operate on a pilot basis initially and is structured to allow participating customers to enroll energy storage assets and receive payment on a performance basis. In approving the program, the Massachusetts DPU found the "approach appropriately considers the ability of a daily dispatch offering to deliver cost-effective benefits to customers prior to a statewide deployment" and that the "pay-for-performance incentives appropriately protect ratepayers because incentives will only be paid for actual performance."[2]

I have attached a copy of testimony submitted to the New Hampshire Public Utilities Commission ("NH PUC") by Sunrun expert consultant Justin Barnes, Director of Research at EQ Research LLC. Mr. Barnes' testimony provides a detailed overview of the BYOD model. In its review of a storage pilot program proposal submitted by Liberty Utilities, the NH PUC ultimately found that the BYOD program was a critical mechanism to mitigate potential negative impacts of the utility ownership proposal on competitive markets. Integrating the BYOD model into energy efficiency programs in New Jersey would provide the necessary pathway for competitive market participants to unlock value for participating customers and ratepayers more broadly to further New Jersey's energy efficiency and peak demand reduction goals.

Thank you for considering Sunrun's comments herein. Please do not hesitate to contact us if you would like further information regarding our input.

Sincerely,

Nicole W. Sitaraman

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[1] Mass. Dept. of Pub. Utils, Docket Nos. 18-110 through 18-119, Order Approving Massachusetts Joint Statewide Electric and Gas Three-Year Energy Efficiency Plan 2019–2021 at 32 (Jan. 29, 2019).

[2] *Id.* at 33-34.

Comments of Rockland Electric Company
NJBPU Energy Efficiency Notice October 15, 2019 – Program Design

On October 30, 2019, the NJBPU held a stakeholder meeting on Energy Efficiency ("EE") Program Design. In its Agenda and Presentation for that meeting, BPU Staff indicated that it was interested in stakeholder input and experience regarding existing State and utility-run EE programs, new EE programs, market barriers, targets and metrics, and funding sources.

Rockland Electric Company ("Rockland" or "the Company") supports New Jersey's EE goals and encourages their implementation in a manner that brings the greatest benefits to all customer classes, including low and moderate income ("LMI") customers, while also minimizing the cost impact to all customers. Utility involvement will be critical in achieving the State's goals, in particular the energy efficiency goals of the Clean Energy Act[1] (CEA"). The Company welcomes the opportunity to play a central role and believes these goals are most achievable with the appropriate regulatory framework, program design and program support.

At the outset, the Company notes that EE programs should be designed so that New Jersey achieves its energy reduction goals. As noted in more detail in these comments, successful EE programs include a strong regulatory framework that provide for the recovery of the program's direct costs, decoupling or similar mechanisms that allow the utility to recover lost revenue contributions, and earnings opportunities for efficiency investments and performance. Further, each utility should design and administer its own programs. Flexibility is key to designing programs that reach the most customers and reduce energy usage; specific programs should not be required for every service territory. The utilities know their service territories and customers, and therefore can design programs to best achieve energy reductions.

The CEA clearly assigns the obligation to reduce energy usage to the utilities. Therefore, utilities should administer all EE programs in their territory, having invaluable insight as the energy provider as to what programs will result in customer participation and achieve energy reductions. Additionally, as other states have learned, allowing multiple parties to administer EE programs in the same territory results in market and customer confusion, which undermines the potential success of reaching New Jersey's EE targets.

The Company sets forth below its responses to Staff's questions in the Agenda and in the Presentation for the October 30 stakeholder meeting.

<u>Staff Question #1:</u>
Which New Jersey programs are considered the most successful? How do you define "success"?

[1] P.L. 2018, Chapter 17.

Response:
A successful EE program reduces energy usage at the least cost for the utility's customers. Successful EE programs have in common a regulatory framework that has been identified by the American Council for an Energy-Efficient Economy ("ACEEE") as the "three-legged stool." According to the ACEEE, a successful utility energy efficiency regulatory framework should include: "recovery of energy efficiency program direct costs; removal of throughput incentives (profits linked to increased energy sales) through decoupling or similar mechanisms that allow recovery of lost contributions to fixed costs; and creation of earnings opportunities for efficiency investments and performance."[2]

State EE experience across the country shows compensation of lost revenues resulting from the implementation of energy efficiency programs removes the disincentive for utilities to pursue these programs and results in more effective EE programs.[3] Lost revenue recovery is not an incentive, but instead makes the utility whole for the revenue loss realized when its customers use less energy as they participate in the utility's EE program. Without lost revenue recovery, utilities risk significant earnings loss and unless offset by a lost revenue mechanism, utilities do not recover the revenue necessary to meet customer needs, resulting in upward pressure on energy rates. Lost revenue recovery is an essential component of a robust energy efficiency portfolio and, in conjunction with an allowed rate of return on the investment and achievable performance incentives, will drive the development of successful energy efficiency programs that align with the State's ambitious energy efficiency goals.

The CEA recognizes the need for earning a return on EE investment that creates a level playing field with utility infrastructure investments. Such comparable treatment encourages and facilitates the integration of EE as part of the utility's core business. In addition, by amortizing the costs of an EE portfolio over the asset life, it allows customers to contribute to EE program costs according to the benefits they receive. This approach eliminates the shifting of EE costs between current customers and future customers and reduces the customer bill impact in any given year. In contrast, expensing these costs in the year they are incurred will result in a significant bill increase for customers as program spending ramps up.

As the ACEE has recognized, the most successful state EE programs include utility incentives with reasonably achievable performance incentives, which provide utilities with the positive incentive for implementing successful energy efficiency programs.[4] The New York Public

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[2] "Policies Matter: Creating a Foundation for an Energy-Efficient Utility of the Future," Maggie Molina and Marty Kushler, ACEEE, page 8 (June 2015). Available at https://aceee.org/sites/default/files/policies-matter.pdf

[3] "The Evidence Is In; Decoupling Spurs Energy Efficiency Investment, Natural Resources Defense Counsel (April 4, 2016). Available at https://www.nrdc.org/experts/samantha-williams/evidence-decoupling-spurs-energy-efficiency-investment

[4] The 2019 State Energy Efficiency Scorecard, Pages 46-48 American Council for an Energy-Efficient Economy ("ACEE') (October 2109). Available at https://aceee.org/research-report/u1908

Service Commission ("NYPSC") highlighted the importance of these financial incentives in its successful EE programs in 2016, and stated:

> Aligning financial incentives with policy goals is the best way to assure the furtherance of [New York's energy efficiency] goals. Where possible, markets and positive financial incentives – rather than direct regulatory mandates with negative consequences - should be the primary drivers of the countless implementation actions, decisions, and initiatives needed to transform the industry. We therefore determine that the direction of rate regulation is towards aligning financial incentives with REV objectives by combining discrete reforms to conventional ratemaking with new earning opportunities that better align the utility and consumer economic welfare interests.[5]

As a result of this policy direction, New York State is well on its way to reducing energy needs by 185 TBtu through 2025, reducing greenhouse gas emissions by 40 percent below 1990 levels in 2030, and sourcing 50 percent of the State's electricity from renewable resources by 2030.[6]

Rockland's Low Income Audit and Direct Install EE program ("LIADI") is an example of an efficient, successful utility program. As noted in a recent study by Rutgers Center for Energy, Economic & Environmental Policy ("CEEEP"), in terms of dollars spent per kWh saved, the Rockland LIADI program was 30 to 70 percent lower than the NJCEP Comfort Partners program from 2009 through 2014.[7] This indicates that, in general, Rockland's program spent less money per unit of energy saved than other similar programs. The CEEEP study also reported that Rockland's LIADI program saved more kWhs per participant than other similar Office of Clean Energy programs from 2009 through 2014.[8]

<u>Staff Question #2:</u>
What programs will achieve the most energy and/or cost savings?

<u>Response:</u>
As other states have learned, utility-run EE, peak demand reduction and demand response programs offer the highest potential to keep energy affordable for all customers. As noted in the Company's response to Staff Question #1, the ACEE has recognized that successful EE

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5 Case 14-M-0101, Order Adopting a Ratemaking and Utility Revenue Model Policy Framework, issued and effective May 19, 2016.
6 "About Reforming the Energy Vision," NYPSC (February 2017). http://www3.dps.ny.gov/W/AskPSC.nsf/96f0fec0b45a3c6485257688006a701a/71bf9b959e12f08a85257fc5005e0679/$FILE/2017%20REV%20info%20sheet%20draft%20FINAL%202-10-17.pdf
7 "Rockland Electric Low Income Energy Efficiency Program Cost-Benefit Analysis," pages 3-4, Rutgers Center for Energy, Economic & Environmental Policy ("CEEE") (January 17, 2017).
8 *Id.*

programs include the recovery of the program's direct costs, decoupling or similar mechanisms that allow the utility to recover lost revenues contributions, and the creation of earnings opportunities for efficiency investments and performance.

Additionally, the NJBPU should avoid having multiple entities run EE programs in a utility's territory. As noted above, the CEA assigns the responsibility of energy reduction to the utilities so it is imperative that the utilities run the EE programs in their service territories. Additionally, utilities are able to tailor programs to their customer base, with an understanding of the type of programs that will drive customer participation and achieve energy reduction in a cost-effective manner.[9] Utilities are also uniquely positioned to administer EE programs, as they are viewed by their customers as trusted energy advisors.

It is also important that EE programs provide customers the ability to manage their energy usage. Pairing advanced metering infrastructure (AMI) data with software data analytics and behavioral programs can provide for more customized actionable recommendations to customers. AMI will enable the implementation of beneficial electrification and advanced technologies as well as provide more accurate and granular price signals, which can encourage informed energy use.

Utility programs can be designed to use software data analytics to demonstrate to customers the benefit of investing in EE and help reduce the upfront capital cost of the efficient equipment. Software data analytics in conjunction with customer usage data can be used to perform virtual energy audits for commercial buildings. These virtual audits can identify efficiency upgrades along with estimates of the simple payback resulting from bill savings to help drive EE. The results from the virtual audit can provide a customized data comparison to industry benchmarks and provide recommendations to help customers reduce their energy consumption.

Small businesses can benefit from programs designed to help them manage their electricity use through more efficient lighting, refrigeration and cooling products – typical drivers of costs for small businesses. Incentives for commercial and industrial customers to participate in programs that allow them to manage their energy use through targeted demand reduction, as well as commercial HVAC and industrial equipment upgrades, can provide system-wide benefits for all customers.

Staff Question #3:

How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?

Response:

As noted above, the CEA assigns the responsibility of energy reduction to the utilities, recognizing utilities are in the best position to run programs in their service territories tailored to

[9] For example, low-income customer demographics vary significantly across the state and while 25 percent of New Jersey single family homes may be classified as low-income, such customers are not spread evenly across all utilities.

their customers' needs and that produce results. EE programs in other states have been evolving to eliminate multiple EE providers in recognition of the strength of utility run programs. EE programs should not be consistent across service territories and the guiding principle should be flexibility in order for utilities to design programs that fit their unique service territory characteristics.

In the past, New York's EE programs were administered by electric and gas utilities and the New York State Energy Research and Development Authority . However, the New York Public Service Commission ("NYPSC") recognized the shortcomings of the shared program administration model and concluded that competition in EE programs creates "confusion in the marketplace," and customers were confused about how the programs offered to them differed and how to evaluate which program was most appropriate for their needs.[10] The NYPSC also concluded that when customers were confused, "they tend to back away from the programs and not pursue any offering."[11] The NYPSC subsequently altered the shared delivery framework by clarifying each entities' unique responsibilities and areas of possible overlap in its February 2015 Order Adopting a Regulatory Policy Framework and Implementation Plan.[12]

As noted above, Rockland's LIADI program is an example where flexibility produced a better outcome than consistency. As noted above, Rockland's LIADI program is an efficient, successful, utility-run EE program that achieves higher energy savings and operates at a lower $/MWh than the state-run Comfort Partners program. In the past, Rockland participated in the Comfort Partners program, but the Comfort Partners program favored utilities with significant urban areas in their territory, which Rockland does not have. Therefore, Rockland initiated its LIADI program, and does not participate in Comfort Partners. As a result of that flexibility, Rockland was able to leverage its knowledge of its customer base and achieve more penetration into its low income customer demographic. Rockland's LIADA program has treated over 80 percent of Rockland's Universal Service Fund customers. From 2010-2016, Rockland's LIADI program has served 519 low income customers, as compared to 33 customers per year when Rockland participated in the Comfort Partners Program.

Other states besides New York have recognized the need for establishing clear and distinct roles for each program administrator to avoid market and consumer confusion.[13] While there may be instances where a statewide program could result in more energy savings at a lower cost, in most cases, only flexible program design will achieve New Jersey's energy reduction targets.

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[10] Moreland Commission on Utility Storm Preparation and Response. (June 2013) Page 27-35. Available at http://www.governor.ny.gov/sites/governor.ny.gov/files/archive/assets/documents/MACfinalreportjune22.pdf
[11] *Id.*
[12] New York Public Service Commission. Order Adopting a Regulatory Policy Framework and Implementation Plan. (February 2015). Page 78. Available at http://documents.dps.ny.gov/public/Common/ViewDoc.aspx?DocRefId=%7b0B599D87-445B-4197-9815-24C27623A6A0%7d
[13] See, for example, "Policy Brief: Best Practices for Shared Efficiency Program Administration Prepared for Delaware's Energy Efficiency Advisory Council, Summer 2015" available at https://neep.org/sites/default/files/resources/Policy%20Brief%20%20Best%20Practices%20for%20Shared%20EE%20Program%20Admin.pdf.

Staff Question #4:
What market barriers are prevalent in specific New Jersey programs?

Response:
One market barrier in New Jersey has been the limited opportunity for utilities to develop programs tailored to their service territory. As discussed above, Rockland ran into this barrier with the Comfort Partners program. In addition, many EE programs result in market barriers for low income customers because these customers do not have the financial ability to participate. Also. small business customers face market barriers because they do not have the time or ability to research which EE measures best suit their needs. The NJBPU should give utilities the flexibility to design EE programs to meet the particular needs of customers in their service territories and overcome these barriers.

Another potential market barrier is outreach and marketing. For example, not all customers have access to the internet, so local outreach may be an alternative. Therefore, it is important that EE programs have the ability for significant outreach. Customers know their utilities, as opposed to other providers, which is another reason to favor flexibility over consistency in programs.

Staff Question #5
How do we ensure equitable access?

Response:
The Company assumes by "equitable access" the question asks how the EE programs can encourage participation of all customers, including low-income customers. The Company agrees that the NJBPU should encourage EE programs that reach all customer groups, including low income customers. The utilities will need the tool of flexible program design to create those programs and achieve New Jersey's energy reduction targets.

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November 6, 2019

VIA ELECTRONIC MAIL ONLY

Aida Camacho-Welch, Secretary
New Jersey Board of Public Utilities
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Re: Energy Efficiency Transition – Programs

Dear Secretary Camacho-Welch:

On October 15, 2019, the Staff of the New Jersey Board of Public Utilities (the "Board") issued notice of a October 30, 2019 stakeholder meeting (the "Stakeholder Meeting") regarding implementation of the energy efficiency requirements of P.L. 2018, c. 17 (the "Clean Energy Act," codified, in relevant part, as N.J.S.A. 48:3-87.9). The notice provided that the Stakeholder Meeting was to address energy efficiency and peak demand reduction programs, the types of programs needed in order to achieve the energy reductions required by the Clean Energy Act ("CEA"), market barriers, program flexibility, and consistency in New Jersey's next generation of energy efficiency and peak demand reduction programs. Furthermore, the agenda issued for the meeting listed five questions on which Board Staff was seeking specific input.

JCP&L thanks the Board for the opportunity to provide feedback on this important issue. Please find below JCP&L's responses to the five questions issued by Board Staff.

1. Which New Jersey programs are considered the most successful? How do you define success?

The New Jersey CEA has established extremely aggressive energy efficiency goals that will require a substantial increase in the amount of energy savings above what is currently being achieved in the state. Therefore, in order to successfully transition toward attainment of these lofty goals, the state will need to alter both the implementation model and approach for energy efficiency program offerings. To attain success, New Jersey will need to significantly expand program offerings, increase program incentives and budgets, identify and count energy savings from all sources, encourage innovative program designs and implementation practices, allow for program implementation and incentive flexibility, and appropriately reward performance.

2. What programs will achieve the most energy and/or cost savings?

Eight electric utility affiliates of JCP&L based in Pennsylvania, Ohio and Maryland have over 10 years of experience in development and implementation of comprehensive energy efficiency and peak demand response program portfolios. All eight of these utilities began program implementation in 2009 as the result of legislative and administration mandates. Based upon this experience, JCP&L believes the programs that will achieve the most energy savings in the residential market are: 1) Home Energy Reports/Behavioral, where reports are provided to customers that encourage them to adopt energy efficiency behaviors through education and specific recommendations to conserve energy in their homes and that provide information on programs available to them; 2) Residential Lighting, where customers are provided an incentive to purchase energy efficient lighting products; 3) Energy Efficiency Kits that provide customers with low cost energy savings measures (e.g. low flow shower heads) to install in their homes with additional energy efficiency and conservation information and information on other program opportunities available to them; and 4) Appliance Turn-In/Recycling, where customers are offered an incentive to recycle old, inefficient operable appliances, such as refrigerators. The programs that will achieve the most energy savings in the commercial, industrial and government market are programs that provide incentives to customers for upgrading or installing energy efficient lighting, for retrofitting specialized processes, and for completing high efficiency building or system improvements.

3. How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?

Consistency and flexibility are not mutually exclusive – they can co-exist with respect to energy efficiency and peak demand response program administration across a state. Entities offering programs can certainly work in coordination and collaboration to support general consistency where appropriate, such as in offering similar types of program opportunities for customers. Collaborative workgroups can also be used as an effective tool to facilitate the sharing of best practice ideas and implementation approaches. However, consistency should not limit flexibility. Flexibility in program selection, design, and implementation practices allows these entities to optimize savings and most cost-effectively achieve their individual targets. Flexibility enables programs, incentives, and implementation approaches to be tailored to fit the uniqueness of the obligated entities' targeted customer demographics, rate structures, service territories, and relationships. It also enables obligated entities to leverage existing operations and pilot unique programs or strategies. Yet, where appropriate and cost-effective, obligated entities can work together to coordinate consistent program operations. This approach leverages the best of both worlds.

To be consistent with the Clean Energy Act's mandate, utilities should be primarily responsible for administering energy efficiency and peak demand response programs in their respective service territories. JCP&L believes that the individual utilities are in the best position to determine what program offerings, program designs, and implementation practices will be best received by their customers. This is because each of the utilities has unique insight into the factors that can potentially impact program adoption and performance in their individual service territories. Customer demographics, local markets and pricing, market participants, and electric rates vary across territories and can affect performance. This knowledge places the utilities in the best position to determine where efficiencies or benefits can be captured through different types of coordination with other utilities, where appropriate.

New Jersey's utilities are also in an optimal position to offer these programs to their customers. Many of New Jersey's utilities have affiliates with extensive experience implementing EE and PDR programs in other jurisdictions. As noted above, JCP&L's affiliated utilities in Pennsylvania, Ohio and Maryland all began implementing energy efficiency programs in 2009. This extensive multi-state experience means that JCP&L has access to already established back-office administrative procedures and systems, and a staff with experience successfully designing and implementing comprehensive programs across multiple jurisdictions. Additionally, these prior experiences mean that JCP&L already has access to knowledge about program designs, program vendors, and implementation practices, which can be leveraged to capture cost savings through economies of scale and different delivery channels that can achieve increased customer participation in a cost-effective manner. Further, JCP&L anticipates continuing its efforts to utilize cross-jurisdictional efficiencies, as its affiliates have done in Ohio, Pennsylvania, and Maryland, where appropriate. This includes leveraging relationships with third-party vendors that have robust networks of trade partners in multiple states and cross-marketing programs where possible to maximize participation through recognized utility branding and service provider trust.

These benefits may not be able to be realized if the Board places too many constraints on utility-administered programs, such as dictating that programs be implemented uniformly across the state, with identical incentive levels or through a single statewide implementer or implementation approach. For example, it may not be possible for the utilities to leverage existing operations and best practices from other states if the utilities are not granted the flexibility necessary to do so. Such constraints may also result in lost opportunities for New Jersey to experiment and learn from different designs and implementation practices.

4. <u>What market barriers are prevalent in specific New Jersey programs?</u>

JCPL believes that a potential market barrier in New Jersey could be the market confusion that may result if competing programs are offered by both the Office of Clean Energy ("OCE") and the customers' utility. Thus, determining the respective roles of the OCE and utilities in the future administration of energy efficiency and peak demand reduction programs in New Jersey is crucial. To the extent that the OCE continues to administer programs (such as through the Clean Energy Program), JCP&L encourages the Board to carefully and clearly delineate the respective roles of the utilities and the OCE to consider and mitigate this barrier.

In addition, as in any market where there are very aggressive energy efficiency goals, there are several common market barriers that can prevent attainment of such goals, including:

Knowledge barriers: Customer or contractor knowledge/lack of knowledge about the performance of different equipment, technologies, buildings, and other systems.
Reliance on others to act: One must consider if there are enough customers in a segment willing to participate in a program and encourage said customers to act rather than be passive.

Principal-Agent problems: The person making decisions on efficiency investments or actions may not pay the electric bills and, therefore, has little incentive to reduce electric usage. This is common in landlord/tenant arrangements.

Economic externalities: Customers' ability to pay for participation in a program (via purchasing equipment, services) and justifying a higher purchase price as compared to less efficient models or services.

Potential limited numbers of providers: The number of producers or sellers, suppliers, or qualified professionals (contractors, builders, etc.) may be insufficient to support adequate market functions.

5. How do we ensure equitable access?

JCP&L believes that providing the utilities the flexibility to develop and implement programs tailored to meet their customers' needs is key to ensuring equitable access. As noted above, the individual utilities are in the best position to determine what program offerings, program designs, and implementation practices will be best received by their customers. This is because each of the utilities has unique insight into their individual service territories, such as customer demographics, local markets and pricing, and market participants. This knowledge places the utilities in the best position to develop and implement programs to ensure equitable access.

Other approaches recognized in the industry as helping to ensure equitable access include:

- Offering a range of eligible measures, including high-efficiency products and equipment;
- Using a portfolio approach;
- Incorporating customer energy efficiency education;
- Promoting flexibility, coordination, and collaboration to make for better programs that serve low-income and multifamily households; and
- Establishing programs that provide comprehensive cost-effective energy saving measures such as air sealing, insulation, and heating system replacement to achieve higher levels of savings.

JCP&L thanks the Board for the opportunity to provide these comments and appreciates the Board and Board Staff's efforts throughout this ongoing stakeholder process. If you have any questions about JCP&L's above comments, please do not hesitate to contact me.

Very truly yours,

Joshua R. Eckert | KBW

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November 6, 2019

Via E-mail (Energy.Efficiency@bpu.nj.gov)

Aida Camacho-Welch, Secretary of the Board
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Re: Energy Efficiency Transition, Stakeholder Meeting No. 2

Dear Secretary Camacho-Welch

Please accept this correspondence on behalf of Public Service Electric and Gas Company ("PSE&G" or "the Company") in connection with the above-referenced matter. PSE&G appreciates the opportunity to provide these comments on these important issues and thanks the New Jersey Board of Public Utilities ("BPU" or "Board") for conducting this stakeholder process.

The second stakeholder meeting related to the Energy Efficiency Transition was held on October 30, 2019, and focused on New Jersey's existing and new energy efficiency programs, market barriers, targets and metrics, and funding sources for energy efficiency programs. The Board seeks specific input and responses to a number of questions regarding these topics and the Company has addressed each individually herein.

1. *Which New Jersey Programs are considered the most successful? How do you define "success?"*

PSE&G has successfully implemented several energy efficiency programs over the last decade. The Company has invested approximately $400 million in award-winning energy efficiency programs for a variety of customer segments, including small businesses, hospitals, multifamily buildings, government facilities, and non-profit entities. PSE&G's Hospital and Multifamily Programs have won multiple awards for innovative program design and as noted by

Senior Director of Policy of ACEEE, programs such as PSE&G's multifamily building program have been flourishing in recent times. Such programs provide for an audit and the engineering and construction of energy efficient measures, while helping address accessibility issues by providing; (1) upfront capital for energy efficient improvements, and (2) valuable expertise that customers may not have at their disposal to usher these types of energy efficiency projects through to completion.

Not only is the Company assisting customers to implement energy efficiency measures on a large scale, but it is also assisting customers on a more fundamental level. PSE&G's data analytics program helps raise awareness of energy usage among its customers and recommends specific actions and measures that a customer can easily take to reduce energy consumption. PSE&G has also implemented a Smart Thermostat program that makes internet-connected smart thermostats available to its customers. These thermostats generate energy savings for customers and may also support future clean energy efforts and utility operations. The program's first wave sold out in approximately 5 months in 2018, demonstrating the incredible viability of a utility-operated online marketplace to deploy residential energy efficiency measures.

While PSE&G has a proven record of accomplishment in executing successful energy efficiency programs, much work remains to meet the state's clean energy goals. Success from the Company's perspective, is being able to implement a variety of programs that allow PSE&G to offer energy reducing solutions that will significantly touch all customers regardless of demographics or socioeconomic status. A significant step toward meeting this goal is the Company's Clean Energy Future Energy Efficiency ("CEF-EE") filing. In this filing, PSE&G proposes 22 subprograms, including seven residential subprograms, seven commercial and industrial ("C&I") subprograms, and eight pilot subprograms where PSE&G implements and manages select, highly advanced approaches to energy efficiency that may support future energy efficiency programs in New Jersey. From a residential customer standpoint all sub-segments are addressed, from new construction and refurbishments; to promoting and incentivizing new equipment and providing easily accessible channels for such purposes; to direct installation and other support for multi-family and low income customers.

Since 2009, PSE&G's energy efficiency programs have saved millions of kWhs of electricity and therms of gas, resulting in substantial energy cost savings to customers. Expanding energy efficiency deployment in PSE&G's service territory at the levels proposed in its CEF-EE Program can result in significantly greater savings to customers, well beyond the levels experienced to date, and set New Jersey on a path toward meeting its clean energy objectives.

2. What programs will achieve the most energy and/or cost savings?

C&I rebate programs, such as the C&I Prescriptive Subprogram proposed in the Company's CEF-EE Program, promote significant energy and cost savings. These savings are achieved by providing incentives to facility owners and operators for the installation of high efficiency equipment and appliances through a variety of channels, including reduced point of sale costs, and a network of trade allies. The measures range in type and price, but include both electric and natural gas technologies that improve energy efficiency. Significant savings can be realized by up-front rebates on all technologies to reduce initial costs. Additionally, some purchases will qualify for on-bill repayments to further reduce first cost barriers. Similarly, residential rebate programs like PSE&G's Residential Efficient Products offer a wide variety of energy efficient products that engage customers at a high level in their energy usage and savings. These products are offered through many different channels such as in-store, online marketplace, and through trade allies.

A major factor in energy conservation and savings is customer behavior. Residential behavioral energy efficiency programs such as those proposed in the Company's CEF-EE filing, offer yet another opportunity for cost-effective EE savings. These programs have similar components to the data analytics program approved by the Board in the Company's EE 2017 program. However, the residential behavioral energy efficiency program looks to build on the success of the data analytics program by providing a linkage enabling customers to realize greater energy savings through the suite of PSE&G energy efficiency subprograms. As the behaviors of customers are positively influenced, customers will reap the benefits of energy savings and realize a reduction in costs.

3. *How do we balance consistency and flexibility in program requirements and incentives if multiple entities are running the same program? How important is consistency versus flexibility?*

Obligated entities can work in coordination and collaboration to support consistency where appropriate, but such collaboration should not limit a given entity's flexibility. Flexibility in program selection, design, and implementation practices allows obligated entities to optimize savings and most cost-effectively achieve their individual targets within a given construct. Collaboration and coordination are also important to ensure broad and equitable access to program opportunities, implement best practice program ideas, provide consistency where appropriate, and coordinate complimentary program offerings. The utilities have demonstrated the ability to work together collaboratively by partnering for over a decade to provide the Comfort Partners program, and more recently by sharing insights from their implementation of existing energy efficiency programs.

While the collaborative approach leverages the best of all worlds, flexibility most importantly enables programs, incentives, and implementation approaches to be tailored to fit the uniqueness of the obligated entities' targeted customer demographics, rate structures and relationships. A rigid "one-size fits all" approach to energy efficiency program development and implementation will not work. The Company must be allowed to structure programs and incentives to match the needs and wants of the customers it serves, in the areas in which it serves them.

4. *What market barriers are prevalent in specific New Jersey programs?*

A number of market barriers exist in New Jersey programs as noted by each of the panelists during the second stakeholder meeting.

<u>Lack of Information</u>

One of the main barriers is lack of information. Customers often do not have access to information to fully understand energy efficiency options and strategies. Customer habits are often difficult to break. Therefore without sufficient information, it is extremely difficult for a customer to assess the risks and benefits of energy efficiency efforts and investments to make a change in his or her energy usage behavior. PSE&G's data analytics program, for example, counteracts this barrier by providing information to customers in a simple format that allows customers to understand their energy usage and implement easy tips to conserve energy and save money on their bills.

Upfront Costs

Another major barrier to energy efficiency programs are the upfront costs associated with many high efficiency improvements. While energy efficiency investments pay dividends, many customers do not have the necessary funds to pay for energy efficient system and/or appliance improvements in their homes or businesses. This is where programs such as PSE&G's C&I and Residential Rebate programs can bridge the gap. Incentives provided to the customer through a variety of channels such as on-bill financing, trade allies, retail and midstream outlets, and digital services via on-line applications are critical in addressing this barrier.

Split Incentives

Split incentives between landlords and tenants with respect to who pays for energy use versus who owns the energy-using equipment are also barriers to energy efficiency program implementation. Generally speaking a landlord has little incentive to make investments in energy efficiency programs because they do not reap the benefits from those efficiency measures. The tenants are often the ones who experience the cost savings, whereas the landlords are the ones making the monetary investment in energy efficiency improvements. In this case, the economic benefits/savings of energy efficiency and conservation measures do not accrue to the person making the investment in energy efficiency. The Company's Residential Multifamily program removes this disincentive and balances the benefit to both landlord as investor and tenant as user.

Availability of Technology and Know-How

Even when customers are informed and ready, willing, and able to install energy efficiency measures in their homes and businesses, customers may find that certain energy efficient products and programs are not offered in their areas. To support a robust marketplace for efficient equipment, PSE&G proposes to promote midstream incentives for specific equipment types, ensuring sufficient stocking and availability of efficient products throughout its territory.

In that regard, customers and trade allies may lack the technical knowledge to deploy energy efficient options. Service technicians may not only lack access to the updated technology, but they also may lack know-how in repairing newer/energy efficient systems and appliances. PSE&G is committed to helping these groups overcome this barrier by providing education and training on these new technologies. PSE&G's Engineered Solutions, Income Eligible, Residential Behavioral and Residential Existing homes provide education and resources to customers to help guide their energy efficiency efforts.

5. *How do we ensure equitable access?*

The Board can help to ensure equitable access to energy efficiency offerings by implementing a dedicated program design focused on addressing market barriers for underserved markets. PSE&G's proposed CEF-EE programs do just that by:

i. Earmarking funds for income qualified customers for energy efficiency upgrades that are performed by qualified experts who assess the customers' needs and implement upgrades to make certain identified improvements.

ii. Addressing the split incentive issue by performing work in multifamily tenant units at no cost to the landlord, thus making buildings that participate in this type of program more likely to help low-income customers.

iii. Engaging students in grades kindergarten through twelfth grade with targeted classroom energy efficiency and awareness education and take-home energy efficiency kits to raise awareness of energy issues particularly in underserved areas.

iv. Focusing on installation of efficiency measures for small non-residential customers that typically lack the time, knowledge, or financial resources necessary to pursue energy efficiency. The subprogram is designed to provide non-residential owners with easy investment decisions for the direct installation of energy efficiency projects.

v. Expanding PSE&G's successful hospital and multifamily programs to include universities, schools, municipalities, and non-profits to ensure access to energy efficiency for these important New Jersey institutions. The subprogram proposes to provide expert-guided service throughout delivery to assist customers in identifying and undertaking large energy efficiency projects on-site, while requiring no up-front funding from the customer.

vi. Establishing Quantifiable Performance Indicators ("QPIs") and cost-benefit tests that recognize the importance of serving vulnerable populations. While QPIs proposed by Optimal in the Market Potential study include metrics for low-income and small business efficiency, the Company suggests that New Jersey's cost-benefit test for EE include benefit "adders" for underserved customer participation to align with any QPIs for these markets. Ensuring that the cost-benefit test properly captures these benefits will help support the utilities' ability to reach these customers.

Conclusion

PSE&G is uniquely situated to help expand cost-effective energy efficiency programs throughout New Jersey. The Company has implemented a number of award-winning energy efficiency programs over the course of ten plus years and it is poised to build on that success with its CEF-EE filing. The result will be lower bills for all participating customers—particularly our most vulnerable ones, and a cleaner environment. PSE&G appreciates the opportunity to provide these comments and looks forward to partnering with the State and the BPU to deliver a Clean Energy Future to all New Jersey residents.

Respectfully submitted,

Joseph F. Accardo Jr.

ReVireo

November 6, 2019

VIA Electronic Mail
Honorable Aida Camacho-Welch, Secretary
NJ Board of Public Utilities
44 South Clinton Avenue
9th Floor, Post Office Box 350
Trenton, New Jersey 08625-0350
EnergyEfficiency@bpu.nj.gov

Re: Energy Efficiency and Peak Demand Reduction Program Comments

Dear: Secretary Camacho-Welch:

ReVireo is an energy efficiency and green building services company founded in 2009 and headquartered in Cranford, NJ. We are partners in both the NJ Clean Energy Program (NJCEP) Residential New Construction (RNC) and Pay for Performance (P4P) programs. We also provide energy code consulting and verification services for developers, homebuilders, and contractors throughout the State of New Jersey. ReVireo is active in the NJ Home Builders Association (NJBA) and Mixed-Use Developers Association (MXD) and advise NJBA/MXD leadership and members on matters related to energy code and above-code energy efficiency utility rebate programs.

Beyond my role as CEO of ReVireo, I am also an Executive Board Member and Treasurer of the NJ Chapter of the U.S. Green Building Council (USGBC), and a lifelong resident of the State of New Jersey. Below are my comments on the implementation of the energy efficiency and peak demand reduction programs required to achieve the goals of the New Jersey Clean Energy Act. Some are restated/reformulated from comments submitted during prior comment periods.

1. **Ensure Both New Construction (Developer & Homebuilder) & Commercial/Multifamily Building Owner (i.e., business facing) Markets Served Same Statewide**

It is critical that markets for new construction (real estate developer and homebuilder) as well as for large-scale existing building owners (commercial and multifamily) be served statewide with consistent incentives, eligibility criteria and rules across all service territories.

Developers, homebuilders, and large-building owners work across utility service territories and any new differentiation between one service territory to another would create significant consternation and dramatically depress participation in the long run. Whatever entity (i.e., NJCEP or individual utility) administers the various programs for new construction and large building owners (i.e., business facing markets), that entity just needs to ensure those programs are the same everywhere in every aspect.

That entity should also strive to achieve continuity with the programs currently offered by NJCEP, as many development/construction/renovation projects have been in the planning stages for years and any sudden major changes would significantly disrupt participation in energy efficiency programs for new construction and large building owners statewide.

Also, developers, homebuilders, and large building owners need to be able to choose from an open market of qualified partner organizations in any energy efficiency programs for new construction or large existing buildings. This is because many developers, homebuilders, and large building owners have established relationships with one or more partner organizations, who in turn encourage participation by developers, homebuilders, and large building owners in such programs. Severing those relationships would decrease participation in such programs. Also, the various partner organizations compete with each other to keep consulting/verification costs down for the developers, homebuilders, and large building owners. This in turn reduces the cost of participation in such programs thereby increasing participation in the long run.

2. Enforce NJ UCC Energy Subcode Consistently

Currently, there is significant variation from one municipality to another in the enforcement of the Energy Subcode referenced in the NJ UCC. There are various reasons for this, but the result end result is that:

a) Many, if not most, newly constructed buildings are not actually compliant with the Energy Subcode referenced in the NJ UCC. This has a long-term effect on NJ's energy usage;
b) NJ's efforts (including NJCEP/utility incentives) to encourage developers to participate in "above code" energy efficiency programs are undercut because the actual baseline for cost comparison is, on average, less energy efficient than minimum Energy Subcode requirements since they are often consistently enforced.

This is a systemic problem resulting from many forces, will be incredibly difficult to solve. But it is worth solving because of the potential cascading, wide-ranging positive impact. It is possible that regionalization or privatization of enforcement of the Energy Subcode, if not of all of the NJ UCC, may prove to be the best option in the long run in order to achieve the goals of the NJ Clean Energy Act.

3. Streamline Green Building Standards for NJEDA Tax Credit Programs (Economic Redevelopment and Growth, Grow NJ, NJ Forward, NJ Aspire, Evergreen etc.)

The most recent version of the "Green Building Standards Guidance for Potential ERG and Grow NJ Applicants (Updated 7/13/16)" allow for various methods for compliance, including not actually earning certification but simply the "equivalency" thereof. There is also redundancy in the standards, which allow compliance based on participation in NJCEP requiring a % energy reduction but then also allow compliance by just directly documenting that energy % reduction without NJCEP participation. This puts the NJEDA in a position of directly reviewing the accuracy of energy modeling results, which are incredibly complex, instead of those results being reviewed and tracked by NJCEP. It would seem to make more sense for NJEDA to follow the NJHMFA model of simply requiring projects to participate in applicable NJCEP (or applicable utility-run) program as a prerequisite for tax credits.

Whatever the future of the NJEDA Tax Credit Programs turns out to be, it should include a streamlining of the Green Building Standards. Considering projects participating in these programs are some of the largest, and most-prominent, in the State – it is of particular importance for them to achieve real demonstrated energy savings through mandated participation in an above-code utility company rebate program (whether through NJCEP or through the servicing utility company).

Matthew Kaplan, MBA, LEED AP
CEO

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November 6, 2019

VIA ELECTRONIC FILING

Enervee Comments, in conjunction with the October 30th "Energy Efficiency Stakeholder Meeting – Programs"

Enervee appreciates the opportunity to comment on questions raised by the State of New Jersey Board of Public Utilities (NJ BPU) regarding the implementation of the Clean Energy Act provisions related to energy efficiency and peak demand reduction programs, in particular, the types of programs needed in order to achieve the Clean Energy Act-required energy reductions and market barriers.

We concur with both Dr. Jennifer Senick (Rutgers) and Maggie Molina (ACEEE), who pointed out at the October 30th stakeholder meeting that, to achieve the Clean Energy Act efficiency goals, it will be essential to finally address persistent and pervasive barriers that stand in the way of capturing all cost-effective energy efficiency potential – or, from the consumer perspective, prevent people from buying the clean, efficient consumer products we know they aspire to. In our February 2019 comments to the NJ BPU discussing how "full economic, cost effective potential" should be defined, we highlighted the importance of identifying barriers and encouraging and prioritizing programs that eliminate barriers.

And we now have the data, technology and behavioral insights to eliminate persistent and pervasive barriers that previously were considered insurmountable. In her remarks on best-in-class energy efficiency programs, Ms. Molina highlighted utility "marketplaces" as an emerging opportunity. Under this heading, her slide featured images of both a utility ecommerce site and San Diego Gas & Electric's online choice engine platform. While both can contribute to incremental energy savings, only choice engine platforms focus on barrier elimination, without incentives, as pointed out by E Source in a recent webinar[1].

The SDG&E Marketplace featured by Ms. Molina, which has attracted over 2 million visits[2], is operated by my firm. Enervee introduced the concept of "choice engines"[3] to the utility sector in 2014 and, in the US alone, over 80 million Americans now have access to an "Appliances Choice Engine" and 30 million, to the "Cars Choice Engine". This represents a growing market transformation opportunity, paving the way for scalable, cost-effective savings, without the need for incentives, and we recommend that NJ BPU plan for a

[1] View 4-minute excerpt from Behavior, Energy & Climate Change Conference (BECC) Webinar on "Utilities Investing in Behavior Change", Wednesday, June 19, 2019.
[2] See SDG&E Press Release, 31 July 2019.
[3] See Nobel Laureate Richard Thaler's 2013 Harvard Business Review article for an intro to choice engines.

rollout of such platforms statewide[4], as a quick win that will make markets work better for consumers, while laying a solid foundation for other efficiency program efforts.

Choice engine platforms offer a proven way to eliminate barriers[5], including:

- Market barriers, such as lack of market transparency with respect to product efficiency. The zero to 100 Enervee Score nudges shoppers towards more efficient choices, on top of any effect of the ENERGY STAR label.
- Social & psychological barriers, such as rational inattention to small, potential per unit energy savings that are challenging to identify while shopping, or the lay theory that efficient products necessarily cost more (which our daily updated market data show is not true).

Maggie Molina also highlighted other benefits of choice engine platforms:

- Unique ability to address the large and growing plug load end uses that do not lend themselves to traditional efficiency program strategies.
- Opportunity to better serve low- and moderate-income households.

The most recent Residential Energy Consumption Survey data from the Energy Information Administration illustrate the importance of plug loads across all income levels:

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[4] The California Public Utilities Commission mandated all IOUs in the state to provide their customers with such platforms by the end of 2017.
[5] See, for example, Arquit Niederberger & Champniss (2017).

Choice engine platforms present an opportunity to modernize LMI programming, by introducing a retail product channel to complement traditional direct-install approaches. We are happy to provide further information, but the following graphic highlights some of the potential benefits of this approach, which utilities outside of NJ are beginning to experiment with.

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With hundreds of millions of energy-using products bought annually (including roughly 25 million in NJ alone), choice engines are ramping up to deliver massive, cost-effective savings. And the industry is taking note of this innovative market-based approach. The Association of Energy Service Professionals singled out one of Enervee's choice engine platforms to receive its prestigious 2019 Outstanding Achievement Award for Residential Program Design & Implementation, because of its ability to nudge shoppers towards more efficient purchases, without monetary incentives[6]. An increasing body of knowledge is documenting the real value that consumers reap from choice engine platforms, as well as gigawatt hour-scale electricity and in the millions of therms of natural gas savings per deployment[7].

Making markets work better for consumers yields significant, very cost-effective savings and should be factored into targets and required as a foundation for other energy efficiency programs. The NJ BPU has an unprecedented opportunity to narrow the gap between economic and market potential – just by making it

[6] Enervee Awarded for Successful Utility Market Transformation Program

[7] An independent assessment of the PG&E Marketplace was published in 2018, and studies for ConEdison and AEP Ohio will wrap up this quarter.

easier for consumers to choose efficient products. We are happy to arrange a briefing and invite you to experience the features and functionality of our live choice engine deployments first-hand[8].

Thank you for the opportunity to share our thoughts on barriers that prevent private investment into efficient consumer products and share information on choice engine platforms that can eliminate them.

Sincerely,

Anne Arquit Niederberger, Ph.D.
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[8] Con Edison, for example, has deployed both our Appliances and Cars choice engines.

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November 6, 2019

VIA Electronic Mail
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Re: Energy Efficiency Transition – Programs

Dear Secretary Camacho-Welch,

The New Jersey Builders Association (NJBA) submits the following comments regarding the Energy Efficiency Transition. NJBA is a professional trade organization representing individuals and businesses in the home building industry who strive for a more vibrant and affordable housing market in New Jersey.

NJBA supports statewide incentives to encourage energy efficiency in homebuilding. Energy efficiency in new home construction has long been a national and state priority. When New Jersey created the New Jersey Clean Energy Program (NJCEP), it made a commitment to promote the use of clean, renewable sources of energy including solar, wind, geothermal, and sustainable biomass with the collateral objectives of creating a stronger economy, less pollution, lower costs, and reduced demand for electricity. To enhance that commitment, BPU and NJCEP energy incentives should be attractive to developers and designed to reduce costs.

Changes in the utility industry continuously result in a state of uncertainty regarding the delivery of quality services by the various utilities. It is imperative that the building industry be served with consistent incentives, eligibility criteria and rules across all service territories. Any disparity of program application between service providers will result in confusion and reduced participation.

A significant amount of planning goes into every development project, and BPU should recognize that existing NJCEP incentives contribute to the safe production and execution of many projects around the State. Future programs and changes to existing programs should contain a level of continuity to decrease any potential disruption. NJBA supports an efficient program design that promotes reliability, uninterrupted service and affordability to all New Jersey residents.

Developers currently have access to an open market of qualified partner organizations for energy efficiency programs in new construction; BPU must continue to offer developers the ability to access an open market to maintain relationships. These relationships stimulate business and ultimately encourage growth and participation in energy efficiency programs. The competition among the various partner organizations keeps costs down for builders resulting in an increased likelihood for participation.

NJBA appreciates the consideration of its comments and recommendations. NJBA looks forward to working with BPU and various stakeholders to create statewide energy efficiency programs to reduce the State's energy consumption and address the harmful effects of climate change.

Sincerely,

Carol Ann Short, Esq.
Chief Executive Officer

Energy Solutions

Honorable Aida Camacho-Welch, Secretary
New Jersey Board of Public Utilities
44 South Clinton Avenue, 3rd Floor
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P.O. Box 350
Trenton, NJ 08625-0350

November 06, 2019

Re: Implementation of P.L. 2018, c. 17 Regarding the Establishment of Energy Efficiency and Peak Demand Reduction Programs
Docket No. QO19010040

Dear Secretary Camacho-Welch:

Energy Solutions appreciates the invitation from the Board to submit comments on New Jersey's energy efficiency programs. We commend the Board on seeking to adopt best practices in Demand Side Management from effective program examples nationwide.

Energy Solutions is a nationwide demand-side management program implementation firm specializing in market scale supply chain market development and market transformation programs with over twenty years of experience. The following comments are based on our experience in program implementation and cite best practices from corroborating references where possible.

As New Jersey enters a new phase of effort in pursuit of the statutory obligations laid out in P.L. 2018, c. 17[1], optimal design of the energy efficiency programs in place over the next five years will greatly influence savings achievement on an annual and lifetime basis. Our comments focus on **midstream program implementation** and **codes and standards advocacy programs**, two program designs that have achieved significantly more savings compared to downstream programs.

<u>Codes and Standards Advocacy Programs</u>

Appliance standards and building code updates have been one of the most cost-effective and significant energy savings initiatives since the 1970s. Codes and standards advocacy at the state and national level can have a dramatic impact on energy efficiency portfolios; in California, these savings represent over half of current of total claimed energy savings and are projected to achieve two-thirds of portfolio savings by 2020 while constituting less than five percent of statewide portfolio costs.[2] Traditional efficiency programs target measures with low market adoption rates, and thus higher net-to-gross savings. Codes and standards programs capture additional cost-effective energy savings that complement traditional program designs. Codes and standards programs can be effectively run as demand side management resource savings programs, and can include compliance improvement, technical support for the origination of new codes and standards, and advocacy for the origination of new codes and standards at the local, state, and federal level.

[1] https://www.njleg.state.nj.us/2018/Bills/AL18/17_.PDF
[2] California Energy Commission, Demand Analysis Office, 2019

As states nationwide realize the highly cost-effective potential savings available through the market transformation that codes and standards programs can provide, there is a groundswell of interest in multiple states – including NY, MA, CT, RI, MI, CO, AZ, MD, and others – in allowing state regulatory or regulated utilities a mechanism for claiming attribution for savings originating from these types of programs. Codes and standards programs also have the added benefit of serving all ratepayers, including hard to reach and disadvantaged communities. We encourage the Board to consider the full range of codes and standards program opportunities, including the technical support for and advocacy of origination of new building codes and appliance standards at the local, state, and federal level. Adoption of a programs to code framework – wherein traditional incentive programs gather information in support of an anticipated code and receive partial savings attribution for that future code – could be another program design to explore.

Midstream Program Implementation

Midstream programs move utility incentives up the supply chain to target the market actors that have the greatest influence on equipment sales and also to target market barriers only addressable by these market actors. By focusing on midstream market actors and maintaining relationships with regional distributors, midstream programs address stocking and upselling practices, amplify the incentive impact through leverage of the markup process in the supply chain, increase program impacts, and increase customer satisfaction. While midstream programs can achieve substantially greater savings than similar downstream programs, specific barriers must be overcome, as discussed in the article "Moving to the Middle – How to Navigate the Ins and Outs of C&I Midstream Programs." (AESP 2016).[3] Furthermore, we offer the following best practices observed in other regions when considering incorporating midstream programs into the portfolio:

- **Create Statewide Market- and Customer Consistency:** Market actors engaged with midstream programs typically sell into more than one program administrator territory. These businesses incorporate pricing and administrative changes into their operations much faster and with fewer errors when there is consistency in program design, incentives, equipment eligibility, and participation rules across as large a territory as possible. Statewide consistency is critical for program adoption and achievement.
- **Streamline Market Actor Participation:** Program participation from midstream market actors should be highly automated and facilitate ease of integration with sales systems, automatic payment tracking, automated customer address matching, automated model matching and verification, and debiting.
- **Alignment with Market Actor Business Models:** Optimal program design pays market actors fast – in a week or less – to maximize market actor return on net assets by reducing their days sales outstanding on transactions qualifying for the program. By paying midstream market actors faster than their standard 60-90 day payment terms, the program makes qualifying transactions more profitable than standard efficiency transactions. A best practice is to design the program to pay fast and debit if any unit later fails to qualify on inspection or after further review. This program design element has been highly effective for motivating the market in other regions. Program design should respect the market actor typical sales cycle and seek to communicate any program changes or ending of program with plenty of time for market actors to complete all pending jobs in their pipeline so as not to cause financial harm to their businesses and endanger future market buy-in for the program in question or its successors.
- **Design Customer Engagement into the Program:** Design the program to include outreach to the downstream end customer receiving the equipment and share with them the role the program had in making the premium efficient equipment available at competitive prices, as well as individually quantifying the impacts for that specific customer based on their past energy usage.

[3] https://www.aesp.org/page/MidstreamPrograms/How-to-Navigate-the-Ins-and-Outs-of-CI-Midstream-Programs.htm

Post-installation outreach is also a perfect opportunity to introduce the customer to other programs and to energy services which support the entire lifecycle of the equipment – quality installation, quality maintenance, strategic energy management, active demand management, and early retirement. Midstream programs typically have ten times or more the energy savings of downstream programs and have the potential for significantly more customer engagement than downstream programs.

- **Fully Engage Utilities in Program Implementation:** There are a variety of successful administration models seen in other states. The most impactful programs have the full engagement and collaboration of the state's utilities to support a broad range of critical program activities including consistent program design, integration with other program offerings, market actor outreach, access to customer energy usage analytics and service address information, access to customer sites for inspections and evaluation, and access to existing utility channels of customer engagement.
- **Procure Midstream Programs Separately from other Portfolio Programs:** The effective delivery of the midstream program model requires a level of market engagement and reciprocal trust with the program implementor. Procuring midstream program implementation separately (rather than bundled with downstream programs), will allow more competition from implementation firms that specialize in supply chain engagement and market development. This competition will lead to a certainty of procuring the most effective resource for the task at hand.

Energy Solutions appreciates the opportunity to provide comments on these topics. We welcome the opportunity to provide further information and share our experiences implementing Codes & Standards and Midstream Market Development programs with the objective of assisting the Board in designing the best possible plan to reach New Jersey's ambitious and visionary clean energy goals.

Sincerely,

Chris Burmester
Vice President, Products & Services