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Clean Energy Fund Investment Plan: Energy Storage Chapter

Portfolio: Market Development

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11 Energy Storage

Energy storage will play a critical role in achieving the State's renewable generation and greenhouse gas reduction objectives. Storage can reduce the intermittency of solar and wind energy, helping these resources to be flexible assets deployed when needed. It can avoid the need for new electric system infrastructure, increase system efficiency and resiliency, and reduce the requirement for fossil fuel plants to meet periods of peak electric demand, which occur infrequently.1 Storage can also integrate with demand response and energy efficiency measures within buildings to achieve greater energy savings without sacrificing occupant comfort. Finally, energy storage can also redefine the transportation system through electric vehicles and rail.

Energy storage is a multi-faceted technology that cuts across many sectors, including clean energy production, energy efficiency, various types of customers and buildings, and established technologies as well as those still in development. NYSERDA's energy storage strategy will target key barriers limiting energy storage adoption in three sectors: customer-sited (behind-the-meter systems), transmission and distribution system needs, and the transportation system. The initial initiative described in this chapter addresses barriers in the customer-sited (behind-the-meter) sector and the ability to use these systems to meet transmission and distribution system needs. Five activities are included in this initiative that contribute toward reducing soft costs by 33% and enabling half of all distributed energy storage installations to provide value to two or more parties within five years: safety validation and permitting for electrochemical systems, best fit customer acquisition, quality assurance (performance confidence), value stacking pilots, and tools to support market replication.

This initiative is part of NYSERDA's coordinated intervention strategies to develop and deploy energy storage products and remove market barriers to their adoption. In addition to this initiative, NYSERDA is considering an integrated PV and storage market development initiative and an energy storage technology and product development initiative for submission. Insights gained from the activities included in this chapter will also be incorporated into the demonstrations proposed under other chapters, as appropriate. Program investments and activities will be informed via engagement with stakeholders and subject matter experts.

11.1 Reducing Barriers to Deploying Distributed Energy Storage

11.1.1 Overview

Present Situation	• Energy storage will help achieve New York's long-term renewable and greenhouse gas reduction goals by integrating intermittent renewables, increasing utilization of electric system assets, and reducing the need for fossil

[1] Average electric system load is approximately 18 GW, yet the system is built to reliably meet well over 30 GW of demand that arise only 60 hours per year.

	fuel peaker plants.[2] In particular, leveraging dispatchable behind-the-meter resources to meet customer need and those of the electric system is integral to a Reforming the Energy Vision (REV) future. • The market is ripe for driving scale as hardware costs are declining, customer interest in energy storage is growing, and the importance of this solution in achieving the State's renewable energy, greenhouse gas, and REV objectives is increasingly recognized. • However today, the typical distributed storage resource is underutilized in serving multiple system needs, has high installed costs relative to the hardware costs, and often has an unacceptable return on investment. This initiative will address these challenges to deploy and validate optimized distributed storage solutions under REV. • While still a nascent market, since 2012, employment in New York's energy storage sector has grown 30% to approximately 3,900 employees and global annual revenues from New York companies have increased 50% to $900 million. A recent study projected that by 2030 this sector could employ 25,000 in New York State and comprise $8 billion in annual revenues.[3] Distributed energy storage is still very much in the early stages of deployment in New York with approximately 23 MW of rated power installed, including the 20 MW Beacon flywheel facility for frequency regulation, and another 10 MW to 20 MW in various stages of permitting. • Three main stall points are preventing wide-scale adoption of distributed energy storage[4] in New York. While these barriers affect all forms of energy storage to different extents, the impact is especially significant on electrochemical systems such as advanced batteries which, due to their features, are especially well suited for many distributed storage functions. o Soft costs: including permitting, customer acquisition, design, interconnection, and financing, can comprise 25% or more of the total installed cost of an energy storage system. While battery costs are declining by 10% or more annually,[5] these soft costs are largely driven by local conditions. o Uncertainty: since the number of distributed storage installations is still fairly small, customers, investors and utilities are uncertain regarding performance, perceived safety risks, and financial models. In addition, uncertainty in future tariff structures adds difficulty in projecting long-term project revenues. o Return on investment limitations: while an energy storage system's flexibility (fast response, precise load management, repeatable load curtailment, generation shifting) allow it to perform multiple functions, in reality, due to unproven use cases, performance uncertainty, and market rules such as minimum system sizing in the wholesale markets, few systems in New York State provide more than one or two services limiting the ability to earn revenue.
Intervention Strategy	• This initiative will primarily target building owners and operators, permitting agencies, and vendors to address the stall points presented above and includes

[2] For example, the *Renewable Electricity Futures Study* prepared by NREL in 2014 identified the need for 2.2 GW to 2.6 GW of energy storage in New York State at 50% renewable penetration, and up to 5.9 GW at 80% renewable generation.

[3] Data obtained from *The Energy Storage Industry in New York: Recent Growth and Projections*, *2015 Update*, June 2016 DRAFT and prepared by Industrial Economics, Inc. Final study to be published soon.

[4] Distributed energy storage refers to energy storage systems in the kW to multi-MW range that are located behind and in-front-of a customer's meter within the distribution and transmission system, but does not include bulk storage resources such as pumped hydro.

	five elements that build upon NYSERDA's reputation as a source of objective and credible information: 1. Safely deploy energy storage technologies by conducting battery testing to address safety uncertainty, training first responders, and engaging with authorities having jurisdiction (permitting agencies) to develop model permitting guides: 2. Reduce customer acquisition cost by identifying characteristics of best fit customers, data mining, and supporting feasibility studies and pilots to accurately predict good fit customers; 3. Increase confidence by compiling and inputting data on deployed systems into a publicly searchable platform, evaluating value propositions and customer bill savings, and conducting educational outreach to customers and vendors; 4. Invest in "value stacking pilots" that assess the effectiveness of using a distributed storage system to meet distribution and/or wholesale system needs in addition to those of the host site; and 5. Invest in tools that support market replication through fact sheets, best practices, and use cases with clear economics. • For a visual representation of this strategy, please reference the flow chart entitled "Logic Model: reducing barriers to installing distributed energy storage," which can be found in Appendix A.
Goals	• Reduce soft costs by 25% per kWh in three years and 33% or more in five years, based on a 2015-16 baseline. This would reduce the total installed cost of a four-hour customer-sited system in New York City by almost $75/kWh (representing 10% of today's installed cost and 15% of projected installed cost by 2022). • Half of all distributed energy storage installations in the market in five years provide value to two or more parties (customer, distribution utility, load serving entity, New York Independent System Operator (NYISO)). • Expand customer choice by increasing the number of experienced vendors selling energy storage solutions in New York State, and increase vendor capabilities and business models through data sharing, case studies, and best practices.
State Energy Plan/Clean Energy Standard Link	• Energy storage will play a critical role in reaching the State's renewable generation and greenhouse gas reduction objectives and in reducing peak electric demand. • Distributed energy storage will firm intermittent renewables avoiding the need for new fossil fuel peaker plants, permit greater customer load control, and reduce electric bills. • Leveraging distributed storage systems to address multiple system needs will create a more cost-effective electric system and reduce ratepayer cost for traditional utility infrastructure. • The proposed strategies will help inform new test tariffs proposed by utilities for locational-based marginal price plus distribution value (LBMP+D), which would reflect the delivered price of electricity at a specific time of day and location.

11.1.2 Target Market Characterization

Target Market Segment(s)	The initial target will be interval-metered customers in the multifamily, commercial, industrial and educational sectors with low load profiles (high peak loads for short periods), their distribution utilities and load serving entities, and vendors. Interval-metered customers are those with the highest amounts of electricity use, typically measured in 15 minute or less intervals. This quantity of electric load data permits

	identifying customers best aligned for realizing bill savings by reducing their electric demand using energy storage. As the costs of energy storage systems decline and value stacking opportunities become better quantified, the target market will expand to medium-sized demand metered entities within these same verticals.
Market Participants	• Building owners and operators • Storage vendors and service providers • Permitting agencies (authorities having jurisdiction (AHJ) such as building and fire departments) • Architects and engineers • Distribution and municipal utilities, load serving entities, curtailment service providers (aggregators), NYISO • Professional associations and trade associations such as Building Owners and Managers Association (BOMA) and the New York Battery and Energy Storage Technology consortium (NY-BEST)
Market Readiness	• Advanced energy storage on the grid, encompassing grid-connected (utility side of the meter) and customer-connected (customer side of the meter) applications are projected to grow globally from 538 MW installed in 2014 worth $675 million to 21,000 MW worth $15.6 billion in 2024, and up to $400 billion by 2030. [6] New York firms engaged in the energy storage sector include Fortune 500 companies, original equipment manufacturers, system integrators, and a strong startup and research community. • Battery prices are declining by 10% or more annually. For example, since 2008-2010, lithium-ion battery module cost has decreased by a factor of four while lifetime and capacity has doubled.[7] In 2016, quoted cost of an installed customer-sited four-hour lithium-ion system in a metropolitan location was on the order of $850/kWh or greater. Multiple market research firms point to customer-sited systems declining to approximately $500/kWh or lower by the early to mid-2020's. Other advanced storage technologies also offer the potential for lower lifetime costs and attractive performance attributes. At these projected price points, the number of systems with positive return on investment increases substantially and large-scale deployment is possible. • Growth in renewable generation, interest in demand response, and desire for utility non-wires alternatives is positioning energy storage to be a significant component in meeting the needs of the electric system. • The number of vendors developing and selling energy storage solutions continues to increase. Many firms are watching the New York market evolve and ready to be engaged more meaningfully.

[6] Navigant Research, *Energy Storage for the Grid and Ancillary Services*, *2Q 2016* (providing 2014 and 2024 market data): http://www.navigantresearch.com/newsroom/energy-storage-for-the-grid-is-expected-to-reach-15-6-billion-in-annual-revenue-by-2024

Citigroup, *Investment Themes in 2015*, January 2015 (providing energy storage market predictions for 2030): https://ir.citi.com/20AykGw9ptuHn0MbsxZVgmFyyppuQUUt3HVhTrcjz4ibR%2Bx79LajBxIyoHIoSDJ3S%2BWRSMg8WOc%3D and http://www.energy-storage.news/news/citigroup-predicts-240gw-energy-storage-market-by-2030

Data from GTM Research, Navigant Consulting, Citibank

[7] Battery price percentage decline prices:

Battery Power Magazine, October 2013, http://www.batterypoweronline.com/main/articles/the-lithium-ion-inflection-point/

PV Magazine, November 2015, http://www.pv-magazine.com/news/details/beitrag/li-ion-battery-costs-to-fall-50-in-next-5-years--driven-by-renewables_100022051/#axzz4G5vZqQof

Bloomberg New Energy Finance Summit historical price chart: http://c1cleantechnicacom.wpengine.netdna-cdn.com/files/2015/09/battery-learning-rate.png

Pike Research and Deutsche Bank price trends: https://grist.files.wordpress.com/2011/09/li-ion-projected-costs.png

Lithium ion density trends: http://static.cdn-seekingalpha.com/uploads/2012/5/14/saupload_Battery_20Energy_20Density.jpg and http://www.nissan-global.com/JP/TECHNOLOGY/FILES/2010/07/f4c4d5d2e20391.jpg

	• Customers are increasingly aware of energy storage but generally remain unclear as to its maturity and value proposition.
Customer Value	• Many multifamily, commercial, and industrial operations are striving to manage their energy demand, uncertain about revenue potential in utility/NYISO demand response programs, and seeking a straightforward semi-automated mechanism to achieve this value. The proposed strategies will identify and help to deploy energy storage in best fit customers to meet these customer needs. • Under REV, distribution utilities will increasingly pursue less expensive, non-wires alternatives including energy storage integrated directly at substations and aggregated from customer-sited systems to provide load relief. The proposed pilots will evaluate the effectiveness of dispatching customer-sited energy storage to also meet distribution utility system needs. • NYSERDA's investments in specific projects through pilots will decrease the customer's payback period from 7 or more years to a projected 5 or fewer years and increase persistence by decreasing the risk of projects being abandoned or systems being under-utilized. This will help to build a library of learnings and successful case studies to further stimulate customer confidence and growth. • Storage can also provide modest resiliency benefits for customers, especially when integrated with on-site generation. • In addition, as intermittent renewables generate the majority of New York's electricity, energy storage will firm these resources so that renewable energy is dispatchable when needed reducing the need for fossil fuel peaker plants, reducing greenhouse gas emissions and health pollutants, and decreasing the cost of meeting peak electric demand.

11.1.3 Stakeholder/Market Engagement

Stakeholder/Market Engagement	Engagement to date: • Building owners, technology vendors and installers, architects and engineers, permitting agencies, and utilities have been engaged in identifying needs and strategy development; strong engagement will continue with these organizations during program development and rollout. • Relationships have been forged and strengthened with the Fire Department of New York City, NYC Department of Buildings, Con Edison, NY-BEST, and the Distributed Generation Hub at City University of New York (CUNY). • Organizations outside of New York are being leveraged for battery safety modeling (Sandia National Lab), building and life safety codes development (Pacific Northwest National Lab), and distributed energy resource (DER) integration and interoperability (Electric Power Research Institute). These relationships will be expanded to achieve the most with CEF funds. Further engagement: • Meaningful engagement with other distribution and municipal utilities, the Department of Public Service (DPS), and the NYISO will be prioritized. • Market participants will be periodically solicited to assess program effectiveness in meeting needs, identify new program opportunities, and refine program strategies based on success in removing barriers. • On-site visits will be conducted to maintain an understanding of project participants' experiences, needs, success, and challenges • Webinars will be conducted for potential customers and energy storage vendors to share results from these activities and best practices

	• NYSERDA will also utilize the Clean Energy Advisory Council (CEAC) as a way to engage with stakeholders, as appropriate.[8]

11.1.4 Theory of Change

Market Barriers Addressed	• Permitting is exacerbated by safety uncertainty which causes significant delays or prevents projects from being considered. • Customer acquisition cost is too high. • Lack of unbiased information on vendor experience or system performance prevents customers from considering energy storage and hinders the distribution utilities and/or NYISO from relying on aggregated storage to address system needs. • Return on investment is poor in many cases when an energy storage system addresses only a single need and/or accesses only a subset of possible value streams the storage system can provide.
Testable Hypotheses	• If safety uncertainty is reduced, then permitting agencies will be more comfortable approving systems resulting in a faster path to deployment. • If model operating procedures are developed, there will be greater clarity to the vendor community resulting in a faster path to deployment. • If soft costs are reduced by 25% or more from a 2015-16 baseline of approximately $220/kWh while battery costs continue to decline through global manufacturing scale-up, then installed cost for a distributed energy storage system in New York State will become much more attractive for greater numbers of customers to manage their peak electric demand and use these systems to meet electric system needs.[9] • If customers, architects, engineers, and distribution utilities have confidence in vendors and system performance, then more systems will be considered for implementation and market growth will accelerate. • If distributed energy storage systems can predictably earn revenue by addressing electric system needs in addition to customer demand management, then many more systems will be financially viable with paybacks of three to six years[10] and energy storage will become integrated into planning decisions without the need for NYSERDA incentives.
Activities	Each of these activities contributes toward reducing soft costs by 25% per kWh in three years and 33% or more in five years, and enabling half of all distributed energy storage installations to provide value to two or more parties within five years. **1. <u>Safely deploy energy storage technologies</u> by conducting battery testing to address safety uncertainty, training first responders, and engaging with authorities having jurisdiction (permitting agencies) to develop model permitting guides:** • **Conduct burn tests** – while electrochemical systems (batteries and ultracapacitors) are well suited for distributed storage because of their fast response, precise load management, and locational flexibility, deployment in New York State has been hindered because of safety uncertainty. An independent lab will be contracted to develop and conduct tests that address questions being raised by permitting agencies and create best practices for first responders. These tests will include evaluating the

[8] The Clean Energy Advisory Council was established by the Public Service Commission through an Order in the Clean Energy Fund Proceeding (Case 14-M-0094. et al, Proceeding on Motion of the Commission to Consider a Clean Energy Fund, Order Authorizing the Clean Energy Fund Framework, filed January 21, 2016).

[9] Refer to the Market Readiness Section for an example of battery installed cost estimates.

[10] This is almost twice as fast a payback as many systems today.

rate of heat rise and ignition, propagation between cells, gases and liquids released during a fire, and efficacy of various extinguishing agents. Initially, lead acid, lithium-ion, and flow batteries will be tested. Scope will then expand to emerging storage technologies such as zinc-based and alkaline batteries, ultracapacitors, or flywheels. Storage technologies tested will be based upon those submitted for approval with Authorities Having Jurisdiction (permitting agencies such as fire and building departments), and will initially be based on those under review by the NYC Fire Department and NYC Department of Buildings.

- **Develop training materials** in collaboration with National Fire Protection Association to inform safe installation of energy storage systems, and identify containment, extinguishing, and ventilation techniques in the event of a building fire.
- **Hold training sessions for New York AHJ** (permitting agencies) and vendors. These training sessions will be integrated with existing training programs, such as PV training, to the greatest extent possible.
- **Create model operating procedures and developer guides** in conjunction with AHJs that aggregate best practices for safe installation of systems, extinguishment and containment, and summarizing existing codes and standards in understandable guides, and educate vendors about these requirements. Assist AHJs in efficiently reviewing applications.
- **Develop model permitting guides** for energy storage technologies in conjunction with AHJs, based on AHJ priorities and independent results obtained through these safety tests and requirements in use elsewhere. This will include model permitting guides for energy storage systems used independently in load management applications and systems integrated with other distributed energy resource such as PV. Guide development of building and life safety code evolution to take into account validated model approaches.
- **Stay engaged on interconnection requirements** – while not yet a stall point, NYSERDA staff will remain engaged on interconnection requirements to help proactively address issues that could arise as the number of storage systems seeking interconnection increases.

2. **<u>Reduce customer acquisition cost</u> by identifying characteristics of best fit customers, data mining, and supporting feasibility studies and pilots to accurately predict good fit customers:**

- **Identify characteristics of best fit customers** – vendor experience has shown that NYC medium and large multifamily buildings with common area load that is in the 100's of kW have been good initial fit customers for using energy storage to reduce demand charges and peak load. Working with this customer class, other early adopters, and the distribution utilities, key characteristics that define best fit customers will be identified and validated. Characteristics will include load predictability, load factor, peak duration, available space, sensitivity to energy costs, curtailment tolerance, and building's alignment within constrained distribution systems.
- **Identify and contact potential customers** – in conjunction with the distribution utilities, interval-metered customers meeting these characteristics will be contacted about DER and load management opportunities including energy storage. Segmentation will continue to expand as best fit customer characteristics are quantified, beginning with common area space in multi-family residential buildings, coops, and condos and commercial buildings including hotels. Opportunities where a distribution utility can earn revenue conducting these data analytics will also be evaluated.
- **Conduct feasibility studies and pilots to validate best fit customer characteristics** and determine if these characteristics accurately predict customer fit for energy

	storage. Data will be captured to create modeling tools made publicly available that identify best fit demand metered customers within different building classifications. These tools may also include modeling to compare customer electric bills among various tariffs, similar to those developed for Combined Heat and Power, to help customers understand tariff impacts on value proposition (e.g., switching to a standby tariff). • **Conduct feasibility studies and pilots to examine under-utilized exterior sites** such as closed landfills or brownfields for solving distribution or transmission constrains by locating energy storage or storage co-located with DER. Often, these sites are located in economically-distressed areas and are otherwise unusable land. **3. <u>Increase confidence</u> by compiling and inputting aggregated data on deployed systems into a publicly searchable platform, evaluating value propositions and customer bill savings, and conducting educational outreach to customers and vendors:** • **Collect and compile data on deployed systems** including performance and revenue/savings data. Non-proprietary information will be aggregated in a publicly searchable platform that allows potential customers to examine operating systems. This will include use cases, building type, case studies, technology, ownership, and business models. • **Conduct bill analytics** for deployed customer-sited systems to evaluate bill savings and value proposition both pre and post energy storage deployment. In particular, this will help to create more accurate and trusted savings models and could lend itself to a future utility revenue service. • **Develop a catalogue of use cases** for deployed systems to reduce customer uncertainty, minimize the need for customized engineering and design, and accelerate the learning curve when a customer is considering storage. • **Conduct educational outreach to** building owners and customers, including events to connect stakeholders, and gathering people to learn, ask questions, and build their knowledge, thereby instilling confidence. • **Engage suppliers** to increase their knowledge of local markets and AHJ requirements, and increase exposure to local partners and resources to engage such as by maintaining a resource directory for stakeholders (e.g., knowledgeable engineering firms). Coach and guide companies through New York State use cases, permitting processes, and the intricacies of rate structure in New York. **4. <u>Invest in "value stacking pilots"</u> that assess the effectiveness of using a distributed storage system to meet distribution and/or wholesale system needs in addition to those of the host site:** • **Evaluate the performance and quantify the value of using customer-sited energy storage to meet electric system needs.** Independent validation will assess the technical and cost effectiveness of using customer-sited energy storage to address customer needs such as energy management as well as distribution system and/or NYISO needs. These system needs could include peak reduction, renewable firming, and ancillary services. Various ownership and business models will be evaluated to determine those that can most effectively optimize a system, and value will be quantified in the context of the next best alternative. Validation will also evaluate the storage system's performance reliability in meeting system needs when competing demands must be optimized. Interoperability needs, aggregation, direct utility control and dispatching the storage resource through a control signal, as well as third party ownership models including energy service companies, will be tested.

- **Information sharing and replication** will occur through a catalog of pilots and use cases that provide guidance on system optimization and inform future tariffs and regulations.
    - Aggregate pilot results and develop case studies to provide customers, vendors, utilities, and policymakers with unambiguous results of a system's ability to effectively serve multiple needs, performance, and value.
    - Produce and promote fact sheets for vendors that clarify energy storage products in the distribution utility and wholesale markets that can currently be monetized, as well as the most compelling and valuable needs identified through these pilots.
    - Provide best practices on alternative business models that facilitate value stacking, including more clearly examining the aggregator business model.
    - Engage with utility partners to model and test new tariff designs, assess effectiveness in driving consumer behavior, and broaden the scope of REV pilots.
- **Pilot projects** will be competitively selected based on distribution or wholesale system locational need, magnitude of statewide replicability, and potential for acceptable returns on investment without incentives if the proposed use cases prove valid. Projects submitted that do not align with current regulations and tariffs will be considered. Projects will adhere to the following criteria:
    - The distribution utility and/or NYISO must support the pilot.
    - The pilot must present a compelling market opportunity with potential to reduce peak electric demand, integrate renewables, and/or reduce the need for fossil fuel peaker plants.
    - The storage system must provide customer value through reduced energy cost and demand charges in addition to one or more of the following benefits:
      (1) utility services including, but not limited to, congestion relief, transmission and distribution deferral, power quality, or renewable firming;
      (2) NYISO services including, but not limited to, capacity reduction, or ancillary services; and
      (3) testing of new products or services such as Volt/VAR optimization.
    - Independent measurement and verification will be conducted for at least 24 months. Projected savings will be compared to actual savings to enable more sophisticated cost/benefit models in the future.
    - NYSERDA cost-share will not exceed 50% of total project cost.

5. <u>Invest in tools that support market replication</u> through fact sheets, best practices, and use cases with clear economics:

- **Disseminate information to market participants** in conjunction with other NYSERDA initiatives, in an integrated manner to reduce customer confusion and burnout, and to ensure that communication methods are most effective and targeted to specific audiences. Information will be targeted to building owners and operators, design and engineering professionals, energy storage vendors/installers, utilities, permitting agencies, and professional networks. Best practices and lessons learned through these soft cost reduction strategies and through deploying value stacking pilots will be disseminated to the vendor community.
- **Serve as an independent information clearinghouse** with a useful library of knowledge including searchable online tools that leverage existing third party platforms, workshops and webinars, and storage breakfasts where potential customers can engage with operators who have deployed systems to learn about:
    - state of commercial deployments, technology readiness, use cases and business models
    - actual performance data, revenue and savings from feasibility studies, pilots and deployed systems

	• **Develop case studies and fact sheets** that help vendors and customers understand and maximize utility tariffs and wholesale market products, best practices, and economics available today and as the regulatory structure evolves. • **Engage with other government partners** including at the local and federal levels to create policy environments conducive to energy storage deployment. • **Work towards replicable financing** in the future through bankability studies and engaging with, and educating, financiers about New York State market structures.
Key Milestones	Milestone 1 (2016) • Issue solicitation to competitively select technical consultants and organizations to assist with soft cost reduction strategies, quality assurance, and feasibility studies under value stacking pilots. Milestone 2 (2017) • Lead acid, lithium-ion, and flow batteries are independently tested with results aggregated into first responder training materials for authorities having jurisdiction. Milestone 3 (2017) • Technical consultants or organizations to assist with soft cost reduction strategies, quality assurance, and feasibility studies are selected. Milestone 4 (2017) • Launch a competitive program funding value stacking pilots. Milestone 5 (2017) • Expand scope of battery testing lab for additional chemistries to be tested. Milestone 6 (2017) • Model permitting guides are developed. Milestone 7 (2017) • Public platform is launched including use cases, system performance results, and fact sheets. Milestone 8 (2017) • Customers with deployed energy storage systems begin engaging for post installation quality assurance to validate savings. Milestone 9 (2017) • Safety testing is completed on additional emerging commercial chemistries. Milestone 10 (2017) • Market segmentation for NYSERDA customer acquisition activities supported under this investment plan expands to non interval-metered customers. Milestone 11 (2017) • Increasing numbers of customers seek information on storage solutions to mitigate their peak demand and electricity requirements, as determined through vendor interviews and the number of permits submitted to authorities having jurisdiction, surveyed at least annually. Milestone 12 (2017) • Increasing numbers of energy storage vendors are engaged in New York State, as surveyed at least annually.

	Milestone 13 (2018) • Safety testing is completed on additional emerging commercial chemistries. Milestone 14 (2018) • Model permitting guides are updated. Milestone 15 (2018) • Convincing use cases and best fit customer characteristics and acquisition tools are publicized. Milestone 16 (2018) • Pilots convert prospective installations into installed energy storage projects that are used to provide customer benefit and address electric system needs. Milestone 17 (2019) • Independent validation assesses the ability of aggregated customer-sited storage systems to provide locational relief to the distribution utility or NYISO when called upon. Milestone 18 (2019) • During the pilot period, NYSERDA direct support for specific projects is reduced annually as installed cost decreases, revenue opportunities are better quantified, and results of pilots increase performance confidence.
Goals Prior to Exit	• Soft costs for distributed energy storage systems have been meaningfully reduced, with a goal of 25% per kWh in three years (end of 2019) and 33% in five years (end of 2021) compared to a 2015-16 internal baseline[11], to be further refined through a soft cost study planned for completion in early 2017. • Permitting, building and life safety codes, and interconnection requirements are clear and unambiguous within concentrated population areas of the State with significant electric load • Industry standards such as Underwriters Lab adequately address safety and performance concerns to the satisfaction of authorities having jurisdiction, distribution utilities, and customers • Identifying and attracting best fit customers is readily accomplished by vendors as measured through vendor surveys and customer surveys • Ability to use distributed energy storage, including aggregated systems behind customer meters, to meet system needs is understood and readily recognized in utility planning and procurement • Termination of individual interventions will be based upon achieving three to six year paybacks within specific verticals, speed in deploying systems, and ability to customer-sited systems to address system needs. NYSERDA will survey the market periodically to measure progress in these areas and will reduce and adjust support as needed to maximize impact.

11.1.5 Relationship to Utility/REV

Utility Role/Coordination Points	• Utilities are key partners in these activities, especially in customer data mining, identifying constrained areas of the distribution feeders, and evaluating load

[11] This internal distributed storage soft cost baseline utilized a GTM Research study and then augmented that data with pricing from New York State deployments under the Demand Management Program and vendor inquiries.

	relief using energy storage. Additionally, the REV Track 2 Order requires utilities to propose system efficiency targets such as peak reduction and load factor improvement, both of which can be accomplished through distributed energy storage. NYSERDA will work directly with distribution utility staff who work on smart grid, REV demos, or non-wires alternatives. All value stacking pilots will be implemented in direct coordination with the distribution utility, assess the effectiveness in using these distributed assets to meet system needs, and evaluate or inform test tariffs. Additionally, utilities will begin identifying roles for storage in the Distribution System Investment Plans submitted to DPS in fall 2016, and these plans will be leveraged in identifying strategic areas of the distribution system for program implementation. • Initial discussions and information sharing with New York Power Authority will be expanded to leverage their ability to finance projects including at municipal and educational customers. • The NYISO is also a key partner to identify wholesale system needs and evaluate the effectiveness of distributed storage solutions in meeting these requirements. • NYSERDA will also take advantage of the CEAC Clean Energy Implementation and Coordination Working Group to coordinate planning and implementation with the New York State utilities.
Utility Interventions in Target Market	• Con Edison's Demand Management Program offered in conjunction with NYSERDA has been fully subscribed. Con Edison's Brooklyn-Queens Demand Management load relief program is seeking load relief strategies in these feeder circuits. Con Edison's Clean Virtual Power Plant REV demonstration is evaluating how aggregated fleets of solar plus storage assets in hundreds of homes can collectively provide network benefits to the grid, resiliency services to customers, monetization value to the utility, and results that help inform rate and market design. • It is possible that additional feeder circuits will be targeted by Con Edison and other distribution utilities, and these opportunities will be coordinated. • Long Island Power Authority (LIPA) and New York State Electric and Gas (NYSEG) have solicited proposals for load relief, generally with larger quantities of bulk energy storage. • Customers will be directed by NYSERDA to these respective utility initiatives.

11.1.6 Budgets & Expenditures

An annual commitment budget for all activities included in this chapter is shown in Table 1. The annual expenditure projection is included in Table 2. Budgets and expenditures do not include Administration, Evaluation, or Cost Recovery Fee; these elements are addressed in the Budget Accounting and Benefits chapter filing. The budget as presented in the Budget Accounting and Benefits Chapter will serve as the basis for any subsequent reallocation request. The additional level of detail presented within the table below is intended for informational purposes only.

Table 1**: Annual Market Development Budget Allocation – Commitment Basis**

Commitment Budget	2016	2017	2018	2019	Total
Tools, Training, and Replication	$900,000	$1,150,000	$950,000	$450,000	$3,450,000
Implementation Support	$750,000	$1,650,000	$2,025,000	$1,075,000	$5,500,000
Direct Incentives and Services	$1,600,000	$5,000,000	$5,000,000	$3,900,000	$15,500,000
Total	$3,250,000	$7,800,000	$7,975,000	$5,425,000	$24,450,000

Table 2: Annual Expenditures Projection

Expenditures	2016	2017	2018	2019	2020	2021	2022	Total
Total	5%	20%	28%	31%	9%	3%	3%	100%

11.1.7 Progress and Performance Metrics

Table 3 provides program Activity/Output indicators representing measurable, quantifiable direct results of activities undertaken in the initiative. Outputs are a key way of regularly tracking progress, especially in the early stages of an initiative, before broader market changes are measurable. Outcome indicators can encompass near-term through longer-term changes in market conditions expected to result from the activities/outputs of an intervention. Outcome indicators will have a baseline value and progress will be measured periodically through Market Evaluation.

Table 3. Initiative Specific Metrics

Indicators [12]		**Baseline (Before/Current)**	**2019 (Cumulative)**
Activities/ Outputs	Total number of projects by project size and technology type seeking approval by authorities having jurisdiction such as local fire and building departments (AHJs)	approx. 15 lead acid and li-ion batteries and thermal storage	160 systems including lead acid, li-ion, flow, and other chemistries and thermal storage
	Number of projects and type of energy storage systems approved by AHJs	approx. 6 lead acid battery systems and thermal storage	130 systems including lead acid, li-ion, flow, and other chemistries and thermal storage
	Number of pilot sites engaged	0	50
Outcomes	Cycle time of projects from customer proposal to commissioning	12-36 months	6-18 months
	Soft costs % decline per kWh of battery storage based on CEF strategies	Not applicable	25% decrease from initial 2015-16 baseline of approx. $220 per kWh
	Direct peak demand reduction through energy storage resulting from pilots (in MW and MWh reduced)	Not applicable	10 MW and 6,000 MWh of annual peak reduction
	Percentage of distributed energy storage installations deployed throughout the New York market that provide value to two or more parties (customer, distribution utility, load serving entity, NYISO)	0	50% by 2021

Benefits shown in Table 4 and Table 5 are direct, near term benefits associated with this initiative's projects. These benefits will be quantified and reported on a quarterly basis and will be validated through later evaluation.

[12] A 0 (zero) denotes that the actual value is currently believed to be zero for baseline/market metrics.

Table 4. Direct Impacts [13]

Primary Metrics		2016	2017	2018	2019	TOTAL
Energy Efficiency	MWh Annual	550	3,600	5,200	4,500	13,850
	MWh Lifetime	5,500	36,000	52,000	45,000	138,500
	MMBTu Annual	-	-	-	-	-
	MMBTU Lifetime	-	-	-	-	-
	MW	1	7	9	8	25
Renewable Energy	MWh Annual	-	-	-	-	-
	MWh Lifetime	-	-	-	-	-
	MW	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual		289	1,890	2,740	2,370	7,286
CO2e Emission Reduction (metric tons) Lifetime		2,890	18,900	27,400	23,700	72,860
Customer Bill Savings Annual ($ million)		$0.07	$0.48	$0.69	$0.60	$1.842
Customer Bill Savings Lifetime ($ million)		$0.73	$4.79	$6.92	$5.99	$18.42
Private Investment ($ million)		$3.40	$9.70	$9.70	$7.30	$30.10

Table 5. Annual Projected Initiative Participation

Participants	2016	2017	2018	2019	Total
Number of customers engaged (sites for deployments)	15	30	45	30	120
Number of vendors engaged	8	10	15	12	45
Total	23	40	60	42	165

Benefits shown in Table 6 represent the estimated indirect market effects expected to accrue over the longer term as a result of this investment and follow on market activity. The indirect benefits that accrue from this investment will be quantified and reported based on periodic Market Evaluation studies to validate these forecasted values. Market Evaluation may occur within one year (-/+) of the years noted in the table and projected future indirect benefits and/or budgets necessary to achieve them may be updated based on the results of market evaluation. Indirect impact across NYSERDA initiatives may not be additive due to multiple initiatives operating within market sectors. The values presented below are not discounted, however NYSERDA has applied a discount of 50% to the overall portfolio values in the Budget Accounting and Benefits chapter.

[13] Impacts are expressed on a commitment-year basis, and are incremental additions in each year. Assumes a 10-year measure life. Benefits are rounded to three significant figures. Totals may not sum due to rounding. Customer Bill Savings are calculated as direct energy bill savings realized by customers participating in NYSERDA's programs.

Table 6. Estimated Indirect Market Impact

Indirect Impact		2021	2025	2030
Energy Efficiency	MWh Cumulative Annual	35,000	90,000	190,000
	MMBtu Cumulative Annual	-	-	-
Renewable Energy	MWh Cumulative Annual	-	-	-
	MW	60	160	340
CO2e Emission Reduction (metric tons) Cumulative Annual		18,400	47,300	100,000

11.1.8 Fuel Neutrality

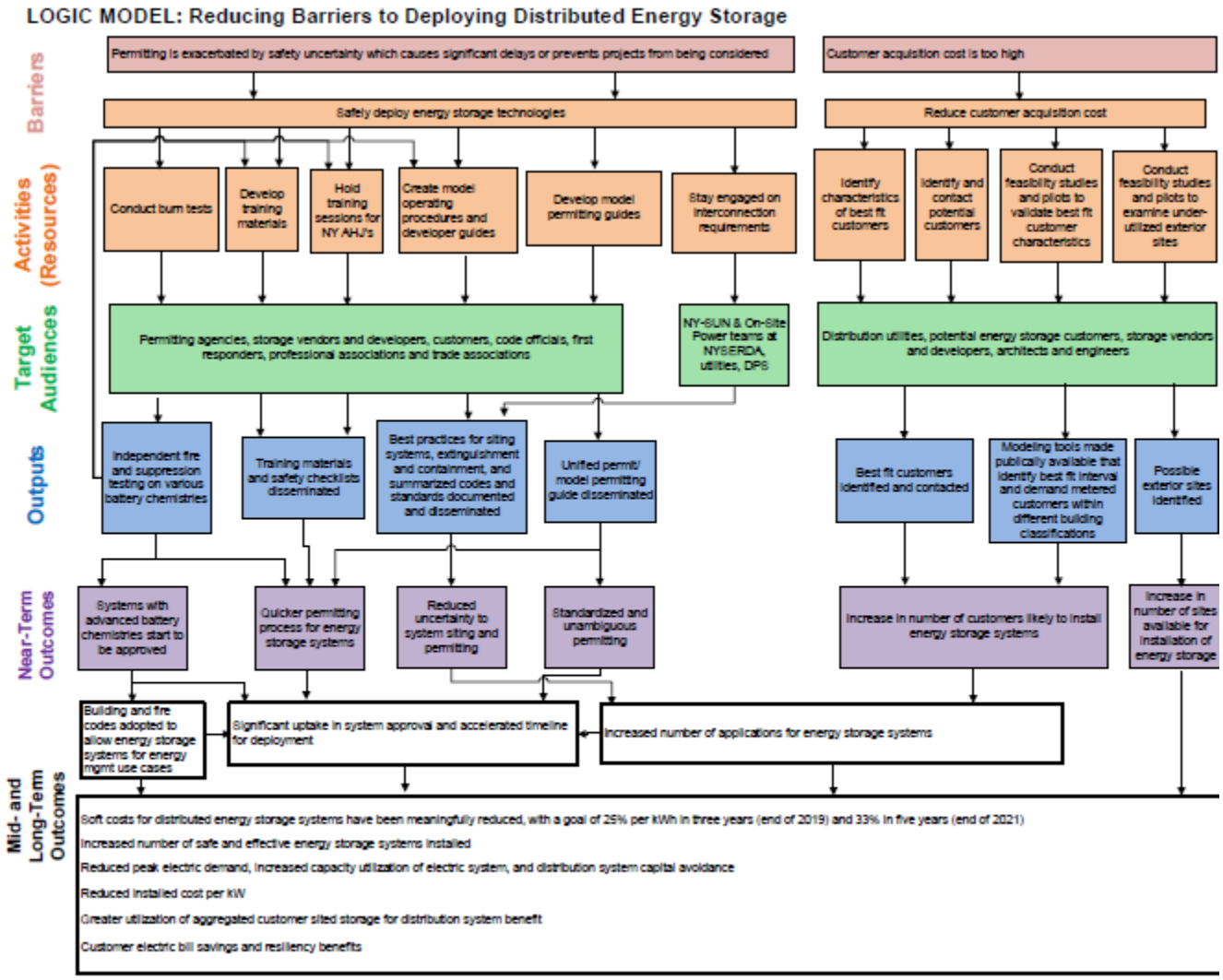
Fuel Neutrality	This initiative is not being delivered on a fuel neutral basis.

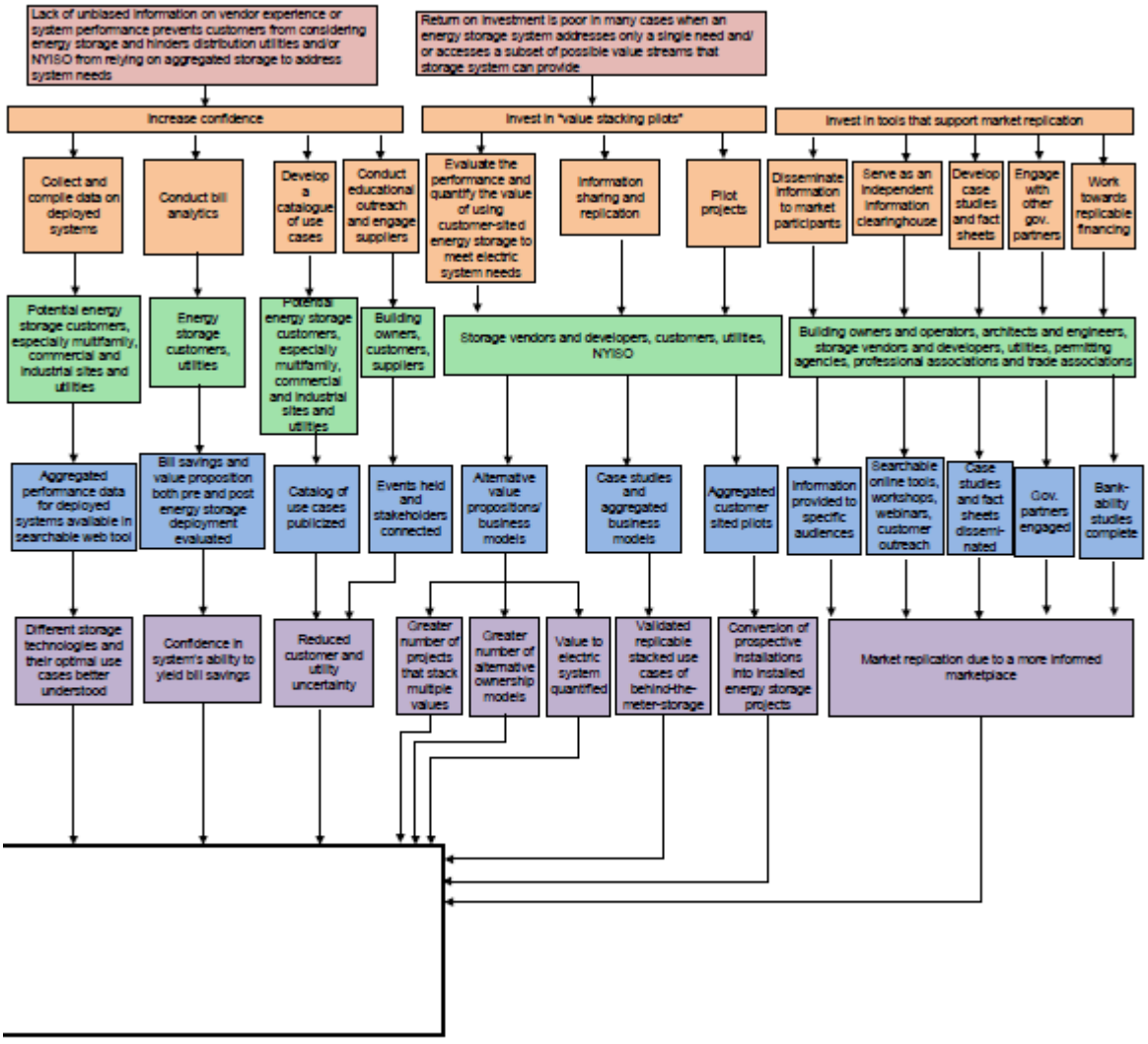
11.1.9 Performance Monitoring and Evaluation Plans

Performance Monitoring & Evaluation Plan	NYSERDA's approach to monitoring and assessing the effectiveness of the initiative and overall market development is described below, and builds upon the evaluation performance embedded in the Activities section above.
	
	<u>Test-Measure-Adjust Strategy</u>
	• NYSERDA will monitor standard activity/output metrics including completion of training materials and guides, pilots underway, etc.
	
	<u>Quality Assurance (M&V)</u>
	• Quality assurance will be integrated into the specific activities described above with the following approaches:
	  o Collect and compile data on deployed systems
	  o Conduct bill analytics for savings
	  o Conduct independent validation to assess technical and cost effectiveness of using distributed storage systems to meet customer and distribution system and/or NYISO needs.
	• Review of the programmatic measurement and verification will occur as needed.
	
	<u>Market Evaluation</u>
	• Market Evaluation draws on the theory of change of the related logic model and will include baseline and longitudinal measurement of key indicators of success.
	• Baseline measurements of key performance indicators will occur within one year of initiative approval and will further quantify indicators including cycle time of projects and balance of system costs for distributed energy storage systems. In these areas, NYSERDA will first utilize existing information and will fill gaps in information as needed and feasible for appropriate baselining.
	• Regular (e.g., annual or biennial) updates to key performance indicators and measurement of market change, including the number of projects and type of energy storage systems approved by AHJs, will occur once the initiative is underway.

	• Sources of data will include public and commercially available data, balance of system surveys conducted by the National Renewable Energy Laboratory (NREL), and primary data collection through surveys of key market actors.

Appendix A – Logic Model




Lack of unbiased information on vendor experience or system performance prevents customers from considering energy storage and hinders distribution utilities and/or NYISO from relying on aggregated storage to address system needs
Return on investment is poor in many cases when an energy storage system addresses only a single need and/or accesses a subset of possible value streams that storage system can provide
Increase confidence
Invest in "value stacking pilots"
Invest in tools that support market replication
Collect and compile data on deployed systems
Conduct bill analytics
Develop a catalogue of use cases
Conduct educational outreach and engage suppliers
Evaluate the performance and quantify the value of using customer-sited energy storage to meet electric system needs
Information sharing and replication
Pilot projects
Disseminate information to market participants
Serve as an independent information clearinghouse
Develop case studies and fact sheets
Engage with other gov. partners
Work towards replicable financing
Potential energy storage customers, especially multifamily, commercial and industrial sites and utilities
Energy storage customers, utilities
Potential energy storage customers, especially multifamily, commercial and industrial sites and utilities
Building owners, customers, suppliers
Storage vendors and developers, customers, utilities, NYISO
Building owners and operators, architects and engineers, storage vendors and developers, utilities, permitting agencies, professional associations and trade associations
Aggregated performance data for deployed systems available in searchable web tool
Bill savings and value proposition both pre and post energy storage deployment evaluated
Catalog of use cases publicized
Events held and stakeholders connected
Alternative value propositions/ business models
Case studies and aggregated business models
Aggregated customer sited pilots
Information provided to specific audiences
Searchable online tools, workshops, webinars, customer outreach
Case studies and fact sheets disseminated
Gov. partners engaged
Bankability studies complete
Different storage technologies and their optimal use cases better understood
Confidence in system's ability to yield bill savings
Reduced customer and utility uncertainty
Greater number of projects that stack multiple values
Greater number of alternative ownership models
Value to electric system quantified
Validated replicable stacked use cases of behind-the-meter-storage
Conversion of prospective installations into installed energy storage projects
Market replication due to a more informed marketplace