

Matter Number 16-00681, In the Matter of the Clean Energy Fund
Investment Plan

Clean Energy Fund Investment Plan: Energy Storage Chapter

Portfolio: Market Development

Submitted by:

The New York State Energy Research and Development Authority

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Clean Energy Fund Investment Plan: Energy Storage Chapter		
Revision Date	Description of Changes	Revision on Page(s)
August 1, 2016	Original Issue	Original Issue
June 23, 2017	Tables 1, 2, 4, and 5 have been updated to reflect a shift in timing of budget and benefits.	Multiple
November 1, 2017	Updated the baseline values in Table 3 to reflect latest data available.	15
September 6, 2018	Addition of Solar Plus Energy Storage Initiative	Multiple

11 Energy Storage

Energy storage will play a critical role in achieving the State's peak reduction, renewable generation and greenhouse gas reduction objectives. Storage will shift renewable energy to times of day that better match the needs of electric customer, grid values or avoid carbon emissions. Storage can reduce the intermittency of solar and wind energy, helping these resources to be more flexible in meeting electrical demand. In many applications, storage could avoid the need for new electric system infrastructure, increase system efficiency and resiliency, and reduce the need for infrequently used peaking fossil fuel plants. Storage can also integrate with demand response and energy efficiency measures within buildings to achieve greater energy savings without sacrificing occupant comfort and often provide a degree of back-up power. Finally, energy storage can also redefine the transportation system as seen with electric vehicles.

New York is at the beginning stages of deploying storage to meet an aggressive storage target of deploying 1,500 MW of advanced energy storage by 2025. In June 2018, Department of Public Service (DPS) and NYSERDA staff released the New York State Energy Storage Roadmap which includes a series of recommended actions intended to achieve the Governor's 1,500 MW target. The Roadmap's recommended policy, regulatory and programmatic actions have been developed to in conjunction with numerous stakeholders to enable, support and accelerate New York's transition to its desired end-state vision for energy storage, which includes full use of distributed energy resources (DERs) including storage to meet system needs; dispatchability and dynamic price signals; flexibility in enabling intermittent renewable resources like solar and wind to be used when needed most; and a thriving energy storage sector.

NYSERDA's energy storage market development strategy targets 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 first initiative described in the Energy Storage chapter, entitled Reducing Barriers to Deploying Distributed Energy Storage, addresses barriers in the customer-sited (behind-the-meter) sector and the ability to use these systems to meet transmission and distribution system needs. In 2016, NYSERDA embarked on a four-year effort under this initiative to reduce soft costs of installing energy storage by 33% by 2021, compared to a 2016 baseline of approximately \$200/kWh. Based on batteries installed in customer-sited applications in 2017 these soft costs now represent approximately 17% of total installed cost, or \$140/kWh. This work to reduce barriers focuses on permitting, customer acquisition, technical consulting, and increasing customer and financier confidence through five activities: 1) safety validation and permitting for electrochemical systems, 2) best fit customer acquisition, 3) quality assurance (performance confidence), 4) value stacking pilots, and 5) tools to support market replication. The budget, benefit, and participant values for this initiative were updated in June 2017 to shift the timing of work completed under this initiative from 2016-2019 to 2017-2020 to reflect a later than expected program start date.

This second initiative of the Energy Storage chapter, Solar Plus Energy Storage, is a first step in NYSERDA's solar plus energy storage market development strategy as recommended in the New York State Energy Storage Roadmap. This initiative works in conjunction with the first initiative to

address soft cost barriers, as well as enabling industry and utilities to address interconnection, metering and compensation mechanisms associated with paired combination systems sooner than otherwise would have occurred. Both initiatives are part of NYSERDA's coordinated intervention strategies to develop and deploy energy storage products and remove market barriers to their adoption. This energy storage market support is closely related to new Value of Distributed Energy Resource tariffs in that it improves the value of distributed renewable energy by shifting the energy output to more valuable times of day.

In addition to the two initiatives described in this chapter, NYSERDA also has an initiative entitled Energy Storage Technology and Product Development in the Renewables Optimization Chapter, which supports product development and initial field testing to reduce total system cost and increase performance. Insights gained from the activities included in this chapter will also be incorporated into the solicitations used to support that product development work.

11.1 Reducing Barriers to Deploying Distributed Energy Storage

11.1.1 Overview

<p>Present Situation</p>	<ul style="list-style-type: none"> • 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 fuel peaker plants.¹ 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.² 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 storage³ 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. <ul style="list-style-type: none"> ○ <u>Soft costs</u>: 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,⁴ these soft costs are largely driven by local conditions. ○ <u>Uncertainty</u>: since the number of distributed storage installations is still 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. ○ <u>Return on investment limitations</u>: while an energy storage system’s flexibility (fast response, precise load management, repeatable load curtailment, generation shifting) allow it to perform multiple functions due to unproven
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¹ 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.

² 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.

³ 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.

	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	<ul style="list-style-type: none"> • This initiative will primarily target building owners and operators, permitting agencies, and vendors to address the stall points presented above and includes five elements that build upon NYSERDA’s reputation as a source of objective and credible information: <ol style="list-style-type: none"> 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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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
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	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	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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. ⁵ 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.⁶ 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.

⁵ 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%2Bx79LajBxlyoHIoSDJ3S%2BWRS Mg8WOc%3D> and <http://www.energy-storage.news/news/citigroup-predicts-240gw-energy-storage-market-by-2030>

Data from GTM Research, Navigant Consulting, Citibank

⁶ 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.wordpress.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>

	<ul style="list-style-type: none"> • Customers are increasingly aware of energy storage but generally remain unclear as to its maturity and value proposition.
Customer Value	<ul style="list-style-type: none"> • 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	<p>Engagement to date:</p> <ul style="list-style-type: none"> • 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. <p>Further engagement:</p> <ul style="list-style-type: none"> • 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.
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	<ul style="list-style-type: none"> • NYSERDA will also utilize the Clean Energy Advisory Council (CEAC) to engage with stakeholders, as appropriate.⁷
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11.1.4 Theory of Change

Market Barriers Addressed	<ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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.⁸ • 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 years⁹ and energy storage will become integrated into planning decisions without the need for NYSERDA incentives.
Activities	<p>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.</p> <p>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:</p> <ul style="list-style-type: none"> • 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 rate of heat rise and ignition, propagation between cells, gases and liquids released during a fire, and efficacy

⁷ 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).

⁸ Refer to the Market Readiness Section for an example of battery installed cost estimates.

⁹ This is almost twice as fast a payback as many systems today.

	<p>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.</p> <ul style="list-style-type: none"> • 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 consider 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. <p>2. <u>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:</u></p> <ul style="list-style-type: none"> • 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).
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	<ul style="list-style-type: none"> • 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 in economically-distressed areas and are otherwise unusable land. <p>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:</p> <ul style="list-style-type: none"> • 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. <p>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:</p> <ul style="list-style-type: none"> • 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. <ul style="list-style-type: none"> ○ 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.
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	<ul style="list-style-type: none"> ○ 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: <ul style="list-style-type: none"> ○ 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: <ul style="list-style-type: none"> (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. <p>5. Invest in tools that support market replication through fact sheets, best practices, and use cases with clear economics:</p> <ul style="list-style-type: none"> ● 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: <ul style="list-style-type: none"> ○ 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	<p><u>Milestone 1 (2016)</u></p> <ul style="list-style-type: none"> ● 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.

	<p><u>Milestone 16 (2018)</u></p> <ul style="list-style-type: none"> • Pilots convert prospective installations into installed energy storage projects that are used to provide customer benefit and address electric system needs. <p><u>Milestone 17 (2019)</u></p> <ul style="list-style-type: none"> • Independent validation assesses the ability of aggregated customer-sited storage systems to provide locational relief to the distribution utility or NYISO when called upon. <p><u>Milestone 18 (2019)</u></p> <ul style="list-style-type: none"> • 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	<ul style="list-style-type: none"> • 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 baseline¹⁰, 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	<ul style="list-style-type: none"> • Utilities are key partners in these activities, especially in customer data mining, identifying constrained areas of the distribution feeders, and evaluating load 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.
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¹⁰ 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.

	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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	2020	Total
Tools, Training, and Replication	\$-	\$1,300,000	\$1,150,000	\$700,000	\$300,000	\$3,450,000
Implementation Support	\$-	\$1,550,000	\$2,175,000	\$1,175,000	\$600,000	\$5,500,000
Direct Incentives and Services	\$30,000	\$4,350,000	\$6,000,000	\$4,900,000	\$220,000	\$15,500,000
Total	\$30,000	\$7,200,000	\$9,325,000	\$6,775,000	\$1,120,000	\$24,450,000

Table 2: Annual Expenditures Projection

Expenditures	2016	2017	2018	2019	2020	2021	2022	Total
Total	0%	16%	31%	32%	10%	7%	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 ¹¹		Baseline (Before/Current)¹²	2020 (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	5 lead acid battery systems and 2 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	Lead acid median of 19.5 months. Thermal storage not provided.	6-18 months
	Soft costs % decline per kWh of battery storage based on CEF strategies	Lead Acid: Min. \$50/kWh; Max. \$100/kWh (Median of 20% of average soft cost of installed lead acid systems). Lithium ion and other storage types not provided.	25% decrease based on \$220/kWh internal baseline ¹³
	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)	<10% ¹⁴	50% by 2021

¹¹ A 0 (zero) denotes that the actual value is currently believed to be zero for baseline/market metrics.

¹² Revised baseline metrics reflect the recently-completed Energy Storage market baseline evaluation. This study will be available publicly on NYSERDA's website and in the DPS Document and Matter Management system in the near future.

¹³ The separate internal NYSERDA program-led 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.

¹⁴ This value is based on internal discussions with developers as part of the separate NYSERDA program-led distributed storage soft cost baseline.

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.

Table 4. Direct Impacts ¹⁵

Primary Metrics		2017	2018	2019	2020	TOTAL
Energy Efficiency	MWh Annual	2,600	4,700	4,600	1,900	13,800
	MWh Lifetime	26,000	47,000	46,000	19,000	138,000
	MMBTU Annual	-	-	-	-	-
	MMBTU Lifetime	-	-	-	-	-
	MW	5	9	8	3	25
Renewable Energy	MWh Annual	-	-	-	-	-
	MWh Lifetime	-	-	-	-	-
	MW	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual		1,370	2,470	2,420	1,000	7,260
CO2e Emission Reduction (metric tons) Lifetime		13,700	24,700	24,200	10,000	72,600
Customer Bill Savings Annual (\$ million)		\$0.35	\$0.63	\$0.61	\$0.25	\$1.836
Customer Bill Savings Lifetime (\$ million)		\$3.46	\$6.25	\$6.12	\$2.53	\$18.36
Private Investment (\$ million)		\$8.50	\$11.60	\$9.50	\$0.40	\$30.10

Table 5. Annual Projected Initiative Participation

Participants	2017	2018	2019	2020	Total
Number of customers engaged (potential sites for deployments)	30	45	30	15	120
Number of vendors engaged	15	15	10	5	45
Total	45	60	40	20	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.

¹⁵ 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.
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11.1.9 Performance Monitoring and Evaluation Plans

Performance Monitoring & Evaluation Plan	<p>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.</p> <p><u>Test-Measure-Adjust Strategy</u></p> <ul style="list-style-type: none"> NYSERDA will monitor standard activity/output metrics including completion of training materials and guides, pilots underway, etc. <p><u>Quality Assurance (M&V)</u></p> <ul style="list-style-type: none"> Quality assurance will be integrated into the specific activities described above with the following approaches: <ul style="list-style-type: none"> Collect and compile data on deployed systems Conduct bill analytics for savings 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. <p><u>Market Evaluation</u></p> <ul style="list-style-type: none"> 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.
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11.2 Solar Plus Energy Storage

11.2.1 Overview

<p>Present Situation</p>	<ul style="list-style-type: none"> • Energy storage serves as a critical resource for enabling New York’s clean energy future. As renewable power sources like wind and solar provide a larger portion of New York’s electricity needs, storage will be used to smooth and time-shift renewable generation and minimize curtailment. • However, intervention is needed to encourage the industry to mobilize resources to deploy paired solar and storage projects, work in conjunction with utility partners and the NYISO to remove barriers to deployment, and generate the valuable lessons learned needed to prepare for New York having 50% of its electrical energy come from renewable sources by 2030. Solar plus storage projects are a key application of storage that leverages the capabilities of solar to deploy systems and gain lessons learned. • To further the energy storage market in New York State, the New York State Energy Storage Roadmap recommended establishing an approximately \$350 million statewide bridge incentive to accelerate adoption of both customer-sited storage and storage sited on the distribution or bulk systems, including when paired with clean generation sources. • To leverage the current NY-Sun program, staff also recommended that NYSERDA create an additional incentive for storage systems under NY-Sun to spur new solar plus storage projects while a broader incentive program is deliberated and developed. • NY-Sun is currently building a robust pipeline of solar projects. Many projects expected to be built in the next several years have the potential to add energy storage, and recent market factors have improved the value proposition for adding energy storage to a project. Shifting solar energy to other hours in the day can improve its value, and new tariffs allow storage to improve a solar project’s revenue by shifting the hours of the energy output. Combining solar and storage also reduces transactions costs by leveraging the solar project’s siting, design, permitting and financing.¹⁶ • A 30% federal tax credit and accelerated depreciation is available to storage charging from solar, but the tax credit is scheduled to begin stepping down after 2019, making the time ripe for pursuing solar plus storage projects to increase benefits to ratepayers.¹⁷ • The cost of battery storage, while declining by an average 10% annually, is expected to remain too expensive for many paired solar plus storage applications in the near term. Until costs decline further, solar developers require additional financial support to add storage to their solar projects to address the fact that adding storage currently complicates their existing business model and adds costs to projects.
<p>Intervention Strategy</p>	<ul style="list-style-type: none"> • NYSERDA will provide financial support to accelerate solar plus energy storage projects. This support, in conjunction with NYSERDA’s Reducing Barriers to Deploying Distributed Energy Storage initiative, will address barriers to the installation of solar plus energy storage and enable projects to be built. The projects will allow developers to gain experience with Value of Distributed

¹⁶ According to NREL, co-locating energy storage with solar could save 26% on soft costs, and up to 36% when combining soft and hardware savings (i.e. shared inverter) as opposed to separate solar and storage.

¹⁷ The Federal Investment Tax Credit will reduce the storage cost by 30% until 2019 before beginning its step to 10% in 2021. This initiative will allow acceleration of these paired solar plus storage projects at a savings of approximately \$12 million by leveraging the federal ITC.

	<p>Energy Resources (VDER) tariff values, financing, deal structure, retail customer agreements and energy storage interconnection as soon as possible.</p> <ul style="list-style-type: none"> • These early adopter projects will also provide lessons learned that can be shared with the marketplace to reduce costs and increase the chance of success for future projects. NYSERDA will: <ul style="list-style-type: none"> ○ Provide financial support through NY-Sun to support solar plus storage projects that would otherwise be too risky or not viable, allowing developers, customers and utilities to gain experience with energy storage implementation. Prior to launching the incentive program, NYSERDA will determine the appropriate incentive level by assessing the level of funding required for projects to break even in high value locations and stakeholder feedback. ○ Reduce project siting and permitting barriers that impede broad deployment of solar plus storage technologies. ○ Disseminate learnings to the market utilizing regulatory, industry and utility collaborative efforts (e.g. Interconnection Technology Working Group (ITWG), Interconnection Policy Working Group, (IPWG)). • For a visual representation of this strategy, please reference the flow chart entitled “Logic Model: Solar Plus Storage,” which can be found in Appendix A.
Goals	<ul style="list-style-type: none"> • Enable energy storage to shift distributed solar generation to times of greater value. • Reduce costs that prevent solar plus energy storage projects from being built. • Accelerate lessons-learned by developers and utilities from actual solar plus storage deployments.
State Energy Plan/Clean Energy Standard Link	<ul style="list-style-type: none"> • The 2015 State Energy Plan identifies energy storage as a key component of New York’s large-scale renewable strategy, noting that “pairing Large Scale Renewables with dynamic distributed energy resources such as demand response and energy storage will maximize the benefits of both kinds of resources.” • This initiative also supports achievement of the Clean Energy Standard for renewable resource electric generation (50% renewable electric generation by 2030 – “50 by 30”) by enabling the deployment of renewables necessary to meet the 50 by 30 goal. • Solar plus energy storage will also play a critical role in reducing peak electric demand, firming intermittent renewables to help reduce the need for fossil generation during peak electric periods, permitting greater customer load control, and reducing electric bills.

11.2.2 Target Market Characterization

Target Market Segment(s)	<ul style="list-style-type: none"> • NY-Sun developers active in the community solar and non-residential solar segments.
Market Participants	<p>Market participants include:</p> <ul style="list-style-type: none"> • Utilities • Solar and energy storage trade associations such as Solar Energy Industry Association (SEIA) and the New York Battery and Energy Storage Technology consortium (NY-BEST) • Energy storage developers, vendors and system integration service providers. • Solar project financiers and investors • New York Green Bank • Authorities having jurisdiction (AHJs) such as building and fire code officials • Commercial and industrial electric customers considering solar

	<ul style="list-style-type: none"> • Subscribers of community solar projects
Market Readiness	<ul style="list-style-type: none"> • In April 2018 the Commission approved the Value of Distributed Energy Resources “value stack” implementation that enables storage to increase the value of distributed renewable generation by shifting when the energy delivered to the grid. Utilities have been ordered to file tariffs that are expected to go into effect in late in 2018 to compensate a hybrid energy storage and distributed generation system. • There are currently approximately 400 MW of mature NY-Sun Community Solar projects in the utilities’ queue and a new wave of solar development is expected to result from recent NY-Sun program changes.¹⁸ Both provide more near-term development of distributed solar which presents more opportunities where the addition of storage may offer value. To leverage this opportunity, some solar companies are beginning to invest business development resources in storage. Some of these companies have experience integrating energy storage and there are several qualified energy storage suppliers with whom they could partner. • The Standardized Interconnection Requirements (SIR) was recently changed to accommodate storage in several important ways to further support deployment. These changes included raising the maximum size of a distributed generator from 2 MW to 5 MW and clarifying that both the solar and storage systems could be 5 MW of nameplate capacity, so long as the export was limited to a total of 5 MW. • Financiers of solar projects are still unfamiliar with obtaining the new ITC for storage and require a premium to cover the perceived risks. The new VDER tariff is also unfamiliar and raises additional financing complexity. • As announced by Governor Cuomo in his 2018 State of the State message, the New York Green Bank will invest \$200 million to ramp up financing for energy storage projects, including those paired with solar, to enable deployment at scale and reduce the cost of capital.¹⁹ • Solar and energy storage systems will be new for permitting agencies to review, which adds complexity and time to project development.
Customer Value	<ul style="list-style-type: none"> • Solar developers value the opportunity to expand their sales to include energy storage and gain experience with solar plus storage systems. • Financiers value examples of the performance and value streams of solar plus energy storage systems. • Community solar subscribers, including residential and commercial electric customers, value the increased bill credits energy storage creates by shifting the solar generation to higher value times. • Commercial and industrial solar customers value the ability of storage to shift the timing of solar production to reduce their retail demand charges and provide demand response.

11.2.3 Stakeholder/Market Engagement

Stakeholder/Market Engagement	<ul style="list-style-type: none"> • NYSERDA has engaged with several energy storage and solar developers to gather feedback regarding a solar plus storage initiative. Developers noted
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¹⁸ On June 18, 2018 NY-Sun announced a program redesign, made in response to a rapidly changing market, includes higher incentive rates, and targeted new incentive adders. NY-Sun also increased the maximum system sizes for both the non-residential and the commercial projects, encouraging to better economy-of-scale. NY-Sun expects increased project development in light if these program improvements.

¹⁹ RFI, Financing Arrangements for Energy Storage Projects in New York State:
<https://portal.greenbank.ny.gov/servlet/servlet.FileDownload?file=00Pt0000005HjmpEAC>

	<p>that they are just beginning to evaluate adding storage to projects under VDER, and that battery costs are still high relative to the incremental VDER values or bill savings. Given the added costs, on their own developers would not likely pursue solar plus storage projects until costs come down, including those costs associated with more complicated siting and interconnection.</p> <ul style="list-style-type: none"> • Developers also reported that adding energy storage to their PV projects introduces additional risks including unknown permitting, interconnection and technical barriers, and financing premiums. • Going forward, NYSERDA will work very closely with NY-Sun developers building storage, industry associations, utilities and regulators to ensure complications are addressed to minimize soft costs and barriers.
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11.2.4 Theory of Change

Market Barriers Addressed	<ul style="list-style-type: none"> • High hard costs to early adopters of adding energy storage to solar. High energy storage equipment costs (i.e., batteries) continue to drive high overall costs for solar plus storage projects. NYSERDA incentives will lower project hard costs as the storage industry continues to drive cost declines that have averaged 10% annually. • High soft costs of adding storage to solar. Soft costs²⁰ are higher for solar plus storage projects, relative to solar alone, and the industry’s lack of experience with new tariffs further increases financing and other costs. Financial support for the initial tranche of solar plus storage projects, as well as disseminating market learnings, will lower future project soft costs by allowing the industry to gain the experience necessary to reduce the impact added design, development and business model risks have on costs.
Testable Hypotheses	<ul style="list-style-type: none"> • If incentives lower the additional hard costs of adding storage to solar projects, then developers will be willing to undertake solar plus storage projects. • If developers deploy storage with solar projects, and NYSERDA provides additional support to address key interconnection and permitting barriers, then the industry will gain valuable lessons learned, translating to a decrease in soft costs, in preparation for future paired solar plus storage deployments. • If NYSERDA actively participates in the Interconnection Policy and Technical Working Groups to reduce solar plus storage interconnection complexities and costs, coordination among the parties will reduce and remove barriers to industry deployment activities.
Activities	<p>Financial Support for Solar Plus Storage Projects</p> <ul style="list-style-type: none"> • NYSERDA will set the incentive level based on projects with the highest economic value. Prior analysis of the opportunities for storage and VDER values analyzed several use cases to determine the incentive level that would be required for solar plus storage projects to break even with sufficient financial returns to enable deployment. The analysis focused on locations where community solar projects are likely to be built, where VDER capacity values were relatively high, and a more general analysis of customer-sited paired systems. • The incentive level will take this analysis into account, as well calibrate the level of funding providing to high value locations where the established storage cost declines will enable projects to make financial sense in the next 3-5 years.

²⁰ Soft costs of adding storage to solar are defined as the additional permitting, interconnection, customer acquisition, and financing costs.

	<p>NYSERDA will also gather stakeholder input before finalizing the incentive level.²¹</p> <ul style="list-style-type: none"> Using the identified incentive level, NYSERDA will provide a standard offer incentive within the NY-Sun program to reduce the developer’s cost of adding energy storage to a solar project. The incentive will be in addition to financial support received thorough the NY-Sun Megawatt Block program. To access the incentive, NY-Sun developers will apply for storage incentives through the NY-Sun open enrollment applications process. <p>Collaborative Support to Address Permitting and Interconnection Barriers</p> <ul style="list-style-type: none"> NYSERDA will actively engage with industry developers, associations, and regulatory and utility staff to find solutions to barriers encountered by funded solar plus energy storage projects. This will include monthly participation in IPWG and ITWG to ensure the development of standardized, efficient and consistent interconnection technical requirements, policies and procedures for energy storage. NYSERDA will also actively engage siting and permitting agencies to reduce barriers and complexity to the addition of storage to solar projects. NYSERDA may also issue task work orders under existing contracts through the Reducing Barriers to Deploying Distributed Energy Storage initiative to supplement working group participation in addressing specific barriers identified by the solar plus storage projects. These scopes may include: tariff analysis, siting and permitting support, project performance M&V, stakeholder outreach and knowledge transfer of lessons learned. <p>Disseminate Learnings to the Market</p> <ul style="list-style-type: none"> Case studies highlighting the performance and value of adding energy storage to solar will be developed and disseminated under through the Reducing Barriers to Deploying Distributed Energy Storage initiative. The work will be conducted via the activity labeled “Increase Confidence.” AHJs have very little experience permitting batteries, so lessons learned will be gathered from developers and disseminated through the Reducing Barriers to Deploying Distributed Energy Storage initiative activity labeled “Safely Deploy Energy Storage Technologies.” The ITWG will also be leveraged as a forum for industry to share their experience amongst themselves and with regulators and utilities to further disseminate lessons learned. Project measurement and verification will also be shared to increase customer and investor confidence in performance and revenue.
<p>Key Milestones</p>	<p><u>Milestone 1 (2018)</u></p> <ul style="list-style-type: none"> Launch changes to the NY-Sun program providing incentives for paired solar plus energy storage projects. <p><u>Milestone 2 (2018)</u></p> <ul style="list-style-type: none"> Participation in IPWG and ITWG meetings throughout the year to address issues of adding storage to solar. <p><u>Milestone 3 (2018-2020)</u></p> <ul style="list-style-type: none"> Award incentives to solar plus storage projects.

²¹ It is anticipated that the incentive level for these early adoption projects could reach 40-50% of the installed cost of the storage system due to higher soft costs and financing costs associated with financier uncertainty of revenue from the VDER tariff and higher initial interconnection costs. This level of incentive is consistent with early adopter markets that were experienced in other NYSERDA initiatives, Con Edison’s initial Demand Management Program, and other states including California.

	<p><u>Milestone 4 (2019-2021)</u></p> <ul style="list-style-type: none"> • Completion of solar plus storage projects. <p><u>Milestone 5 (2019)</u></p> <ul style="list-style-type: none"> • Publish case studies with learnings from initial solar plus storage projects. <p><u>Milestone 6 (2019)</u></p> <ul style="list-style-type: none"> • Participation in IPWG and ITWG meetings throughout the year to address issues of adding storage to solar. <p><u>Milestone 7 (2020-2021)</u></p> <ul style="list-style-type: none"> • Release case studies based on measurement and verification results for supported solar plus storage projects to increase customer and investor confidence in performance and revenue. <p><u>Milestone 8 (2020)</u></p> <ul style="list-style-type: none"> • Participation in IPWG and ITWG meetings throughout the year to address issues of adding storage to solar. <p><u>Milestone 9 (2020)</u></p> <ul style="list-style-type: none"> • Publish case studies with learnings from remaining solar plus storage projects.
<p>Goals Prior to Exit</p>	<ul style="list-style-type: none"> • NYSERDA anticipates the need for continued market support beyond this initiative through the broader energy storage bridge incentive recommended in the New York State Energy Storage Roadmap as declines in energy storage hardware costs begin to materialize and grid values become more refined. • The solar plus storage development activity funded under this initiative will reduce the soft costs of adding storage to future distributed solar projects. As they will be the first solar projects paired with storage, they will provide valuable lessons learned and serve as a model for future projects, enabling a reduction in installation costs in the future. Priorities and approaches to support adding storage to solar will shift as the various policy, market values, applications and proportion of renewables change. • NYSERDA anticipates exiting the activities described in this initiative when adding storage to NY-Sun commercial and non-residential systems makes financial sense based on commercial terms alone due to costs declines and additional value opportunities. Project modeling indicates that many of these paired projects will make economic sense in the next 3-5 years without additional storage incentives based on established cost declines.

11.2.5 Relationship to Utility/REV

<p>Utility Role/Coordination Points</p>	<ul style="list-style-type: none"> • Investor owned utilities have three roles in the market for solar plus storage; implementation of tariffs, distributed generation interconnection, and distributing bill credits generated by community solar projects to subscribed electric customers. Solar plus storage projects will not be eligible for any other program funding from the utilities. • NY-Sun will update the utilities on the new program for energy storage and continue to coordinate with the utilities on issues of application processing and queue management. • The utilities publish the tariffs that encourage shifting renewable generation with storage and indicate where DERs are most valuable. The tariffs
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	<p>therefore indicate locations solar plus storage is most valuable and where a NYSERDA market development intervention is most efficient.</p> <ul style="list-style-type: none"> • The utilities are participating on the ITWG and IPWG. Utility interconnection policy and technical issues will be addressed in the Interconnection Working Groups to coordinate consistent implementation among utilities.
Utility Interventions in Target Market	<ul style="list-style-type: none"> • Utilities are considering solar plus energy storage systems in non-wires alternative procurements on a competitive basis. • The utilities do not offer incentives for solar plus storage projects, however utilities do incent and compensate stand-alone storage in demand reduction and demand response programs. • Con Ed and Orange and Rockland utilities have REV solar plus storage demonstration projects underway that include residential solar, commercial behind-the-meter solar and community solar. • DER tariffs, similar to the VDER value stack, are under development for LIPA and NYPA customers. NY-Sun has a Megawatt Block offering that supports solar projects statewide, including for LIPA and NYPA customers that do not pay into the System Benefits Charge (SBC). NYPA currently does not offer direct financial support for solar plus storage projects currently. NYSERDA will coordinate with LIPA on development of a solar plus storage offering the utility is considering in their service territory.

11.2.6 Budgets & Expenditures

An annual commitment budget for all activities included in this chapter is shown in Table 7. The annual expenditure projection is included in Table 8. 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.²²

Table 7: Annual Market Development Budget Allocation – Commitment Basis

Budget	2018	2019	2020	Total
Direct Incentives and Services ²³	\$5,000,000	\$15,000,000	\$20,000,000	\$40,000,000
Total	\$5,000,000	\$15,000,000	\$20,000,000	\$40,000,000

Table 8: Annual Expenditures Projection

Expenditures	2018	2019	2020	2021	2022	Total
Total	6%	31%	38%	19%	6%	100%

²² Storage projects in Long Island will not be eligible for this proposed incentive.

²³ This initiative will leverage the activities in the Reducing Barriers to Deploying Distributed Energy Storage initiative to disseminate learning to the market, therefore the budget here is solely for providing financial assistance.

11.2.7 Progress and Performance Metrics

Table 9 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 9. Initiative Specific Metrics

Indicators ²⁴		Baseline (Before/Current)	2022 (Cumulative)
Activity/Outputs	Number of NY-Sun projects awarded support for storage	0	50
	Number of NY-Sun projects commissioned with storage	0	40
	Commissioned MW of storage capacity awarded support	0	60
	Commissioned MWh of storage awarded support	0	120
Outcomes	Percent decrease in incremental soft costs of adding storage to solar projects in the initiative's participant population ²⁵	0%	33%

The 33% soft cost reduction by 2022 outcome is associated with the incremental soft costs of adding storage. However, the soft cost reduction work in this population of paired systems will also accelerate the broader energy storage soft cost reduction strategies recommended in the NYS Energy Storage Roadmap. Staff estimates indicate that the \$350 million in recommended bridge incentives, could reduce soft costs by up to \$50 per kWh for a distribution/bulk-sited system and up to \$150 per kWh for a customer-sited system by 2025. The cost reductions, both for solar plus storage systems and energy storage more broadly, will help support a significant amount of system deployments, accelerating cost declines and establishing critical foundations for a self-sustaining market without direct incentives. It is estimated that this work could accelerate the cost decline curve by almost two years and save approximately \$200 million from the projected cost of

²⁴ A 0 (zero) denotes that the actual value is currently believed to be zero for baseline/market metrics.

²⁵ Currently, there are no comparable existing installations in NYS from which a baseline could be derived. Many of the soft costs of paired solar and storage and operating under the VDER value stack are currently unknown because this is a new application for storage with limited numbers of developers proposing paired systems to customers. The first paired solar and storage will likely have additional soft costs related to more complicated interconnection and tariff uncertainty that raises the cost of capital. The trend of cost reduction will be measured over time through participants of this initiative by comparing the soft costs for projects in early years of the initiative to soft costs for projects initiated later in time.

deploying 1,500 MW of energy storage by 2025 and more than \$400 million from the projected cost of deploying 3,000 MW by 2030.

Benefits shown in Table 10 and Table 11 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.

Table 10. Direct Impacts

Primary Metrics ²⁶		2018	2019	2020	TOTAL
Energy Efficiency	MWh Annual	-	-	-	-
	MWh Lifetime	-	-	-	-
	MMBtu Annual	-	-	-	-
	MMBtu Lifetime	-	-	-	-
	MW ²⁷	5	14	19	38
Renewable Energy ²⁸	MWh Annual	-	-	-	-
	MWh Lifetime	-	-	-	-
	MW	-	-	-	-
CO2e Emission Reduction (metric tons) Annual		-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime		-	-	-	-
Customer Bill Savings Annual (\$ million)		-	-	-	-
Customer Bill Savings Lifetime (\$ million)		-	-	-	-
Private Investment (\$ million)		\$5	\$15	\$20	\$40

Under VDER, shifting renewable generation using storage substantially improves its value. The MWs of storage deployed under this initiative are expected to improve the value of the shifted renewable energy by \$3M annually, creating about \$60M of additional value over the lifetime of the solar plus storage asset. The portion of this value that would be passed to retail customer subscribing to a community solar project is estimated at 10%, while 90% would go to be applied to the capital costs of storage.

Near-term, these early storage applications paired with solar do not present additional carbon savings, due to the roundtrip conversion losses in storage (approximately 15-20%) and the temporal misalignment with more carbon-intense generation. Longer term, however, as the generation fleet includes substantially more renewable energy, adding storage will result in substantial carbon reduction by shifting renewable production to displace fossil generation in other hours of the day. Storage can play a critical role addressing the ramp rate that can occur in the late afternoon when solar production declines and electric demand increases. While the California electric system is different in many respects to the New York system, it does present an illustrative

²⁶ Impacts are expressed on a commitment-year basis and are incremental additions in each year.

²⁷ MW of expected reduction during the system peak hour from coincident shifting the renewable energy with storage.

²⁸ Solar generation is captured in the NY-Sun investment plan.

example of this ramp rate issue. On March 4, 2018, solar produced almost 50% of the total electricity in the State of California. However, as solar production started to decline as the sun set the grid experienced a ramp rate of over 7,500 MW of new generation required in a single hour to make up for the declining solar generation, and almost 15,000 MW over three hours – equal to half of the total electric demand the grid would face in a typical day.²⁹

Table 11. Annual Projected Initiative Participation

	2018	2019	2020	Total
Participants ³⁰	5	15	20	40

11.2.8 Fuel Neutrality

Fuel Neutrality	<ul style="list-style-type: none"> This initiative is not being offered on a fuel neutral basis.
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11.2.9 Performance Monitoring and Evaluation Plans

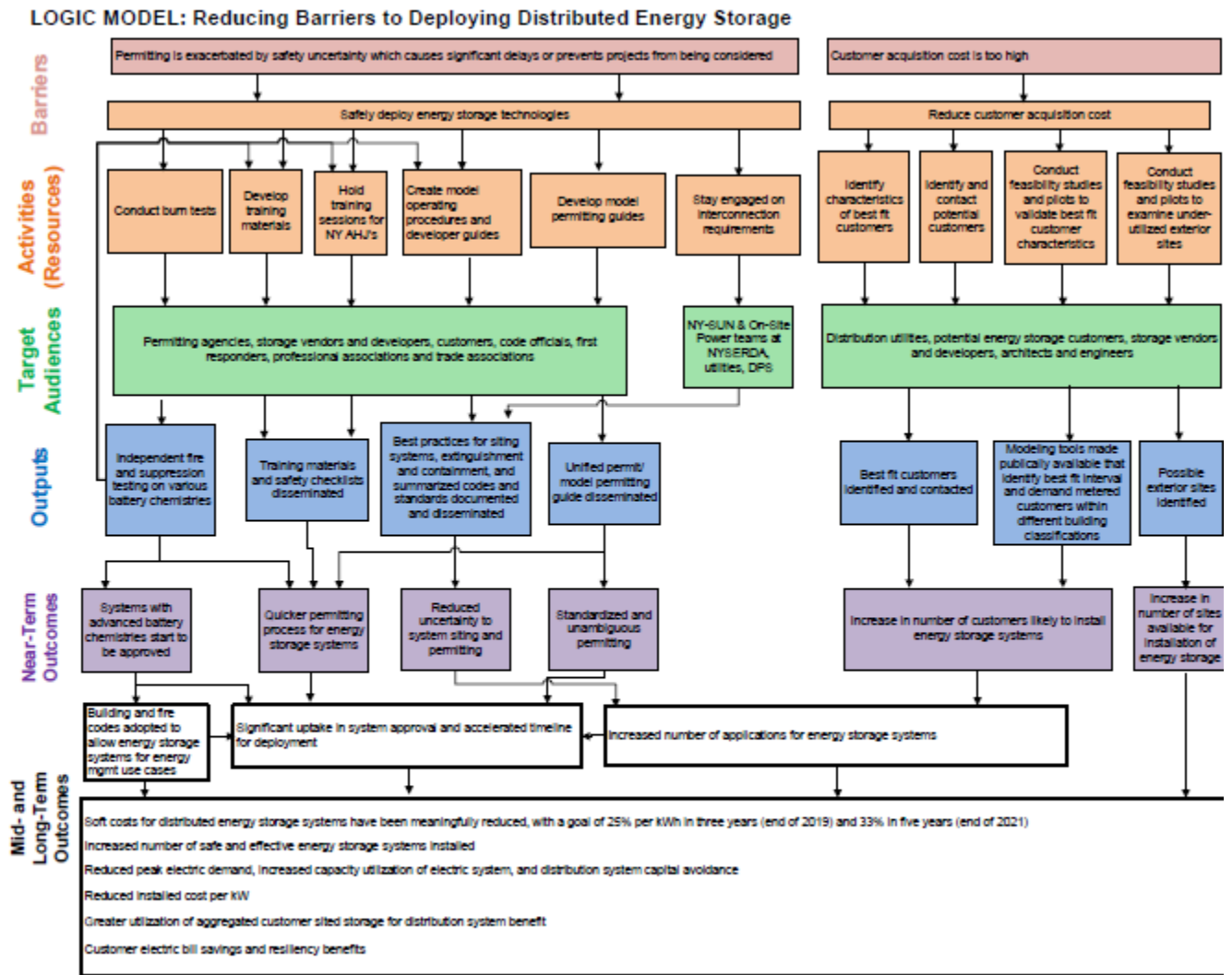
<p>Performance Monitoring & Evaluation Plan</p>	<p>NYSERDA’s approach to monitoring and assessing the effectiveness of the initiative and overall market development is described below.</p> <p><u>Test-Measure-Adjust Strategy</u></p> <ul style="list-style-type: none"> NYSERDA will monitor the pace of NY-Sun project applications and awards for energy storage support. Marketing messages, incentive levels/structure, administrative process, and other program activities will be adjusted based on periodic review of these metrics. Based on progress of NY-Sun projects awarded storage support and outcome of the contracting and implementation processes, NYSERDA may revise program implementation as needed over the course of the initiative. Factors to be considered include: <ul style="list-style-type: none"> Number of responding solar project owners/developers, and quantity of projects and storage MW/MWh capacity applying Rate of completion, delay, and/or attrition of projects awarded support Insights as to how the initiative can be optimized will be gathered and applied to future initiative design to ensure greatest market impacts within specific sectors of the solar market. <p><u>Market Evaluation</u></p> <ul style="list-style-type: none"> The trend for solar plus storage soft costs will be assessed as systems are commissioned under this initiative. Currently, there are no comparable existing installations in NYS from which a baseline could be derived. The soft cost reduction noted in Table 3 is expected to occur inside of the participant population as experience is gained, but also be transferrable to non-participants as the initiative matures. Regular (e.g., annual or biennial) updates to soft cost measurements will occur to gauge both participant and non-participant (market wide) costs.
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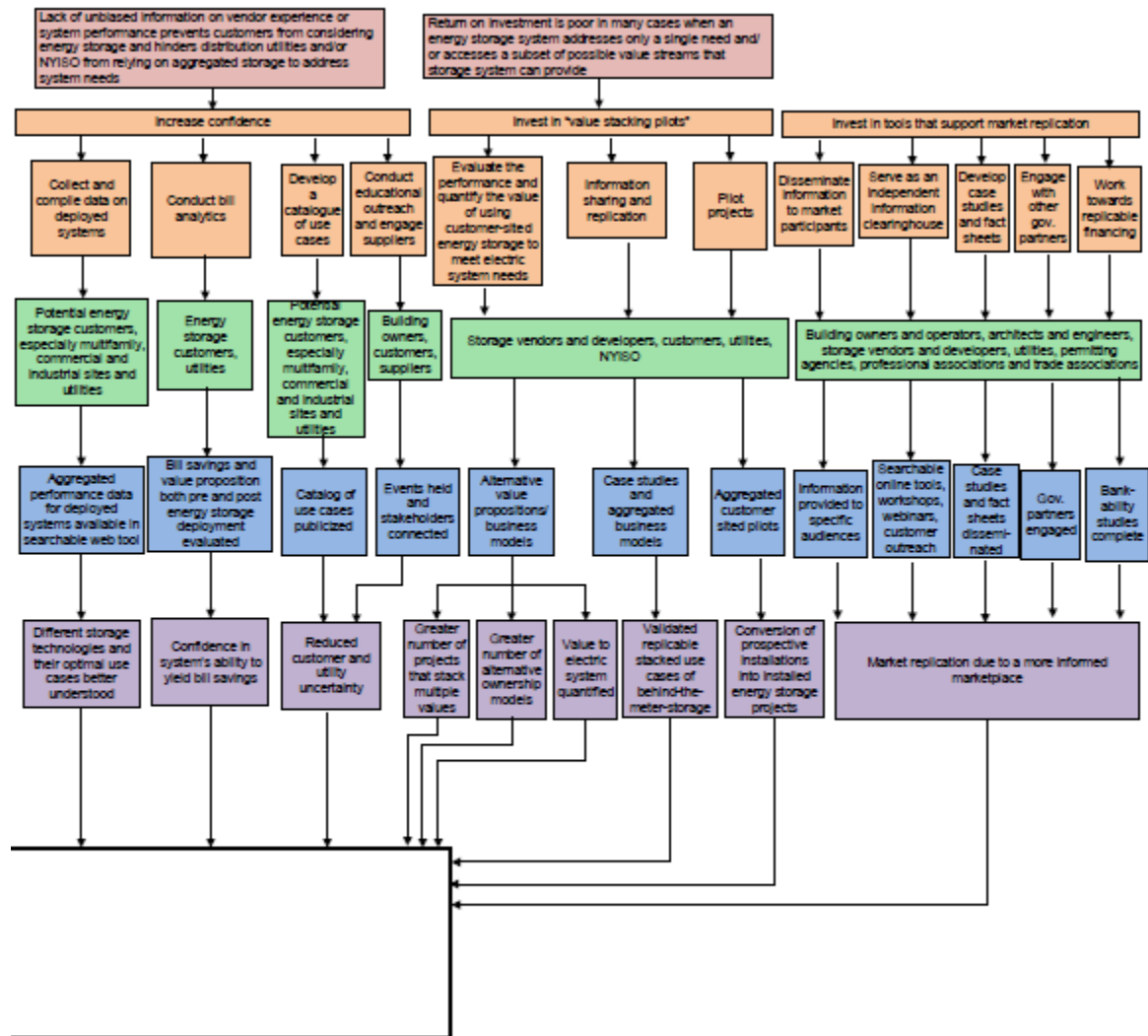
²⁹ https://www.greentechmedia.com/articles/read/california-sets-two-new-solar-records#gs.oPu9_fg

³⁰ Participants are Community Solar or Non-residential NY-Sun projects getting support for energy storage

	<ul style="list-style-type: none">• Sources of data will include public and commercially available data, Salesforce, and primary data collection through surveys of key market actors. <p><u>Impact Evaluation/Field Verification</u></p> <ul style="list-style-type: none">• Impact Evaluation will be completed for the NY-Sun portfolio as a whole. NYSERDA will develop an approach to identify these projects in the NY-Sun portfolio and to represent them in the evaluation.• As projects are installed, the amount of renewable energy shifted will be verified via the NYSERDA Distributed Generation Integrated Data System website or other remote monitoring systems. This verification will be conducted according to the International Performance Measurement & Verification Protocol (IPMVP) method(s) most appropriate.• Data from Field Verification/Impact Evaluation can be used to help lend confidence in the market, especially among other end users.
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Appendix A – Logic Model





LOGIC MODEL: Solar Plus Energy Storage

