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Clean Energy Fund: Renewables Optimization Chapter

Portfolio: Innovation & Research

Submitted by:

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Clean Energy Fund: Renewables Optimization Chapter		
Revision Date	**Description of Changes**	**Revision on Page(s)**
March 3, 2017	Original Issue	Original Issue
November 1, 2017	Updated the baseline values in Table 3 to reflect latest data available.	10
September 7, 2018	Added National Offshore Wind Research & Development Consortium initiative.	Multiple
April 19, 2019	As part of the Annual Investment Plan & Performance Report (IPPR) process, NYSERDA has updated budget and benefit values to align with actuals for past years and adjusted budget and benefit forecasts for future years, as appropriate, based on experience to date. Budget and benefit tables have been moved to Appendix B of this chapter and output/outcome tables have been moved to Appendix C of this chapter. Updated rounding convention has been applied to budget and benefit tables.	Multiple
June 15, 2020	As part of the Annual Investment Plan & Performance Report (IPPR) process, NYSERDA has updated budget and benefit values to align with actuals for past years and adjusted budget and benefit forecasts for future years, as appropriate, based on experience to date.	Multiple

18 Renewables Optimization

Increased utilization of renewable energy assets and energy storage has many grid and consumer benefits. Optimizing the energy output and uptime of renewable resources will provide both near term economic benefits and decrease the total cost of deploying renewable technologies in future. Energy storage can reduce the intermittency of solar and wind energy, helping these resources to be flexible assets deployed when needed. Energy storage can also avoid the need for new electric system infrastructure, increase system efficiency and resiliency, and reduce the need for fossil fuel plants to meet periods of peak electric demand. NYSERDA's energy storage strategy will target barriers limiting energy storage adoption in three sectors: customer-sited (behind-the-meter systems), the transmission and distribution system, and transportation.

NYSERDA aims to achieve accelerated market adoption and realization of these benefits through strategies that improve performance, reduce cost, improve renewable hosting capacity and improve integration with a grid that is distributed energy resources (DER) friendly. The initiatives in this chapter will improve the economics for renewable and distributed energy resources by addressing technical barriers, as well as advancing renewable technologies that have potential to drive large scale greenhouse gas reductions, improve grid resiliency, and contribute to New York State's renewable generation objectives.

The first initiative described in this chapter, Energy Storage Technology and Product Development focuses on the development of innovative energy storage systems. Specific focus will be on reducing hardware (including balance-of-system hardware) costs of energy storage devices, as well as improving their performance in terms of efficiency, energy & power density and thermal stability. This initiative complements NYSERDA's market development initiative focused on reducing soft costs of energy storage, which together will work to develop and deploy energy storage products and remove market barriers for their adoption.

The second initiative described in this chapter, National Offshore Wind Research & Development Consortium focuses on establishing a nationwide research and development consortium for the offshore wind industry to address U.S.-specific technology issues and accelerate cost reductions in the United States offshore wind sector.

Program investments and activities will be focused on development of a portfolio of multiphase projects addressing prioritized (based on return on investment) technical challenges, bringing technologies and products from feasibility to commercialization. Activities will be informed via engagement with stakeholders and subject matter experts.

18.1 Energy Storage Technology and Product Development

18.1.1 Overview

Present Situation	• Total energy storage capacity in USA is currently approximately 24,180 MW.[1] 22,560 MW (93.3%) of that storage capacity is in the form of pumped hydro storage (PHS) and, with the remainder spread across battery storage, compressed air energy storage (CAES), flywheel energy storage and thermal energy storage technologies. California is leading the nation with 298 MW of installed energy storage, followed by Texas with 171 MW of installations; in comparison, New York State has 31 MW.[2] California has set the goal of having 1,330 MW of total behind-the-meter and transmission and distribution system energy storage applications implemented by 2024.[3] • New York's energy storage sector has grown 30% since 2012 to approximately 3,900 employees, and global annual revenues from New York companies has increased 50% to $900 million. The New York energy storage roadmap developed by NY-BEST has set the goal of deploying 2,000 MW of energy storage capacity by 2025 and 4,000 MW by 2030.[4] A recent study projects that by 2030 this sector could employ 25,000 in New York and comprise $8 billion in annual revenues. • Despite advances in storage technology, several technological challenges still exist including high upfront costs (both hardware and soft costs), safety, and system performance uncertainty. These barriers affect the growth of energy storage deployment. • New York has deep industrial, testing, and academic research and development (R&D) capability in energy storage, with many institutions/companies poised to play a key role in developing better performing and lower cost energy storage technologies. • Investment opportunities to improve performance in energy storage technologies include advanced analytics and controls, system integration, and better materials/components in a range of energy storage devices including batteries, ultracapacitors, and flywheels.
Intervention Strategy	• This strategy will make investments primarily through competitive solicitations that focus on supply chain innovations and determining the best technology fit for specific applications. The advancements identified will reduce costs, improve performance (efficiency, safety, energy density), and stimulate growth of the cleantech industry in New York. • This will complement NYSERDA's current energy storage Market Development strategy, which is addressing barriers to deployment of behind-the-meter energy storage. From a cost perspective, the energy storage Market Development work is trying to reduce energy storage soft costs which account for about 25% of total system costs. This Innovation initiative is focusing on the other 75% of the cost components of energy storage – specifically the hardware costs, including balance-of-system hardware.

[1] U.S DOE (February 2017) "Global Energy Storage Database Projects."

[2] This includes both transmission and distribution system and behind-the-meter and applications. This does not include pumped hydro.

[3] California Independent System Operator (ISO), California Public Utilities Commission (CPUC), and the California Energy Commission (CEC) (2014) Advancing and Maximizing the Value of Energy Storage Technology: A California Roadmap.

[4] NYSERDA Energy Storage and NY-BEST Program: Market Characterization and Assessment. EMI Consulting and Industrial Economics, Inc. (IEc), February 2017. Does not include pumped hydro.

	• This initiative will target three sectors/applications: customer sited (behind-the-meter), transmission and distribution system applications, and transportation system applications. • Investments will leverage NY's unique innovation/testing assets; adapt innovation from other regions, including testing and optimization under typical NY duty cycles/use cases, relevant environmental/weather conditions and in NY's regulatory environment; facilitate commercialization-oriented partnership; and work with stakeholders to define technical performance specifications that can serve as market relevant stretch goals to drive innovation. • For a visual representation of this strategy, please reference the flow chart entitled "Logic Model: Energy Storage Technology and Product Development," which can be found in Appendix A.

Goals	• 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.
	• Increase the value proposition of energy storage for New York applications by reducing cost and improving performance, specifically seeking to:
	  ○ Demonstrate innovative solutions that can decrease energy storage hardware costs (including balance of system and hardware installation costs), by 20% by 2022, compared to industry average in that year, for a portfolio of projects.
	  ○ Demonstrate innovative solutions that can yield a 20% improvement in critical system performance parameters by 2022 compared to industry average in that year, for a portfolio of projects.
	• Grow a vibrant energy storage cluster in New York.

State Energy Plan/Clean Energy Standard Link	• The New York State Energy Plan discusses energy storage as a focus for State R&D support to "facilitate and reduce cost of New York State's transition to a REV-based energy system." It also recognizes the important multifaceted role that energy storage technologies can play to improve reliability, reduce peak load, enable greater integration of intermittent renewables, and enhance resiliency when deployed with microgrids. • Energy storage is important to the Clean Energy Standard where it is recognized for its ability, along with wind and solar, to help "develop and operate the electric grid to be more responsive, efficient, secure, and clean."

18.1.2 Target Market Characterization

Target Market Segment(s)	The target market is energy storage technology and product developers.
Market Participants	Market participants include: • Startup/emerging companies • Technology developers • Component manufacturers, system integrators, supply chain partners • Commercial and residential consumers (load side) • Utilities and Energy Service Companies (ESCOs) • Metropolitan Transportation Authority (MTA), State University of New York (SUNY), Public Service Commission (PSC) and New York Independent System Operator (NYISO) • Brookhaven National Lab (BNL), New York Battery and Energy Storage Technology (NY-BEST) Consortium, Rochester Institute of Technology (RIT) Prototyping Center, Eastman Business Park • Universities, research organizations, government agencies

Market Readiness	• Behind-the-meter and transmission and distribution system energy storage applications are projected to grow globally from 538 MW installed in 2014 (valued at $675 million) to 21,000 MW (valued at $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 75% while lifetime and capacity has doubled.[6] In 2016, quoted cost of an installed behind-the-meter four-hour lithium-ion system in a metropolitan location was on the order of $850/kWh or greater. Multiple market research firms point to behind-the-meter 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. • NYSERDA has been developing an ecosystem for energy storage innovations and their path to commercialization in NY State. Thru these efforts NYSERDA already is deeply engaged with local energy storage companies, large original equipment manufacturers (OEMs), Utilities, NYPA, NYISO, PSC, SUNY, MTA, BNL, Eastman Business Park, Battery prototyping and commercialization center at RIT, Empire State Development's Division of Science, Technology and Innovation (NYSTAR), and NY-BEST.
Customer Value	• Technology innovations are expected to reduce costs to customer and address important performance attributes limiting customer acceptance (e.g., safety, footprint). • If NYSERDA is successful in achieving the cost reduction noted above, this could reduce payback to customer from 7 or more years to a projected 5 years for a behind-the-meter application. • Successful development of higher performing/lower cost energy storage for grid-support could reduce capital costs for system upgrades and reduce the revenue requirements that would need to be spread across the rate-base (i.e., providing value to all customers).

[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*

[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.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

18.1.3 Stakeholder/Market Engagement

Stakeholder/Market Engagement and Customer Discovery	• NYSERDA has conducted ongoing stakeholder engagement in the NYS renewables market that has included technology providers, project developers, OEMs, the NYISO, and NYS utilities. This interaction was used to better understand the challenges facing the market, to determine whether and where NYSERDA intervention could be most helpful, and ultimately to refine the approach outlined in this initiative. • A key aspect of this initiative is regular engagement with market stakeholders across the value chain (from technology providers to project developers and operators). Objectives of this engagement will be to define technology performance specifications/technology challenges and ensure that NYSERDA remains in tune with and responsive to market needs. • NYSERDA is also actively engaged with NY-BEST, Battery Commercialization Prototyping Center in Rochester, and Smart Energy Facility at SUNY Binghamton to accelerate innovation and understand customer needs.

18.1.4 Theory of Change

Technology Barriers and Opportunities Addressed	• **Total hardware costs and installation cost of energy storage systems are high.** Total hardware costs include the energy storage device cost, along with the hardware balance-of-system cost. This combined with the difficulty in monetizing all the value streams associated with energy storage limits the return on the investment and, in turn, market adoption of the systems. Potential innovations to be investigated to decrease these costs include: applications of advanced analytics and controls, improved processes for system integration/packaging, better power electronics, higher performing/longer-lived materials (including solid state materials), advanced computational approaches for materials testing, use of simulations and digital testing to reduce innovation cycle times for new energy storage technologies, and advanced manufacturing processes. • **Performance (efficiency, life, and safety) of energy storage systems is suboptimal.** The number of allowable charge cycles and round-trip charge/discharge efficiencies of most current energy storage systems are not attractive enough to propel quick market acceptance. Furthermore, these systems often do not readily meet the safety standards that are set in dense urban environments. These factors hinder wide-scale market adoption and therefore technology innovations are needed in these performance measures to make energy storage systems attractive to the market. • **Technology risks in integrating energy storage devices with the grid at transmission and distribution level, are neither well understood nor fully optimized.** Energy storage performance is very application/site specific, requiring significant "real world" testing before the technology can become adopted by the market. The applications could include energy storage for peak demand reduction, energy storage to make the large-scale wind and Solar PV predictable, energy storage for rail braking energy recovery, and storage solutions at distribution as well as transmission level to avoid costly grid upgrades. While advanced simulations can reduce some of this need for field demonstrations, the current state-of-the art still requires in-field applications testing and optimization. Successful field demonstration projects integrating energy storage system with the grid at congested grid junctions are necessary to open path to large scale applications. • **Small and medium-size companies do not know who to work with at large OEMs, limiting the ability for strategic partnerships that could accelerate**

	innovations. From a business innovation perspective, New York has vibrant energy storage cluster with many small start-ups and medium-sized firms. These start-ups can take more risk than established companies and can accelerate the pace of innovation. However, a successful path to market may include a partnership with a larger company (either through licensing, intellectual property acquisition, or supply chain relationships).
Testable Hypotheses	• If energy storage devices capital costs are reduced and their performance is improved, energy storage market penetration by new customers and investors will increase. • If energy storage devices are integrated at the distribution and transmission level, they will reduce peak demand and increase the value of power generated by intermittent renewable resources (i.e. solar PV and large-scale wind). • If energy storage devices are integrated at the distribution and transmission level, they will increase customer and grid resiliency, enhance grid asset utilization, and defer costly grid upgrades. • If NYSERDA facilitates partnerships among small/medium companies and large OEMs, more rapid commercialization will occur.

Activities	• Provide competitive funding opportunities in support of technology companies to leverage existing capabilities, validate technologies, create innovative products and applications, and otherwise facilitate the development of energy storage in New York. NYSERDA will issue broad competitive solicitations for project proposals to identify teams and approaches to address innovations focusing on:
	  ○ Hardware BOS including power electronics cost reduction for energy storage systems.
	  ○ Hardware cost reduction for energy storage components and devices.
	  ○ Performance improvements (efficiency, safety, energy density) of storage devices, especially for NY-specific applications and duty cycles (e.g., building demand response, electric vehicle charging, solar photovoltaics, and large-scale wind firming).
	  ○ Load-side and generation-side applications of energy storage to reduce peak load, store and reuse solar PV and wind energy to aid firming up these resources, and provide ancillary services.
	• Facilitate strategic corporate partnerships among small/medium sized companies and large OEMs to speed up the path to commercialization.
	• Explore viability of establishing technical performance specifications that can serve as market-relevant stretch goal to drive innovation. If appropriate, use the stretch goal as a technology challenge in one or more competitive solicitations.

Key Milestones	<u>Milestone 1 (2017) – Complete</u> • Issue 1st Competitive Solicitation. <u>Milestone 2 (2017) - Complete</u> • Contract projects from 1st Competitive Solicitation. <u>Milestone 3 (2017) - Complete</u> • Review portfolio of activities, solicit market input and reassess technology challenges areas and targets. <u>Milestone 4 (2017) - Complete</u> • Issue 2nd Competitive Solicitation. <u>Milestone 5 (2018) - Complete</u> • Contract projects from 2nd Competitive Solicitation. <u>Milestone 6 (2018) - Complete</u>

	• Review portfolio of activities, solicit market input and reassess technology challenges areas and targets. <u>Milestone 7 (2018) - Complete</u> • Issue 3rd Competitive Solicitation. <u>Milestone 8 (2019) - Complete</u> • Contract projects from 3rd Competitive Solicitation. <u>Milestone 9 (2019) - Complete</u> • Review portfolio of activities, solicit market input and reassess technology challenges areas and targets. <u>Milestone 10 (2019) - Complete</u> • Issue 4th Competitive Solicitation.

Goals Prior to Exit	• Due to the nature of this work, NYSERDA envisions continuing to pursue innovation this space for many years. Research priorities will shift as various Energy Storage Innovation functionalities are realized and new or improved energy storage functionalities are identified.
	• By accomplishing the following, NYSERDA seeks to improve the economics and performance of energy storage in several important applications in New York:
	  ○ Integration of energy storage solutions at the behind-the-meter and transmission and distribution system level to make intermittent renewables (solar PV and wind power) assets always deployable.
	  ○ Energy storage serves as generators and ancillary services providers, especially during peak demand hours, through behind-the-meter or large-scale storage systems;
	  ○ Demonstration of solutions for rail-braking energy recovery through storage.
	• NYSERDA will exit or cease funding specific areas of technology development and shift focus once market scalability is confirmed and a value proposition to customers, regulators and policy makers is validated/demonstrated.

18.1.5 Relationship to Utility/REV

Utility Role/ Coordination Points	• Under REV, utilities may own storage when integrated into their distribution network. This could enable them to maintain reliable system operation without new capital investments unless necessary. • New York utilities are routinely solicited by vendors looking to test and/or deploy new energy storage technology. However, much of this new technology is not sufficiently field tested or de-risked to allow for widespread application on the utility grid, and utilities currently have modest internally funded research and development activities related to energy storage. • Furthermore, New York utilities participate to varying degrees in broader energy storage research programs that often are designed to serve a multitude of utility interests across differing jurisdictions and markets; so unique interests of concern to New York may not be entirely addressed. • NYSERDA has and will continue to work with the utilities to better understand the role of energy storage in the evolving development of DSIPs under REV. This will include continued engagement with utilities through the Joint Utilities (JU) Distributed System Implementation Plan (DSIP) Advisory group and NYSERDA's Grid Modernization advisory group. NYSERDA will also try to seed REV demonstrations where appropriate, potentially developed and identified through REV Connect and other avenues.

	• NYSERDA will consult with the utilities in designing technical challenges under this program to ensure that it is investing in applications/use cases that will address utility system needs, including addressing the challenges identified above, such as field testing and de-risking technologies.
Utility Interventions in Target Market	• New York utilities do not have offerings to the market in this area. However, utilities are a key direct customer of this initiative and therefore are considered part of the target market.

18.1.6 Budgets

An annual commitment budget for all activities included in this chapter is shown in Appendix B. Budgets 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 Appendix B is intended for informational purposes only.

18.1.7 Progress and Performance Metrics

Appendix C 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. The metrics here provide a view on the first five years of the initiative. As innovation focus areas shift as the market evolves, NYSERDA will identify and provide additional indicators to track outcomes associated with these new focus areas. These updates will be provided in advance of the end of the 5-year term projected in Appendix C.

These outcomes will be the results of successful field demonstrations of the interventions backed by favorable business value propositions. The energy storage products developed through this intervention will demonstrate stated improvements above the industry would be able to produce in that year.[7]

In addition, NYSERDA will also assess the following broad outcomes:

- Improved value of the intermittent renewables (Solar PV and Wind).

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[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

- Improved grid and behind-the-meter resiliency including peak load reduction, reliability, and ancillary services.

Benefits shown in Appendix B, listed as direct, 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.

18.1.8 Fuel Neutrality

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

18.1.9 Performance Monitoring and Evaluation Plans

Performance Monitoring & Evaluation Plan	<u>Test-Measure-Adjust Strategy</u> • NYSERDA will monitor standard activity/output metrics including number of projects initiated and completed by type, private investment, etc. • For any new technology developments launched under the program, on a yearly basis, NYSERDA staff and contractor will reassess the Technology and Commercialization Readiness Levels for each project in the portfolio. • NYSERDA will conduct peer reviews of certain projects based on need. Examples – technical impasse, pivot point, critical milestone. • NYSERDA will assess the portfolio of projects annually regarding goals, metrics, outputs, and outcomes. <u>Market Evaluation/Impact Evaluation</u> • Market Evaluation will draw on the logic model and will include baseline and longitudinal measurement of key indicators of market success. • Baseline measurements of key performance indicators will occur soon following initiative approval and will address indicators including hardware cost. 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) updates to key performance indicators and measurement of market change will occur once the initiative is underway. Sources of data include public and commercially available data, and primary data collection through surveys of key market actors. • A broad demonstration project impact evaluation will include projects from this area and will examine benefits of demonstration projects, rate of success factors associated with replication, and benefits of replication projects. Cost savings will be quantified as part of this study.

18.2 National Offshore Wind Research & Development Consortium

18.2.1 Overview

Present Situation	• New York has adopted a nation-leading mandate to obtain 50% of the state's electricity supply from renewable energy sources by 2030 under the Clean Energy Standard (CES) adopted by the Public Service Commission in 2016. As part of the CES, the Public Service Commission issued an order in July 2018 formally adopting a target of 2,400 MW of offshore wind by 2030, making offshore wind a key pillar to the CES achievement strategy.[8] Additionally, the order authorized the procurement of approximately 800 MW of offshore wind in 2018 and 2019 to jump-start the New York offshore wind market. • Based on its analysis of global market trends, NYSERDA has previously estimated that offshore wind could be cost competitive with land-based renewable generation sources by the time the 2,400 MW goal is met.[9] However, any acceleration of this anticipated cost decline trajectory will directly benefit New York ratepayers through the achievement of offshore wind's substantial environmental and economic benefits at lower costs. • Although the offshore wind global market is now approximately 17GW,[10] the U.S. market is nascent. There are only 30 MW of operating offshore wind in the US today, and New York currently has only one project under development, the 90 MW South Fork Project (under contract to the Long Island Power Authority). • Scaling the U.S. market for offshore wind to achieve the cost declines that are already being observed in Europe will require tackling unique technical challenges that have not been addressed by the global development community thus far. Design standards and product solutions for offshore wind turbines, their substructures, installation infrastructure, and the ecological challenges specific to U.S. metrological, bathymetry, met ocean and geological conditions are not fully developed or validated to a degree that can be financed or insured.
Intervention Strategy	• To address these challenges, and to accelerate offshore wind progress in New York and the U.S., NYSERDA recently proposed to the U.S. Department of Energy (DOE) and was awarded a $20.5 million grant to establish a nationwide research and development consortium ("Consortium") for the offshore wind industry, contingent on NYSERDA's provision of matching funds for the activities of the Consortium. The Consortium will address U.S.-specific technology issues and accelerate cost reductions in the United States offshore wind sector. • The independent, non-profit entity that will administer the Consortium will be led by key industry stakeholders and will prioritize research and development projects based on the three core research pillars identified in the 2016 National Offshore Wind Strategy.[11] The Consortium will focus on supporting innovations in wind plant design, developing methods to reduce siting and installation costs, and exploring advanced technological solutions for operations, maintenance and supply chain development

[8] Order Establishing Offshore Wind Standard and Framework for Phase 1 Procurement issued and effective July 12, 2018. - http://documents.dps.ny.gov/public/MatterManagement/CaseMaster.aspx?MatterCaseNo=18-e-0071

[9] NYSERDA – Offshore Wind Policy Options Paper, January 24, 2018: "With achievement of the 2.4 GW goal contributing to similar scale economies in the U.S. Northeast, NYSERDA projects that by 2030 the cost to procure offshore wind will be lower than the cost of Tier 1 Renewable Energy Credits (RECs) associated with other large-scale renewable technologies."

[10] Navigant Research, Offshore Wind Market and Project Assessment 2017, February 7, 2018 Press Release.

[11] DOE, National Offshore Wind Strategy, September 2016.

	through research initiatives that engage industry, academia, and national laboratories in targeting specific barriers to implementing offshore wind across the nation. • As prime awardee of the DOE grant, NYSERDA will have primary responsibility for set-up of the initial Consortium budgets, governance and controls, compliance with the DOE award terms, and initial administration and operation of all activities within the DOE Statement of Project Objectives. The Consortium will be subject to the governance structure designed by NYSERDA and approved by DOE, including the Conflict of Interest and Intellectual Property policies and competitive contracting processes that will be required by the DOE, as well as NYSERDA terms and conditions, and activities will be performed in an open, fair and transparent manner. • The Consortium will directly leverage $20.5 million in federal funding and NYSERDA's $22.5 million, encourage participation of other U.S. states, and leverage additional private sector contributions. The industry engagement and funding strategy will be modeled after the Carbon Trust's successful Offshore Wind Accelerator in the United Kingdom • In addition to establishing the Consortium, NYSERDA will implement the Consortium's activities for a period until the entity is able to hire staff and otherwise develop its own systems and controls. Such implementation will include developing and launching a series of rolling solicitations to support offshore wind focused R&D, with the intention that the solicitations will eventually be administered directly by the Consortium. • For a visual representation of this strategy, please reference the flow chart entitled "Logic Model: National Offshore Wind Research and Development Consortium," which can be found in Appendix A.
Goals	• Reduce Levelized Cost of Electricity (LCOE)[12] for offshore wind through technology, operational and grid integration advancement. • Increase penetration of offshore wind on the New York State electric grid in furtherance of the CES targets of 50% renewable energy by 2030 and 2,400 MW of offshore wind by 2030, at lower cost to New York ratepayers. • Establish New York as a global offshore wind research and development innovation hub, including supporting the formation of National Offshore Wind Research & Development Consortium. • Accelerate the development of U.S. based supply chain to support the deployment of offshore wind projects by advancing research projects that will adapt the industry to U.S.-specific infrastructure and supply chain expertise.
State Energy Plan/Clean Energy Standard Link	• New York's CES requires that 50% of the state's electricity come from renewable energy sources by 2030 and now requires that at least 2,400 MW come from offshore wind specifically. Additionally, the 2015 SEP set a goal of reducing the state's greenhouse gas emissions 40% by 2030 and 80% by 2050. Offshore wind will contribute to reaching both the CES and SEP goals by increasing the level of renewables deployed in New York.

[12] LCOE represents the net present value of the unit cost of electricity over an assumed lifetime of a generating asset.

18.2.2 Target Market Characterization

Target Market Segment(s)	The target market for this initiative includes entities engaged in the development of new offshore wind technologies and approaches, including universities, researchers, and companies.
Market Participants	Market participants include: • Offshore wind technology innovators and solution providers • Offshore wind project developers • Large original equipment manufacturers (OEMs) with a focus on offshore wind • New York Independent Systems Operator (NYISO) and utilities • Universities and research organizations with known research activities in offshore wind • US DOE • National Laboratories including: National Renewable Energy Laboratory (NREL), SANDIA, and Brookhaven National Labs • Trade associations including: Alliance for Clean Energy New York (ACE NY), New York Offshore Wind Alliance (NYOWA), and the Northeast Clean Energy Council (NECEC)
Market Readiness	• With the State's adoption of the target of 2,400 MW of offshore wind by 2030, and the authorization of the procurement of approximately 800 MW of offshore wind in 2018 and 2019 a focused effort is needed to grow the nascent offshore wind market in New York State and the United States as a whole. • Scaling the market to meet the goal will require a focused approach to addressing barriers to offshore. Stakeholder interest and commitment to participating in the Consortium indicates that the market is ready to engage in a such an effort. • In focusing on solutions related to the unique challenges associated with offshore wind including levelized cost, ecological concerns, site operations and maintenance, and manufacturing and supply chain development, the Consortium will directly complement public and private efforts to grow offshore wind.
Customer Value	• Companies and research institutions value the ability to leverage NYSERDA resources to de-risk investments, gain access to established market participants and market intelligence, and secure additional follow on capital to advance their innovative concepts to commercial readiness. • End users of the technologies, and electricity consumers will receive value from the cost reductions, performance improvements, and accelerated penetration of offshore wind on the grid realized through the innovations. For example, a 10% cost reduction from current offshore wind LCOE values could lead to $100 million in cost savings in 2030.

18.2.3 Stakeholder/Market Engagement

Stakeholder/Market Engagement	• Over 40 organizations have pledged support for the formation of the Consortium, including 9 offshore wind project developers. Support ranges from direct financial commitments to logistical and academic assistance. • NYSERDA will continue regular engagement with market stakeholders across the value chain (from technology providers to project developers and

	operators) throughout the initiative to ensure that NYSERDA remains in tune with and responsive to market needs.

18.2.4 Theory of Change

Technology Barriers Addressed	• **Lack of an organized innovation ecosystem for offshore wind power in New York.** NY State has committed to installing 2,400 MW of offshore wind power by 2030. However, NY does not currently have an organized pool of companies and innovators with offshore wind technology expertise. Opportunities exist to develop the innovation talent pool and infrastructure to support offshore wind technology advancement and LCOE reduction.
Testable Hypotheses	• If economic and performance improvements in offshore wind are achieved, then renewable penetration on the New York electric system will increase and assist the state in meeting or exceeding the CES and offshore wind targets. • If support is provided to the U.S. and N.Y. offshore wind innovation community through the establishment of the Consortium, then offshore wind technology and product advances will be accelerated, offshore wind LCOE will be reduced, and a leading New York offshore wind innovation ecosystem will be created.

Activities	**Support the formation of a New York based, National Offshore Wind Research and Development Consortium**
	• Initial efforts on the part of NYSERDA will focus on the formation of the Consortium as an independent non-profit, including designing governance structure and developing and implementing all operating procedures and policies – including Conflict of Interest and Intellectual Property policies.
	• The Consortium will build upon an existing model in UK, a consortium developed by the Carbon Trust.[13] The consortium will be governed by a volunteer Board of Directors, whose membership will be governed by corporate by-laws, which NYSERDA is in the process of designing in coordination with DOE for approval at the first formal board meeting of the Consortium. The Board of Directors will be composed of public sponsors, private sponsors, and independent members.
	  ○ Public sponsors include NYSERDA and DOE. As the Consortium moves forward, it is anticipated that additional public sponsors will be brought on, including other states, that may contribute additional funding.
	  ○ Private sponsors include technology agnostic wind developers whose motivation is reducing the cost of offshore wind installations. These entities do not generally prefer a given OEM or technology design. Inclusion of the Private Sponsors allows for fair and objective leadership of the Consortium by ensuring that manufactures or researchers are not setting the research agenda.
	  ○ Independent members include entities that have significant interests related to offshore wind, subject matter expertise, or relevant leadership experience. Initial members include representation from an electric utility, the national labs, and the director of the Carbon Trust.
	• The Board of Directors will set the Consortium's research agenda, subject to the terms and conditions of the agreements with DOE and NYSERDA. This will include weighing in on the establishment of research priorities that represent challenges that developers are facing and assisting in research

[13] https://www.carbontrust.com/offshore-wind/owa/.

project selection, in collaboration with DOE and NYSERDA. Public and Private Board of Directors members will also contribute funds to support Consortium operations.

- Other Consortium roles and responsibilities include the following planned advisory groups:
  - R&D Advisory Group (RDAG), which consists of representative from academia and primarily researchers.
  - Strategic Advisory Network (SAN), which includes organizations that have interests associated with offshore wind, including environmental groups (e.g. National Resources Defense Council), Industry Groups (e.g. Pacific Ocean Energy Trust (POET)), and other regulatory organizations (e.g. New York Independent System Operator, National Association of Regulatory Commissioners, etc.)
  - Technology to Market Group (TTM), which includes investors and philanthropic organizations.
  - Manufacturing, Supply Chain & Service Provider Council (MSSC), which includes established OEMs such as GE and Siemens Gamesa, smaller entities developing relevant technologies and products, and other representation across the offshore wind supply chain.
- Resources will be allocated toward implementation of the Consortium including the development of all operating principles including bylaws, governance, conflict management, intellectual property management, financial management, membership, communication activities, and industry stakeholder outreach. Effort will be allocated toward the development of contractual and licensing mechanisms to enable rapid technology transfer and facilitate commercialization. NYSERDA will be directly involved in initial and early implementation efforts and will be assisting the Consortium to develop capabilities necessary for the transition to self-sufficiency and on-going operations. As such, NYSERDA's expected level of engagement will lessen over time as the Consortium assumes these capabilities.

Establish a series of targeted solicitations to support offshore wind research and development

- Until it becomes self-sufficient, NYSERDA, on behalf of the Consortium, will develop and launch a series of competitive solicitations to support offshore wind focused R&D. The solicitations will reflect a set of technology innovation priorities that will identify key challenges and barriers to offshore wind to address. An initial set of priorities will be determined as part of establishing the Consortium and will be updated every 6 months.
- The process of establishing the initial Consortium research agenda has already kicked-off with industry developers and stakeholders providing input on initial research priorities through structured questionnaires. Additionally, DOE is currently conducting a Request for Information (RFI) to identify national research and test facility capabilities and investment opportunities. The RFI results are expected in late September 2018 and will further inform research priorities and investment needs for the U.S. offshore wind market.
- The competitively selected projects will focus on solutions to address these challenges and barriers. The technology innovation priorities and subsequent solicitations will focus on three core research pillars:
  - **Advancing offshore wind plant technology.** This pillar focuses on assessing and supporting innovations in wind plant design, modeling, and risk mitigation to reduce LCOE of offshore wind energy. Examples include: Field validate advanced turbine control technologies to reduce

	blade loads, assess lower cost foundation and construction methods, and utilize high fidelity tools (e.g. super computers) to analyze turbine or farm layout to maximize output. ○ **Develop innovative methods for wind resource and site characterization.** This pillar focuses on site characterization to mitigate risk, shorten timelines, and reduce siting, installation, and O&M costs. Examples include: unify wind and wave sensing methods to create new site-specific resource assessment methods and identify new approaches for detecting marine animals to extend construction window; reducing risk, time, cost in habitat areas. ○ **Develop advanced technology solutions for installation, O&M, and supply chain.** This pillar focuses on reducing direct installation costs and maximizing potential wind areas. Examples include: develop predictive tools and condition-based maintenance methods for gear boxes and other high-risk components to reduce down-time and O&M costs and perform fabrication and supply chain studies leveraging existing assets and expertise in other industries (e.g. offshore drilling). • Projects will be selected through a competitive process with determination of awards being a collaborative effort between NYSERDA, DOE and Consortium staff, with Consortium Board of Directors approval. Projects will be selected, awarded, and contracted on a rolling basis per defined NYSERDA and DOE required procedures and processes. Project deliverables will be milestone based. • Until the Consortium is fully-staffed, NYSERDA will administer the contracting processes with awardees, and management and oversight of projects will be a joint effort between NYSERDA staff and the Consortium. Activities will include development and implementation of the solicitation(s), and scoring, selection, contracting and administration of the R&D projects, which will be completed using NYSERDA's existing process. • NYSERDA's processes, which comply with applicable New York State and DOE contracting rules and requirements, will remain in effect even upon the future transfer of this responsibility to the Consortium. This includes the right of NYSERDA and DOE to determine whether a recipient or prospective recipient of NYSERDA or DOE funding under this effort can reasonably be expected to fully and satisfactorily comply with the required technical milestones, deliverables, contractual arrangements, and strategic direction of the overall effort. Failure to achieve any of these requirements may cause a recipient to be deemed to be materially noncompliant by either NYSERDA or DOE. Upon such a determination, either NYSERDA or DOE shall have the right to deny, suspend or terminate an award. These requirements will be identified in the contract between NYSERDA and the Consortium that will be executed at the first formal Board of Directors meeting of the Consortium. **Support the ongoing operations of the Consortium** • NYSERDA, with support from key Consortium partners and vendors, will support the ongoing operations of the Consortium for a transitional period until the Consortium demonstrates an acceptable level of financial and operational self-sufficiency. Specific activities to be undertaken during this period include: ○ Periodic updates to R&D priorities and resulting solicitations based on market feedback. ○ Develop mechanisms to facilitate cooperation between diverse offshore wind innovation resources including national labs, corporations, universities, and test facilities, while fostering collaboration across

	organizations in executing mutually beneficial offshore wind R&D projects. ○ Grow membership by attracting key U.S. national and global industry stakeholders as members of the Consortium, including offshore wind developers, turbine OEM's, suppliers, service providers, investors, and state and public entities. ○ Conduct technology to market outreach. NYSERDA will work to create visible opportunities for private and public investment in Consortium research and innovation partners, supporting startups and accelerating growth. ○ Demonstrate value to public sponsors and investor outreach to attract private investors, spurring sustained investment that provides a path to financial self-sufficiency. ○ Regular reporting to DOE on R&D projects and Consortium progress. • Over time the Consortium will add staff and associated capabilities for the following as determined appropriate by the Consortium Board of Directors: ○ Executive Management: Direct and oversee the technical program and operational teams. Engage with advisory groups. Report to the Board of Directors and represent technical and operations issues with Board of Directors vote. ○ Operations Management: Coordinate funding, legal and policy activities to support project execution. Develop recommendations for new and revised policies to support research priorities and overall offshore wind program goals. Coordinate engagement with advisory groups; schedule and administers Consortium sponsored conferences, meetings, and other stakeholder engagement activities. Manage technical staff. ○ Technical Director: Direct research according to the Board of Directors approved R&D priorities. Develop solicitations and drive project execution. Represent Consortium to oversee the competitive project selection process and recommend qualified project proposals to the Board of Directors. ○ Technical staff: Project managers to oversee each technical pillar. Manage efforts to identify R&D priorities, R&D project execution including schedule, budget, and achievement of technical milestones. ○ Legal: Oversee all legal functions including contracting, due diligence, export compliance and intellectual property. Ensure project adherence to applicable federal, state, and local policies pertaining to leasing, environmental compliance, labor and other areas. ○ Finance: Manage program finances including collection of membership fees, public and private funding sources. Ensure financial compliance and generate required reports and disclosures.
Key Milestones	<u>Milestone 1 (2018) - Complete</u> • National Offshore Wind Research and Development Consortium incorporated. <u>Milestone 2 (2018) - Complete</u> • Approval of Consortium bylaws, governance procedures, membership procedures, and operating procedures by Consortium Board of Directors and DOE. <u>Milestone 3 (2018) - Complete</u> • Consortium kickoff meeting held.

	Milestone 4 (2018) - Complete • Contract establishing Consortium fully executed with DOE. Milestone 5 (2018) - Complete • Release of initial R&D priorities. Milestone 6 (2018) - Complete • Consortium staff and membership structure approved by Consortium Board of Directors. Milestone 7 (2018) - Complete • Intellectual property management plan approved by Board of Directors and DOE. Milestone 8 (2019) - Complete • Consortium communication and outreach strategy approved by Consortium CEO. Milestone 9 (2019) - Complete • Consortium website launched. Milestone 10 (2019) - Complete • Project financial, intellectual property, and contractual templates, terms & conditions, guidelines and policies approved by the Consortium Board of Directors. Milestone 11 (2019) - Complete • Collaboration agreement and standard project terms and conditions with each national research and test facility partner approved by Consortium legal staff and CEO. Milestone 12 (2019) - Complete • Competitive solicitation procedures and processes, templates, scoring guidelines and mechanisms approved by the Consortium Board of Directors. Milestone 13 (2019) - Complete • Issue competitive solicitations for initial R&D priorities. Milestone 14 (2019) - Complete • Contract projects selected through initial solicitations. Milestone 15 (2019) - Complete • Update R&D priorities. Milestone 16 (2019) - Complete • Revise competitive solicitations to align with updated R&D priorities. Milestone 17 (2020) • U.S. manufacturing and data management plans approved by Board of Directors and DOE. Milestone 18 (2020) • Investor and public sponsor outreach strategies approved by Board of Directors.

	Milestone 19 (2020) • Issue awards for projects selected through solicitations. Milestone 20 (2021) • Issue awards for projects selected through solicitations. Milestone 21 (2022) • Issue awards for projects selected through solicitations.
Goals Prior to Exit	• New York is a nation leading offshore wind research and development center and innovation hub. • National Offshore Wind Research and Development Consortium is self-sustaining. • Reduction in the Levelized Cost of Electricity (LCOE) for offshore wind.

18.2.5 Relationship to Utility/REV

Utility Role/Coordination Points	• The Consortium Board of Directors will have representation from one of New York's investor owned utilities. National Grid has agreed to serve as the initial utility board member. The Long Island Power Authority and the New York Independent System Operator (NYISO) will also participate in Consortium activities in an advisory role. • In this role, the utility representatives will contribute towards defining research priorities, selection of research projects, identifying interconnection and grid reliability challenges and facilitating technology transfer.
Utility Interventions in Target Market	• While utilities are not investing directly in renewables, they are developing a range of systems to facilitate integration of renewable resources at the distribution and bulk power level.

18.2.6 Budgets

An annual commitment budget for all activities included in this chapter is shown in Appendix B. Budgets 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 Appendix B is intended for informational purposes only. In addition to the NYSERDA budget provided in Appendix B, this initiative will also allocate $20.5 million in federal DOE funding.

18.2.7 Progress and Performance Metrics

Appendix C 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.

In addition, NYSERDA will also assess the following broad outcomes:

- Reduced Levelized Cost of Electricity (LCOE) for offshore renewables[14]

Benefits shown in Appendix B, listed as direct, 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. Due to the nature of the activities, estimating energy savings impacts at this stage is difficult because the specific technologies that will be supported are not known. However, energy savings for projects supported by this initiative will be tracked and reported.

18.2.8 Fuel Neutrality

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

18.2.9 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. **<u>Test-Measure-Adjust Strategy</u>** • NYSERDA will monitor standard activity/output metrics including number of projects initiated and completed by type and private investment. • For any new technology developments launched under the program, on a yearly basis, NYSERDA staff will reassess the Technology and Commercialization Readiness Levels for each project in the portfolio. • NYSERDA will conduct peer reviews of certain projects based on need. Examples – technical impasse, pivot point, critical milestone. • NYSERDA will assess the portfolio of projects annually regarding goals, metrics, outputs, and outcomes. The solicitation process and the technologies that are supported through the first procurement of projects will be assessed to determine any adjustments that could improve the procurement activity for subsequent solicitations. **<u>Market Evaluation</u>** • Specific technologies funded through this initiative will not be identified until proposals are received through various solicitations. Focusing on the selected proposals, NYSERDA will gather and document relevant baseline indicator values, such as LCOE values, from known sources such as internal, public, and commercially available data. This baseline information will be gathered following each round of projects contracted under the competitive solicitations. • Baseline values and their associated change over time will be assessed using cost and performance data from project proposals and final project reports.

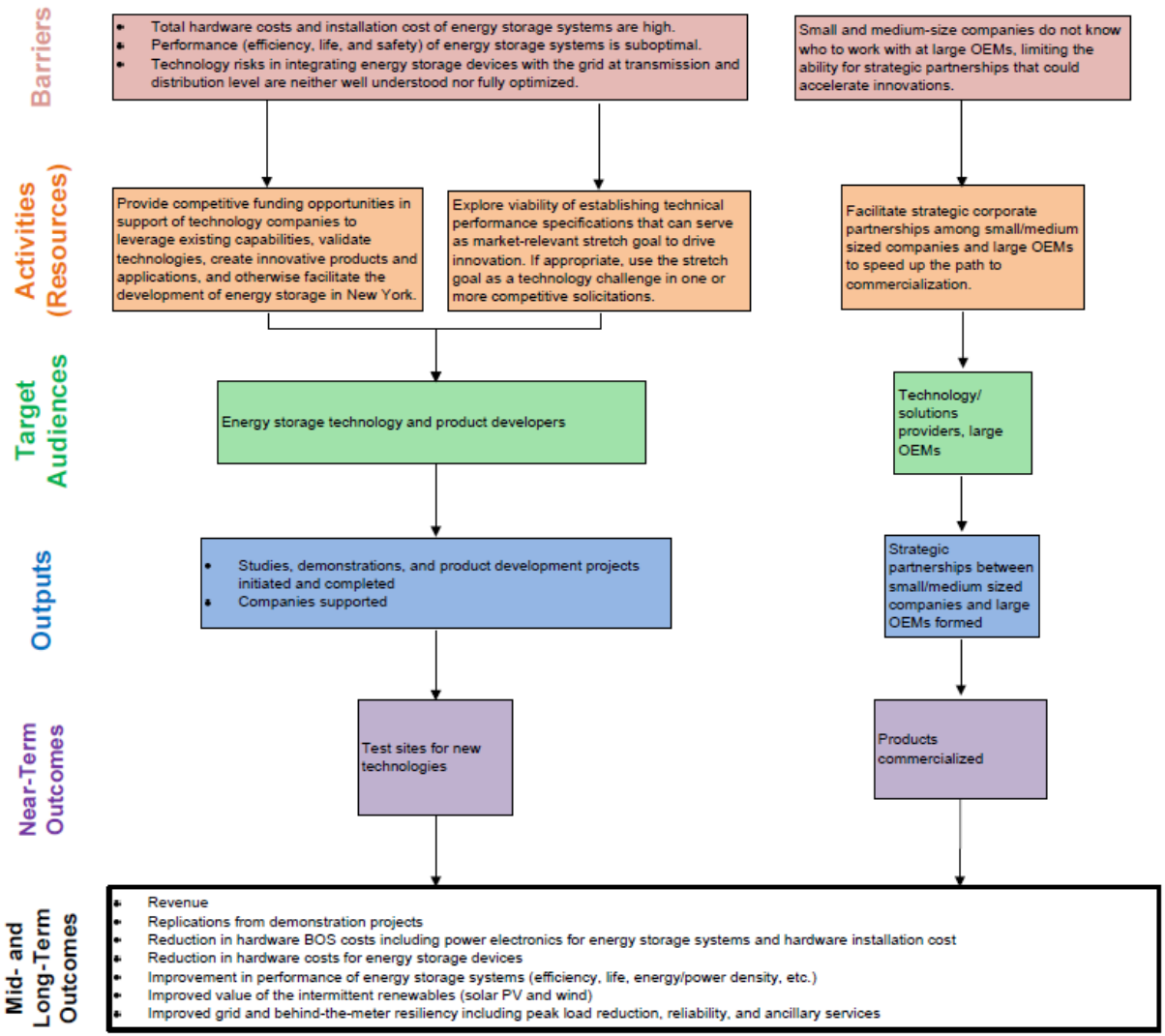
[14] As part of a standard approach towards project management NYSERDA and the Consortium will require that project awardees assess the price, performance, and other impacts of the R&D efforts. This will include efforts to determine baseline values for the metrics to be tracked/assessed.

	These values will be specific to the technologies funded under this initiative, and will be vetted by the solicitation scoring committee, including NYSERDA staff for accuracy. • Case studies and historical tracing methods will be used to assess outcomes and indicators after a critical mass of program-initiated activity has been completed. These methods will measure and substantiate the initiative's role in areas such as LCOE and offshore wind penetration. **Impact Evaluation** • A broad demonstration project impact evaluation will include projects from this area and will examine benefits of projects, rate of success factors associated with replication, and benefits of replication projects.

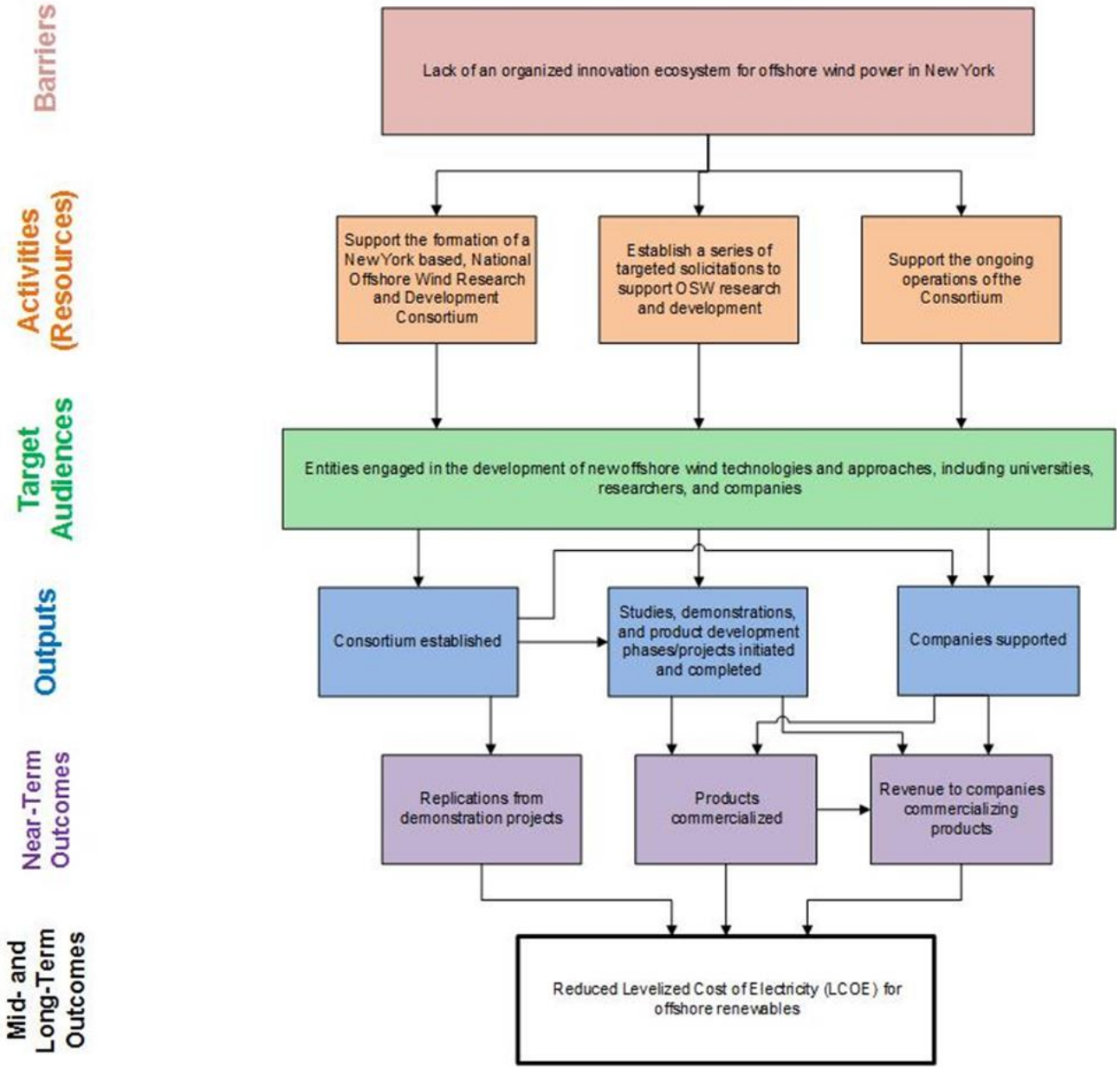
Verified Gross Savings Specifications – not applicable

Appendix A – Logic Models

LOGIC MODEL: Energy Storage Technology and Product Development



LOGIC MODEL: National Offshore Wind Research & Development Consortium



Appendix B | Initiative Budget and Benefits Summary

Energy Storage Technology and Product Development

	Actuals	Actuals	Actuals	Actuals	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	
Direct Benefit	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Energy Efficiency MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Participant Bill Savings Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Participant Bill Savings Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leveraged Funds	-	3,503,655	20,327,855	24,418,420	22,000,000	33,000,000	18,150,000	18,150,000	18,150,000	14,592,768	-	-	-	-	-	172,292,698

Indirect Benefit	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Energy Efficiency MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MW Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Energy Usage	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Direct Energy Usage MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Participants	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Participants	-	2	8	18	5	8	6	6	6	6	-	-	-	-	-	65
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**-**	**2**	**8**	**18**	**5**	**8**	**6**	**6**	**6**	**6**	**-**	**-**	**-**	**-**	**-**	**65**

Budget	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Direct Incentives and Services	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Implementation Support	-	19,605	218,693	133,438	60,502	62,122	63,791	65,510	67,280	128,064	-	-	-	-	-	819,005
Research and Technology Studies	-	700,731	4,065,637	4,861,396	4,000,000	6,000,000	3,300,000	3,300,000	3,300,000	2,653,231	-	-	-	-	-	32,180,995
Tools, Training and Replication	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Support	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**-**	**720,336**	**4,284,331**	**4,994,834**	**4,060,502**	**6,062,122**	**3,363,791**	**3,365,510**	**3,367,280**	**2,781,295**	**-**	**-**	**-**	**-**	**-**	**33,000,000**

Table Notes:

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

b. Participants are awardees of NYSERDA contracts.

Appendix B | Initiative Budget and Benefits Summary

National Offshore Wind Research & Development Consortium

	Actuals	Actuals	Actuals	Actuals	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	Plan	
Direct Benefit	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Energy Efficiency MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MW	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Participant Bill Savings Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Participant Bill Savings Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Leveraged Funds	-	-	1,394,261	34,965,445	47,546,026	15,000,000	9,374,125	1,482,500	1,532,500	1,533,910	-	-	-	-	-	112,828,767

Indirect Benefit	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Energy Efficiency MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Energy Efficiency MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Renewable Energy MW Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
CO2e Emission Reduction (metric tons) Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Energy Usage	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Direct Energy Usage MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Direct Energy Usage MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MWh Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MWh Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MMBtu Annual	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Indirect Energy Usage MMBtu Lifetime	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Participants	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Participants	-	-	3	7	10	9	8	-	-	-	-	-	-	-	-	37
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Total	**-**	**-**	**3**	**7**	**10**	**9**	**8**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**37**

Budget	**2016**	**2017**	**2018**	**2019**	**2020**	**2021**	**2022**	**2023**	**2024**	**2025**	**2026**	**2027**	**2028**	**2029**	**2030**	**Total**
Direct Incentives and Services	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Implementation Support	-	-	2,581	242,137	272,500	281,500	291,500	296,500	306,500	306,782	-	-	-	-	-	2,000,000
Research and Technology Studies	-	-	278,852	3,576,416	6,644,732	-	-	-	-	-	-	-	-	-	-	10,500,000
Tools, Training and Replication	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Business Support	-	-	-	3,416,675	2,000,000	3,000,000	1,583,325	-	-	-	-	-	-	-	-	10,000,000
Total	**-**	**-**	**281,433**	**7,235,228**	**8,917,232**	**3,281,500**	**1,874,825**	**296,500**	**306,500**	**306,782**	**-**	**-**	**-**	**-**	**-**	**22,500,000**

Table Notes:

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

b. Participants are awardees of NYSERDA/Consortium contracts.

Energy Storage Technology and Product Development

	Indicators	Baseline (Before/Current)	**2019** Target (cumulative)	**2022** Target (cumulative)
Outputs	Number of studies, demonstrations, and product development projects initiated	0	30	60
	Number of studies, demonstrations, and product development projects completed	0	10	46
	Number of strategic partnerships between small/medium sized companies and large OEMs formed	0	5	23
	Number of companies supported	0	25	55
Outcomes	Number of products commercialized	0	3	14
	Number of test sites for new technologies	0	9	18
	Revenue to companies commercializing products ($millions)	0	$3	$23
	Number of replications from demonstration projects	0	10	30
	Hardware BOS cost including power electronics for energy storage systems and Hardware Installation cost	Lead acid system: $1000/kWh for 4 hr. duration. Lithium ion system: $667-$670/kW.	10% cost reduction	20% cost reduction
	Hardware cost for energy storage devices	Lead acid system: $600-$650/kWh for 4 hr. duration. Lithium ion system Hardware (excluding battery): $369-$380/kW Battery only: $350- $500/kWh	10% cost reduction	20% cost reduction
	Performance of energy storage systems (efficiency, life, energy/power density, etc.)	TBD	10% improvement	20% improvement

Table notes

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

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

c. Within the recently-completed Energy Storage and Renewables Optimization market baseline evaluation, these values are from New York State installations in 2016.

d. Within the recently-completed Energy Storage and Renewables Optimization market baseline evaluation, these values are from secondary data and do not reflect New York State specific costs. Baseline data will be updated when New York State installations are available.

e. Within the recently-completed Energy Storage and Renewables Optimization market baseline evaluation, these values are from New York State installations in 2016.

f. Within the recently-completed Energy Storage and Renewables Optimization market baseline evaluation, these values are from secondary data and do not reflect New York State specific costs. Baseline data will be updated when New York State installations are available.

Appendix C | Initiative Outputs and Outcomes Summary

National Offshore Wind Research & Development Consortium

	Indicators	Baseline (Before/Current)	2021 Target (cumulative)	2025 Target (cumulative)
Outputs	Number of studies, demonstrations, and product development projects initiated	0	25	31
	Number of studies, demonstrations, and product development projects completed	0	6	31
	Number of companies supported	0	12	15
Outcomes	Number of products commercialized	0	0	3
	Non-NYSERDA revenue to companies commercializing products ($ millions)	0	$0.5	$10
	Number of replications from demonstration projects	0	0	4

Table notes

a. A 0 (zero) as the baseline value denotes that NYSERDA will not count any activities, outputs, and outcomes supported with prior resources (e.g., pre CEF) towards the achievement of the stated goals in this table.

b. Here, replications are defined as known incidences where the innovation was deployed without NYSERDA involvement.