2018 Energy Storage Market Evaluation

Final Survey Report

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1 Introduction

1.1 Program Description

This report presents results from primary data collection efforts completed by the evaluator for the following two NYSERDA energy storage initiatives:[1]

1. Reducing Barriers to Deploying Distributed Energy Storage (DES) Investment Plan:[2] Energy storage is a multifaceted technology that cuts across many sectors, including clean energy production, energy efficiency, various types of customers and buildings, and both established technologies and those still in development. NYSERDA's energy storage strategy targets key barriers limiting energy storage adoption in three sectors: customer-sited (behind-the-meter [BTM] systems), transmission and distribution (T&D) system needs, and the transportation system. This initiative originally sought to reduce soft costs for customer-sited energy storage systems, specifically related to permitting, customer acquisition, and interconnection, by 25% per kWh in three years and 33% or more in five years, based on a 2015-16 baseline of $200/kWh at the time. This goal has now been recalibrated to the broader objectives described in the PSC Energy Storage Order which referenced estimates in the NYS Energy Storage Roadmap that New York can reduce total soft costs by up to $50 per kWh for a distribution/bulk storage system and up to $150 per kWh for a customer sited system by 2025 compared to 2017-18 costs. These soft cost reductions are now inclusive of all use cases and include permitting, interconnection, customer acquisition, as well as engineering and construction costs, and tools to support market replication. This initiative works in conjunction with NYSERDA's market acceleration storage incentives.[3]

[1] The evaluator is currently conducting secondary data collection and analysis and will present those results in Fall 2019.

[2] Clean Energy Fund Investment Plan: Energy Storage Chapter. Portfolio: Market Development. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. Revised April 19, 2019. https://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/CEF-Energy-Storage.pdf

[3] https://www.nyserda.ny.gov/All-Programs/Programs/Energy-Storage/Developers-Contractors-and-Vendors

2. Energy Storage Technology and Product Development Investment Plan:[4] There are many grid and consumer benefits from the increased use of renewable energy assets and energy storage. Optimizing the energy output and uptime of renewable resources will provide near-term economic benefits and decrease the total cost to deploying renewable technologies in the 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. To meet these goals, NYSERDA is undertaking the following activities:

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

1.2 Summary of Evaluation Objectives and Methods

The evaluation objectives and select results from the 2018 primary data collection efforts completed by the evaluator are shown in Table 1 and Table 2. The evaluation design is

[4] Clean Energy Fund Investment Plan: Renewables Optimization Chapter. Portfolio: Innovation & Research. Matter Number 16-00681, In the Matter of the Clean Energy Fund Investment Plan. September 7, 2018. https://www.nyserda.ny.gov/-/media/Files/About/Clean-Energy-Fund/CEF-Renewables-Optimization-chapter.pdf

longitudinal in nature and is structured to capture data over multiple years. This design allows program stakeholders to compare current market conditions to baseline market conditions established in 2017 and to observe market trends over time. The time-series data developed over the course of the evaluation will help NYSERDA and other program stakeholders better understand the actors and dynamics that drive the energy storage market in New York State as the market grows from its current nascent state.

Table 1: Evaluation questions mapped with 2018 primary data collection results

Objective: Develop a reliable, detailed, New York-based estimate of current soft costs ($/kWh) of DES systems as a component of the total installed cost ($/kWh, duration)

Evaluation Question(s)	2018 Findings
What is the current estimate of soft costs ($/kWh capacity) of DES systems?[5]	Average = $212/kWh Median = $200/kWh *n*=5
What is the installed cost per kilowatt-hour capacity for energy storage systems by duration?[6]	Average = $1,000/kWh Median = $1,000/kWh Duration not specified[7] *n*=5
How many alternative ownership models (e.g., third-party ownership, end-user ownership, performance contracting) are being used?	Limited data was reported in 2018 for both behind-the-meter (BTM) and front-of-the-meter (FTM) projects, though third-party performance contracting models and end-user ownership were mentioned by survey respondents. Given that this is an emerging market, this may not be indicative of larger trends over time.
What is the percent conversion rate (%) of prospective installations from proposal to installed projects?	Median = 5% Average = 18% *n*=5
What is the current cycle time (months) for the permitting process?[8]	Insufficient data collected.[9]
Are there challenges with siting and permitting requirements?	Two survey respondents mentioned known challenges with permitting requirements in New York City which have been the subject of significant NYSERDA engagement.
What is the cycle time (months) of projects from customer proposal to commissioning?	Reported total cycle time for BTM projects was 12 months. Insufficient data was collected for FTM projects; however, it appears this cycle time can be up to two times longer.

[5] Includes a combination of two- to four-hour systems.

[6] Duration is defined as the ratio of the storage system's energy capacity to power capacity which indicates the length of the system's full discharge.

[7] NYSERDA opted not to collect data in 2018 regarding system duration characteristics given the anticipated limited number of survey respondents.

Table 2: Evaluation questions mapped with secondary data collection results

Objective: Develop a reliable, detailed estimate of current hardware and hardware balance of system (BOS) costs ($/kWh) of energy storage systems

Evaluation Question(s)	2018 Findings
What is the current hardware cost ($/kWh) for energy storage devices?	These results are forthcoming; expected publication date, Fall 2019.
What is the current hardware BOS cost for energy storage systems including power electronics and hardware installation cost ($/kWh)?	
What is the current performance of energy storage systems in terms of efficiency, life, energy/power density, etc.	

[8] Definition of cycle time and permitting process details can be found in the survey document (Appendix A)

[9] Too few survey responses to accurately draw quantitative conclusions. Qualitative observations presented in Section 2.1.3.

2 Market Characterization and Assessment

2.1 Primary Data Collection Results

This section summarizes DES system installation costs, project cycle times, characteristics of projects statewide, value propositions, ownership models, and barriers in the New York market. The data included in this analysis was compiled from 26 companies that responded to the evaluation survey. The analysis included all companies that contracted or completed DES projects in New York State in 2018. Not all companies answered all survey questions, however, so the evaluator presents the number of responses for each set of results. Section 3.1.3, "Respondent Characteristics," provides additional details regarding the companies that responded to the evaluation survey.

2.1.1 System Costs

The survey asked responding companies to provide information on average installed costs for their primary use case DES systems.[10] The evaluator collected information from five respondents serving commercial and industrial (C&I) BTM customers and three respondents serving utility front-of-the-meter (FTM) customers. While the survey sample includes a small number of respondents, the storage market in New York is relatively nascent with few players. NYSERDA tracks operational projects in New York State and has confirmed the survey responses collected by the primary research activities are representative of the market and capture the companies implementing most projects in the state.[11]

Survey respondents reported that 10 use cases were electrochemical systems, with nine lithium ion (Li-ion) installations (including one secondary use case) and another secondary use case lead-acid installation. Five of the Li-ion installations and the one lead-acid installation were BTM and

[10] The survey also asked companies to provide information on average installed costs for secondary use case DES systems. Two respondents provided both primary and secondary use case information as defined in the survey document (See Appendix A).

[11] A database of all distributed energy resource projects installed throughout New York is available here: https://der.nyserda.ny.gov/

the remaining four Li-ion installations were FTM. Three DES systems were installed in New York City, four in Westchester County, and the remaining two were installed in other parts of the state. Reported system size ranged from 60 kWh to 20,000 kWh, with the average and median system size both equaling 500 kWh. While the average system duration was not collected in the 2018 survey, the evaluator recognizes that system duration affects total system cost—shorter duration systems will be more expensive.[12] In future years, the evaluator will collect duration data on a project-specific basis and duration will be a consideration in reporting system costs.

The evaluator asked companies to estimate what percentage of total system cost was spent on hardware, engineering and construction, and soft costs. These categories are defined as follows:

- **Hardware costs:** Battery module, inverter, and BOS costs such as fire controls, power electronics, communication system, containerization, insulation, HVAC system, meter, control system, and outdoor containerization (when necessary).
- **Engineering and construction costs:** Cost of design, site preparation, transportation, siting, Professional Engineer approval, testing and commissioning, electrician and installation labor, wiring, fencing, and other overhead.
- **Soft costs:** Cost of customer acquisition, permitting and interconnection, and financing.

Seven of the eight respondents who provided complete use case information also provided soft cost information. The evaluator analyzed these use cases separately. The results presented in Table 3 are for respondents who provided complete soft cost data. The evaluator excluded from the analysis one respondent who provided incomplete soft cost data.

Table 3: Average costs of BTM C&I DES projects in 2017 and 2018, by component*

Name	Unit	2017		2018	
		Average	Median	Average	Median
Total average installed system cost	$/kWh	$883	$850	$1,000	$1,000
Hardware costs	%	62	60	55	50
Engineering and construction	%	22	20	24	20

[12] NYSERDA opted not to collect data in 2018 regarding system duration characteristics given the anticipated limited number of survey respondents.

Name	Unit	2017		2018	
		Average	Median	Average	Median
Soft costs	**%**	**17**	**15**	**21**	**20**
Customer acquisition costs	*%*	*3*	*3*	*2*	*2*
Permitting	*%*	*8*	*10*	*6*	*8*
Interconnection	*%*	*5*	*5*	*10*	*10*
Financing costs	*%*	*1*	*0*	*3*	*0*

*The percent sum of average hardware costs, engineering and construction costs, and soft costs should sum to 100, any variance is due to rounding. The median values do not necessarily sum to 100, due to the variance within data points. Soft costs are a sum of the average customer acquisition costs, permitting, interconnection, and financing costs. These also sum to 100 for average columns, but not the median columns.

Survey respondents indicated that average installed system costs in 2018 were $1,000/kWh. This value is slightly higher than the 2017 value. The percent of costs attributable to soft costs was 21% on average in 2018, which is also higher than the percent observed in 2017 (17%). While trends in installed system costs and soft costs appear to have increased over time, the limited number of respondents means that a few projects could skew these generalized results from one year to the next. The evaluator will continue to collect time-series data regarding these metrics in the coming years so that NYSERDA and other program stakeholders can monitor these trends as the market matures and an increasing number of DES projects are installed in New York State.

Few 2018 survey respondents reported installing FTM DES systems; however, of those that did, it appears that the larger scale of these installations located outside of the Con Edison service territory led to a lower average installed cost per kilowatt-hour than the BTM projects reported in Table 3.

2.1.2 Value Proposition and Alternative Ownership Models

Survey respondents cited several benefits of DES systems that were important in closing the deal for potential customers. As shown in Table 4, the most frequently cited benefits in 2018 shifted somewhat from 2017 with 75% of responding companies (n=4, 2 FTM, 2 BTM) citing distributed generation integration and non-wires alternative services most frequently. In 2017 (n=5), the investment tax credit, demand charge management, and demand response payments were the most frequently mentioned benefits (63%).

Table 4: DES system benefits important for deal closure

Benefit	Percent of Respondent Companies	
	2017	2018
Investment tax credit	63%	50%
Distributed generation integration	38%	75%
Non-wires alternative services	38%	75%
Demand charge management	63%	50%
Demand response payments	63%	50%
Resilience/backup power	38%	25%
Other	25%	0%

Multiple response question, 2017 n=9, 2018 n=4 (2 FTM, 2 BTM)

One of NYSERDA's objectives is to increase the number of alternative ownership models (e.g., third-party ownership, end-user ownership, performance contracting) for DES projects. Respondents provided limited data in 2018 for both BTM and FTM projects, though third-party performance contracting models and end-use ownership were mentioned for both categories. Given that this is an emerging market, this may not be indicative of larger trends over time.

2.1.3 Barriers in the New York State Market

NYSERDA aims to increase the percent conversion rate for DES projects receiving a proposal to projects receiving a contract. The development of a major storage proceeding in 2018 caused a pause in the market as DES developers waited for the State's plans.[13] The NYSERDA incentive program launched in early 2019 and is expected to positively influence the number of DES installations in New York State in 2019 and beyond. Developer reticence to engage in new

[13] On June 21, 2018 Governor Cuomo announced the release of the State's Energy Storage Roadmap. The Roadmap identifies short-term recommendations for how energy storage can deliver value to New York electricity consumers and cost-effectively address the needs, and demands of the grid, supporting the Governor's energy storage target of 1,500 MW by 2025. In December 2018, the New York Public Service Commission (PSC) issued a landmark energy storage order, based upon the Roadmap recommendations. The order established a 3,000 MW by 2030 energy storage goal and deployment mechanisms to achieve both the 2025 and 2030 energy storage targets. On April 25, 2019, NYSERDA filed its approved implementation plan with the PSC that outlines the details of the incentive structure and design that will be used to support the incentive programs. The implementation plan adopts the foundational commitment of the energy storage order and aims to create a self-sustaining energy storage market over time.

projects in 2018 is supported by companies (n=5) that reported an average of 18% of 2018 projects that received a proposal went on to receive a contract, compared to an average of 45% in 2017 (n=6).[14] Conversely, companies reported an average of 25% of DES projects (n=5) waiting for permits to be approved in 2018, compared to an average of 42% of DES projects (n=9) waiting for permits to be approved in 2017.

Responses were not conclusive on how long the total project cycle time is for New York State-specific projects relative to other jurisdictions, with some companies reporting longer time required in New York State, while others said New York State was similar to or slightly faster than other jurisdictions. One company expanded upon its response and stated that New York State-specific projects tend to take longer than California and shorter than Canada.

2.2 Secondary Data Collection Results

This section is forthcoming; expected publication date, Fall 2019.

[14] Some zero values were excluded because all companies included in the analysis reported at least one 2017 project installed, commissioned, or in the pipeline with an executed contract.

3 Findings

Finding 1

Total installed average system cost and proportional percent of soft costs increased in 2018 compared to 2017. However, the evaluator acknowledges that both years' analyses are based on a limited number of respondents and may not reflect larger market trends. NYSERDA tracks operational projects in New York State and has confirmed the survey responses collected by the primary research activities are representative of the market and capture the companies implementing most projects in New York State.

Finding 2

Survey respondents were asked to provide average total cost and soft costs for their New York State energy storage projects in 2018 but did not report costs on a project-specific basis. Future evaluations should include collection of project-specific cost data by either program staff or the evaluator. This includes cost data for all projects located in New York State, such as utility-owned projects not previously surveyed, in order to most accurately reflect market evolution.

Methods

3.1 Primary Data Collection Methods

This section describes the methods the evaluator used to complete the primary data collection activities.

3.1.1 Survey Design and Data Collection

NYSERDA fielded a survey to 85 energy storage companies in February and March 2019. Due to a low initial response rate, the evaluator collaborated with NYSERDA to target key respondents for enhanced communication including email follow-up, outbound phone calls, and personal messaging via LinkedIn. The evaluator closed the survey in the second week of March. The survey instrument gathered data on the following items:

- Key selling points for DES projects
- Characteristics of DES projects in New York State
- Characteristics of each company's primary DES use case
- Percentage of DES project costs spent on hardware, engineering and construction, and soft costs

- Length of DES project sales and implementation cycles
- Differences between the DES market in New York State and other markets
- Company characteristics

Twenty-six companies responded to the survey (31% response rate) with nine companies answering all questions in the survey, including providing cost information. Several companies cited confidentiality concerns as a reason for not answering all questions in the survey. One company installed thermal energy storage projects, which the evaluator removed from the analysis due to the differences between thermal storage and battery systems. The remaining 16 companies did not install, commission, or have any projects in the pipeline with an executed contract in New York State in 2018 so they indicated that many questions were not applicable to their business.

3.1.2 Analysis

The evaluator fielded the survey using Qualtrics and downloaded the data for analysis in Excel. The evaluator conducted all data analysis, excluding all instances where missing information could not be resolved. The evaluator also excluded responses from companies that indicated they did not install, commission, or have any projects in the pipeline with executed contracts in New York State in 2018, except those related to respondent characteristics. Results were not weighted due to a concern that weighting would add additional bias.

3.1.3 Respondent Characteristics

Companies were asked what roles they filled in the energy storage market. Mirroring 2017, developer (n=14) was the most common role fulfilled by companies in 2018 followed by integrator (n=5) and manufacturer (n=5). Results are shown in Table 5.

Table 5. Company roles in energy storage market (multiple response)

Company Type	Number of Companies (2017, n=20)	Number of Companies (2018, n=23)
Developer	13	14
Integrator	8	5
Installer	8	4
Manufacturer	6	5
Sales	4	3
Financier	4	1
Distributor	3	2
Other	3	2

3.1.4 Statewide DES Projects

In addition to providing metrics on their primary and secondary use cases, energy storage companies were asked to report on all projects installed, commissioned, or in the pipeline with an executed contract in New York State in 2018. On average, companies (n=7) reported that 47% of their North American (i.e., U.S. and Canada) energy storage portfolio was located in New York State and 31% of their New York State energy storage portfolio was located in New York City.[15]

Respondents (n=7) reported that 18 total projects were installed, commissioned, or had a contract signed in New York State in 2018. The majority of reported projects (n=12) were BTM. All projects were electrochemical projects, with three lead-acid projects and 15 Li-ion projects. Thermal projects in New York City were reported by one developer; however, the evaluator removed this data from the analysis due to the differences between thermal storage and battery systems. Nineteen companies indicated that they did not implement any projects in New York State in 2018.

[15] These percentages are based on energy storage system capacity.

Seven companies provided information on the sectors they most frequently served, with two reporting that they served the utility sector and five reporting that they served commercial facilities.

3.2 Secondary Data Collection Methods

This section is forthcoming; expected publication date - Fall 2019.