

2019 Energy Storage Market Evaluation

Appendices to the Final Report

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Notice

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Appendix A: Additional Secondary Data Collection and Analysis

Table A-1 shows the calculated compound annual growth rate (CAGR) values for costs by component (Section 2.2.4.6). The evaluators calculated pre-2018 and post-2018 CAGR values relative to the 2018 prices from the duration analysis using sources with data across multiple years.

Table A-1. Annual Cost Reductions by Component (CAGR)

Timeframe	Battery	PCS	BOS	HW	EMS	EPC	Total Cost
2015-2017	-10%	-10%	-6%	-10%	-	-	-
2017-2018	-25%	-22%	-32%	-26%	-	-	-
2018-2021	-11%	-12%	-4%	-10%	-2%	-6%	-10%

A list of sources used in both 2017 and 2018 analyses and the type of data obtained from each of the sources is shown in Table A-2.

Table A-2. List of Sources

Source	Cost	Performance		
		Efficiency	Density	Lifetime
Black & Veatch	✓			
Bloomberg	✓			
BMZ		✓	✓	✓
BYD		✓		
Con Edison			✓	
Deloitte		✓	✓	✓
EIA	✓			
Electrovaya			✓	✓
Eos		✓	✓	✓
EPRI	✓		✓	
GE		✓	✓	✓
GTM	✓		✓	✓
HDR	✓	✓		✓
IRENA	✓	✓	✓	
IVA		✓	✓	
Kokam		✓	✓	✓
Leclanche			✓	✓
LG Chem		✓	✓	
Lockheed Martin		✓	✓	
McKinsey	✓			
Navigant	✓	✓	✓	✓
NREL	✓			
NYSERDA	✓			
PacifiCorp	✓	✓		✓
Panasonic		✓		
Primus Power		✓		✓
Samsung SDI			✓	✓
SGIP		✓		
Tesla	✓	✓		
UniEnergy		✓		✓
Vionx Energy		✓	✓	✓

Appendix B: Acronyms and Abbreviations

AC	Alternating current
CAGR	Compound annual growth rate
C&I	Commercial and industrial
BMS	Building management system
BOS	Balance of system
DC	Direct current
DES	Distributed energy storage
EMS	Energy management system
EPC	Engineering, procurement, and construction
HVAC	Heating, ventilation, and air conditioning
HW	Hardware
kW	Kilowatt(s)
kWh	Kilowatt-hour(s)
Li-ion	Lithium ion
LFP	Lithium iron phosphate
LTO	Lithium titanate oxide
MUSH	Municipal, university, school, and hospital buildings
MW	Megawatts
NYSERDA	New York State Energy Research and Development Authority
OEM	Original equipment manufacturer
PCS	Power conversion system
PE	Professional Engineer
PV	Photovoltaics
REV	Reforming the Energy Vision
SGIP	Self-Generation Incentive Program (California)
W	Watt(s)

Appendix C: 2018 Survey Instrument

Start of Block: Respondent Company Profile and Introduction

Q1.2 What is your firm's role in the market for energy storage systems? [Check all that apply]

1. Manufacturer
2. Distributor
3. Sales
4. Integrator
5. Developer
6. Installer
7. Financier
8. Other (please specify)_____

End of Block: Respondent Company Profile and Introduction

Start of Block: Installation Activities

Q2.1 Please respond to the following questions for energy storage projects that meet **all** of the following criteria:

- Energy storage primarily for load management or grid services
- [in 2018 only] Installed, or contracted and submitted for permitting and interconnection
- Located in New York State

Please only include projects that your company was the lead contractor on.

How many total projects meet all of the above conditions? If none, please enter 0.

Q2.1.1 In front of the meter projects: [Numeric response]

Q2.1.2 Behind the meter projects: [Numeric response]

[If Q2.1.1 = 0 AND Q2.1.2 = 0, skip to Closing block]

[If Q2.1.1>0]

Q2.2.1 How do the [ANSWER from Q2.1.1] **in front of the meter** projects split across the following technologies and system locations? [Constant Sum question type; force responses to sum to answer to Q2.1.1]

Lead Acid: [NUMERIC REPSONSE]

Lithium Ion: [NUMERIC REPSONSE]

Thermal: [NUMERIC REPSONSE]

Other: [NUMERIC REPSONSE]

[If Q2.1.2>0]

Q2.2.2 How do the [ANSWER from Q2.1.2] **behind the meter** projects split across the following technologies and system locations? [Constant Sum question type; force responses to sum to answer for Q2.1.2]

Lead Acid: [NUMERIC REPSONSE]

Lithium Ion: [NUMERIC REPSONSE]

Thermal: [NUMERIC REPSONSE]

Other: [NUMERIC REPSONSE]

Energy capacity for battery systems is defined in this survey as: the installed usable energy capacity in kilowatt hours measured in alternating current (AC).

Q2.3 Based on capacity, what percentage of your company's energy storage portfolio in North America (U.S. and Canada) is in New York State?

% _____

Prefer not to answer

Q2.4 Based on capacity, what percentage of your company's New York State energy storage portfolio is in New York City?

% _____

Prefer not to answer

Q2.5 Approximately what percent of your New York State customers that have received energy storage proposals since January 2018 have received contracts?

% _____

Prefer not to answer

Q2.6 Of those 2018 New York State projects with executed contracts, what percent are waiting for permits to be approved?

% _____

Prefer not to answer

End of Block: Installation Activities

Start of Block: Intro and primary use case

[If Q2.1.1 = 0 and Q2.1.2 = 0, Skip to Q8.1, Closing]

Q4.1 Next are some questions about the primary use case (geographic location, customer type, technology, system location and size) of energy storage systems your company installed, or contracted and submitted for permitting and interconnection in 2018 in New York State.

Please define your primary use case (geographic location, customer type, technology, system location, and size) [Choose one from each drop down list below]

Q4.2 Customer type

1. Utility customers
2. Industrial customers
3. Commercial customers
4. Residential customers – single family
5. Residential customers – multi-family

Q4.3 Geography

1. New York City
2. Westchester County
3. Long Island
4. Other locations in NYS

Q4.4 Technology

1. Lithium ion
2. Lead acid
3. Thermal
4. Other

Q4.5: System Location

1. Behind the meter
2. Front of the meter

Q4.6 Average system size (kWh)

1. Average kWh (1) _____

You have defined your **primary use case** as:

Customer type: [restore Q4.2]

Geography: [restore Q4.3]

Technology: [restore Q4.4]

System location: [restore Q4.5]

Average kWh: [restore Q4.6]

End of Block: Intro and primary use case

Start of Block: Total Installed Cost

Q5.1 For your primary use case what is the average total installed cost \$/kWh?
Total includes all costs for hardware, engineering and construction, and soft costs.

\$/kWh (1) _____

Q5.2 For your primary use case of energy storage systems in New York State in 2018, which percentage is constituted by the following: [Sum to 100%]

Hardware cost (%) (Battery modules, inverter, containerization, controller, power control, HVAC system, meter, insulation. Excludes upgrades required for permitting or interconnection approval.) : _____

Engineering and Construction cost (%) (Design, site preparation/survey, transportation, PE approval, testing, electrician and installation labor, wiring, fencing, testing, commissioning, and enrollment in energy markets. Excludes upgrades required for permitting or interconnection approval.) : _____

Permitting cost (%) (Including application fees, responding to requests for additional information, studies, and unique safety protections required from the AHJ). : _____

Interconnection cost (%) (Including application, and required upgrades or studies cost). : _____

Customer acquisition cost (%) : _____

Finance cost (%) (Including origination fee ONLY). : _____

Total : _____

End of Block: Total Installed Cost

Start of Block: Cycle Time and Staff Time

Q6.1 Next are some questions about the project cycle time for the primary use case for energy storage systems your company installed or contracted and submitted for permitting and interconnection in 2018 in New York State. This cycle time is incurred up to and including system commissioning.

You have defined your **primary use case** as:

Customer type: [restore Q4.2]

Geography: [restore Q4.3]

Technology: [restore Q4.4]

System location: [restore Q4.5]

Average kWh: [restore Q4.6]

What is the overall project cycle time for your primary use case, from initial engagement to system commissioning? Please round to the nearest month.

number of months

prefer not to answer

Q6.2 Please list the average project cycle times in 2018 for various stages. We understand there are many factors that influence the project cycle time, but we'd like you to provide your best estimate.

1. Length of time for customer acquisition: from initial engagement to proposal being presented to the customer
2. Length of time from proposal to agreement to proceed
3. Length of time from agreement to proceed to site contract execution
4. Length of time to prepare electrical, building and/or fire department permits (before application submission)
5. Length of time to obtain approved permits from building and/or fire departments (after application submission)
6. Length of time to obtain interconnection approval from utility
7. Length of time from site contract execution to system commissioning
8. Length of time to commission the system

You have defined your **primary use case** as:

Customer type: [restore Q4.2]

Geography: [restore Q4.3]

Technology: [restore Q4.4]

System location: [restore Q4.5]

Average kWh: [restore Q4.6]

Q6.3 For your primary use case of ES systems in New York State in 2018, is the staff time required on New York State specific projects different as compared to other states where you do business? For example, impacts on staff time required due to permitting, interconnection, customer training, financing, and project management.

1. More time [_____]%
 2. Less time [_____]%
 3. The same amount of time
 4. We only have projects within New York State
-

Q6.4 Within customer acquisition of your primary use case, what comprises the most extensive portion of your staff's time?

1. Customer Identification
2. Closing the deal
3. Contracting
4. Audit/site assessment/data logging
5. Some other activity _____
6. Don't know
7. prefer not to answer

Q7a. Do you have a secondary use case for energy storage systems in New York State in 2018?

Yes

No

Q7b. Are you willing to answer cost questions about that secondary use case as well?

Yes

No

[If Yes proceed to secondary use case questions. Else, skip to Business Strategies Block]

Please define your secondary use case (geographic location, customer type, technology, system location, and size) [Choose one from each drop down list below]

Geographic location

Q7.2 Customer type

6. Utility customers
7. Industrial customers
8. Commercial customers
9. Residential customers – single family
10. Residential customers – multi-family

Q7.3 Geography

5. New York City
6. Westchester County
7. Long Island
8. Other locations in NYS

Q7.4 Technology

5. Lithium ion
6. Lead acid
7. Thermal
8. Other

Q7.5: System Location

3. Behind the meter
4. Front of the meter

Q7.6 Average system size (kWh)

2. Average kWh _____

You have defined your **secondary use case** as:

Customer type: [restore Q7.2]

Geography: [restore Q7.3]

Technology: [restore Q7.4]

System location: [restore Q7.5]

Average kWh: [restore Q7.6]

For your secondary use case what is the average total installed cost \$/kWh?
Total includes all costs for hardware, engineering and construction, and soft costs.

\$/kWh _____

For your secondary use case of energy storage systems in New York State in 2018, which percentage is constituted by the following: [Sum to 100%]

Hardware cost (%) (Battery modules, inverter, containerization, controller, power control, HVAC system, meter, insulation. Excludes upgrades required for permitting or interconnection approval.) : _____

Engineering and Construction cost (%) (Design, site preparation/survey, transportation, PE approval, testing, electrician and installation labor, wiring, fencing, testing, commissioning, and enrollment in energy markets. Excludes upgrades required for permitting or interconnection approval.) : _____

Permitting cost (%) (Including application fees, responding to requests for additional information, studies, and unique safety protections required from the AHJ). : _____

Interconnection cost (%) (Including application, and required upgrades or studies cost). : _____

Customer acquisition cost (%) : _____

Finance cost (%) (Including origination fee ONLY). : _____

Total : _____

Is the project cycle for your secondary use case longer or shorter than the primary use case?

1. Longer; please estimate the % increase in time: []
2. Shorter; please estimate the % decrease in time: []
3. About the same
4. Don't know

Is the staff time required for your secondary use case longer or shorter than the primary use case?

1. Longer; please estimate the % increase in time: []
2. Shorter; please estimate the % decrease in time: []
3. About the same
4. Don't know

End of Block: Cycle Time and Staff Time

Start of Block: Business Strategies

Q1.1 How many employees does your company have in terms of FTE (Full Time Equivalent)? [Enter number]

1. Overall in New York State
2. In New York State doing energy storage projects
3. Overall outside New York State in North America (U.S. and Canada)

Q3.1 What percent of your energy storage systems in New York State in 2018 have each of the following types of contractual arrangements?

	In front of the meter (%)	Behind the meter (%)
Third party ownership		
Site or end user ownership		
Performance contracting or shared savings		

Q3.2 What percent of your energy storage customers in New York State in 2018 are in each of the following sectors [Sum to 100%]

- Single family to four plex residential (%) : _____
- Multifamily (five or more units) (%) : _____
- Commercial (not utility) (%) : _____
- Industrial (not utility) (%) : _____
- Utility (%) : _____
- Municipal, University, Schools, or Healthcare ("MUSH") (%) : _____
- Other (specify): : _____
- Prefer not to answer

Total : _____

Q3.3 Which of the following benefits are important in closing the deal for your energy storage customers in New York State in 2018? [Check all that apply]

1. Investment tax credit
2. Demand charge management
3. Demand response payments
4. Distributed generation integration
5. Non-wires alternative services
6. Any other benefits you typically promote (specify): _____
7. Don't know
8. Prefer not to answer

End of Block: Business Strategies

Start of Block: Closing

Q8.1 Is there anything about your experience completing energy storage projects in New York State that we have not discussed today, or that worked well or didn't work well, that you would like to convey to NYSERDA?

End of Block: Closing

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