

2019 Energy Storage Market Evaluation

Appendices to the Annual Report

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Appendix A: 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	Photovoltaic
REV	Reforming the Energy Vision
SGIP	Self-Generation Incentive Program (California)
W	Watt(s)

Appendix B: 2019 Survey Instrument

Programming Notes:

Purple text in {} brackets indicates programming logic.

Numbers contained in parentheses indicate code values.

Closed bullets indicate single answer response options, while open bullets indicate multiple response options.

Dashed lines indicate a page break.

Start of Block: Respondent Company Profile and Introduction

Intro We are collecting data on Energy Storage (ES) systems that have been installed or contracted for in New York in 2019. Our data collection is focused on ES utilized primarily for load management or grid services rather than installed primarily for backup power or resilience. NYSERDA will use this data to identify cost trends, market insights, and key market barriers, which will inform and guide NYSERDA's energy storage program. We appreciate your participation in this critical data collection effort. If you cannot complete the survey in its entirety or you accidentally exit the survey mid-course, you can resume the survey where you left off by clicking the link from your invitation email or hitting the back button.

Q442 What is your company's name?

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

{Multiple responses allowed}

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

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 2019 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.

In front of the meter (1) _____

Behind the meter (2) _____

{If no projects are entered (FTM=0 & BTM=0), skip to Q3.2. Following questions are displayed only if the respondent indicates their company has qualifying 2019 projects.}

End of Block: Installation Activities

Start of Block: Pt. 2: Installation Activities

Q2.5 Approximately what percent of your New York State customers that have received energy storage proposals since January 2019 have received contracts?

- % (1) _____
- Prefer not to answer (2)

Q2.6 Of those 2019 New York State projects with executed contracts, what percent are waiting for permits to be approved?

- % (1) _____
- Prefer not to answer (2)

End of Block: Pt. 2: Installation Activities

Start of Block: Primary Use Case

Q4.1&2 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 2019 in New York State.

Please define your primary use case. Choose one from each drop down list below.

Customer Type

▼ Drop down menu including the following:

- Utility customer (1)
 - NYISO (2)
 - Industrial customers (3)
 - Commercial customers (4)
 - Residential customers – single family (5)
 - Residential customers – multi-family (6)
-

Q4.3 Geography

▼ Drop down menu including the following:

- New York City (1)
 - Westchester County (2)
 - Long Island (3)
 - Other locations in NYS (4)
-

Q4.4 Technology

▼ Drop down menu including the following:

- Lithium Ion (1)
 - Lead Acid (2)
 - Thermal (3)
 - Other (4)
-

Q4.5 System Location

▼ Drop down menu including the following:

- Behind the meter (1)
 - Front of the meter (2)
-

Q4.6 Average system size

- Average kW (4) _____
- Average kWh (5) _____

End of Block: Primary Use Case

Start of Block: Total Installed Cost - Primary Use Case

Q5.1 You have defined your **primary use case** as:

- Customer type: {carry forward selected customer type}
- Geography: {carry forward selected geography}
- Technology: {carry forward selected technology}
- System location: {carry forward selected system location}
- Average kW: {carry forward selected average kW}
- Average kWh: {carry forward selected average kWh}

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 2019, 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.*) : _____ (1)

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.*) : _____ (2)

Permitting cost (*Including application fees, responding to requests for additional information, studies, and unique safety protections required from the AHJ beyond the requirements of IFC 2021.*) : _____ (3)

Interconnection cost (*Including application, and required upgrades or studies cost.*) : _____ (4)

Customer acquisition/Site acquisition cost : _____ (5)

Finance cost (*Including origination fee ONLY*) : _____ (6)

Total : _____ {Automatically summed}

End of Block: Total Installed Cost - Primary Use Case

Start of Block: Cycle Time and Staff Time - Primary Use Case

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 2019 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: {carry forward selected customer type}
- Geography: {carry forward selected geography}
- Technology: {carry forward selected technology}
- System location: {carry forward selected system location}
- Average kW: {carry forward selected average kW}
- Average kWh: {carry forward selected average kWh}

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: (1) _____
- Prefer not to answer (2)

Q6.2 For your primary use case in New York State in 2019, please list the average cycle time for various stages. We understand there are many factors that influence the cycle time, but we'd like you to provide your best estimate in months.

- _____ Length of time for customer acquisition/site acquisition: from initial engagement to contract execution (1)
- _____ Length of time from contract execution to system commissioning (3)
- _____ Length of time to obtain electrical, building and/or fire department permits (4)
- _____ Length of time to obtain zoning and other siting approvals (if required) (8)
- _____ Length of time to obtain interconnection approval from utility (9)

End of Block: Cycle Time and Staff Time - Primary Use Case

Start of Block: Secondary Use Case

Q7.1 Do you have a secondary use case for energy storage systems in New York State in 2019?

- Yes (1)
 - No (2)
-

{Display if Q7.1=Yes (1)}

Q7.2 Are you willing to answer cost questions about that secondary use case as well?

- Yes (1)
- No (2)

{If no, skip to Q3.1. Following questions are displayed only if the respondent indicates they are willing to answer questions about the secondary use case.}

Q7.3 Please define your secondary use case.

Customer Type

▼ Drop down menu including the following:

- Utility customer (1)
 - NYISO (2)
 - Industrial customers (3)
 - Commercial customers (4)
 - Residential customers – single family (5)
 - Residential customers – multi-family (6)
-

Q7.4 Geography

▼ Drop down menu including the following:

- New York City (1)
 - Westchester County (2)
 - Long Island (3)
 - Other locations in NYS (4)
-

Q7.5 Technology

▼ Drop down menu including the following:

- Lithium Ion (1)

- Lead Acid (2)
- Thermal (3)
- Other (4)

Q7.6 System Location

▼ Drop down menu including the following:

- Behind the meter (1)
- Front of the meter (2)

Q7.7 Average system size

- Average kW (3) _____
- Average kWh (4) _____

Q7.8 You have defined your **secondary use case** as:

- Customer type: {carry forward selected customer type}
- Geography: {carry forward selected geography}
- Technology: {carry forward selected technology}
- System location: {carry forward selected system location}
- Average kW: {carry forward selected average kW}
- Average kWh: {carry forward selected average kWh}

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 (1) _____

Q7.9 For your secondary use case of energy storage systems in New York State in 2019, 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.*) : _____ (1)

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.*) : _____ (2)

Permitting cost : _____ (3)

(*Including application fees, responding to requests for additional information, studies, and unique safety protections required from the AHJ beyond the requirements of IFC 2021.*) : _____ (7)

Interconnection cost (*Including application, and required upgrades or studies cost.*) : _____ (4)

Customer acquisition/Site acquisition cost : _____ (5)

Finance cost (*Including origination fee ONLY.*) : _____ (6)

Total : _____ {Automatically summed}

Q7.10 Is the project cycle for your secondary use case longer or shorter than the primary use case?

- Longer; please estimate the % increase in time: (1)

- Shorter; please estimate the % decrease in time: (2)

- About the same (3)
- Don't know (4)

End of Block: Secondary Use Case

Start of Block: Business Strategies

Q3.1 What percent of your energy storage systems in New York State in 2019 have each of the following types of contractual arrangements?

	{FTM response option only displays for respondents who indicated their company has qualifying 2019 FTM projects.} In front of the meter (%) (1)	{BTM response option only displays for respondents who indicated their company has qualifying 2019 BTM projects.} Behind the meter (%) (2)
Third party ownership (1)		
Site or end user ownership (2)		
Performance contracting or shared savings (3)		
Total {Automatically summed}		

Q3.2 What percent of your energy storage customers in New York State in 2019 are in each of the following sectors? [Sum to 100%]

- Single family to four plex residential : _____ (1)
 Multifamily (five or more units) : _____ (2)
 Commercial (not utility) : _____ (3)
 Industrial (not utility) : _____ (4)
 Utility : _____ (5)
 Municipal, University, Schools, or Healthcare ("MUSH") : _____ (6)
 Other (specify): : _____ (8)
 Total : _____ {Automatically summed}

Q3.3 Which of the following benefits are important in closing the deal for your energy storage customers in New York State in 2019? [Check all that apply]

{Multiple responses allowed}

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

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

Appendix C: Bibliography

- Black & Veatch. 2012. *Cost and Performance Data for Power Generation Technologies*. Prepared for the National Renewable Energy Laboratory. <https://www.bv.com/docs/reports-studies/nrel-cost-report.pdf>.
- Bloomberg. 2019. "A Behind the Scenes Take on Lithium-ion Battery prices." <https://about.bnef.com/blog/behind-scenes-take-lithium-ion-battery-prices/>.
- Bloomberg. 2019. "Battery Reality: There's Nothing Better Than Lithium-Ion Coming Soon." <https://www.bloomberg.com/news/articles/2019-04-03/battery-reality-there-s-nothing-better-than-lithium-ion-coming-soon>.
- Bloomberg New Energy Finance (BNEF). 2017. *Global Energy Storage Forecast, 2016-2024*.
- BNEF. 2017. *Lithium-ion Battery Costs and Market*. <https://data.bloomberglp.com/bnef/sites/14/2017/07/BNEF-Lithium-ion-battery-costs-and-market.pdf>.
- BNEF. 2019. *2019 Long-Term Energy Storage Outlook*.
- BNEF. 2019. *Energy Storage System Costs Survey 2019*.
- Clean Energy States Alliance (CESA). 2020. "State of the U.S. Energy Storage Industry: 2019 Year in Review." Energy Storage Technology Advancement Partnership (ESTAP) Webinar. <https://www.cesa.org/wp-content/uploads/ESTAP-webinar-slides-2-6-20.pdf>.
- Electric Power Research Institute (EPRI). 2016. "Batteries and Energy Storage: Looking Past the Hype." Presentation to Tucson Electric Power. https://www.tep.com/wp-content/uploads/2016/04/12-TEP_UNSE-2017-IRP-Workshop-Energy-Storage-EPRI.pdf.
- EPRI. 2016. "Energy Storage Trends and Challenges – New Mexico's Numerous Contributions." Next Mexico Regional Energy Storage and Grid Integration Workshop presentation. https://www.sandia.gov/ess-ssl/docs/NMRESGI/2016/4_Energy_Storage_Trends_and_Challenges_Willard.pdf.
- EPRI. 2017. "Energy Storage Update: Status, Trends, Research Directions, and Resources." Presentation to Maryland PSC Energy Storage WG. http://dnr.maryland.gov/pprp/Documents/EPRI-Presentation-Maryland_20170815.pdf.
- EPRI. 2018. "Energy Storage Technology and Cost Assessment." <https://www.epri.com/research/products/000000003002013957>.
- EPRI. 2019. "Solar Plus Storage Cost Assessment and Design Considerations: Executive Summary." <https://www.epri.com/research/products/000000003002016637>.
- Energy Information Administration (EIA). 2018. U.S. Battery Storage Market Trends. https://www.eia.gov/analysis/studies/electricity/batterystorage/archive/2018/pdf/battery_storage.pdf.

- Green Tech Media (GTM). 2017. *Large-scale Energy Storage System Price Trends, 2012-2022*.
- GTM. 2018. “Energy Storage – Evolution and Revolution on the Electric Grid.” Presentation prepared for the National Conference of State Legislatures.
http://www.ncsl.org/Portals/1/Documents/energy/Webinar_energy_storage_Manghani_present_32165.pdf
- GTM. 2018. *The Future of Lithium-Ion Batteries*.
- GTM. 2018. *U.S. Front-of-the-Meter Energy Storage System Prices, 2018-2022*.
- Guidehouse Insights. 2020. *Market Data: Energy Storage Pricing Trends*.
- HDR. 2017. *Battery Energy Storage Technology Assessment*. <https://www.prpa.org/wp-content/uploads/2017/10/HDR-Battery-Energy-Storage-Assessment.pdf>.
- HDR. 2019. *2019 Energy Storage Technology Assessment*. <https://www.prpa.org/wp-content/uploads/2019/10/2019-Energy-Storage-Technology-Assessment.pdf>.
- International Renewable Energy Agency (IRENA). 2017. *Electricity Storage and Renewables: Costs and Markets to 2030*. http://www.irena.org/-/media/Files/IRENA/Agency/Publication/2017/Oct/IRENA_Electricity_Storage_Costs_2017.pdf.
- McKinsey & Company. 2018. “The new rules of competition in energy storage.”
<https://www.mckinsey.com/industries/electric-power-and-natural-gas/our-insights/the-new-rules-of-competition-in-energy-storage#>
- Navigant Research. 2018. *Innovations in Power Conversion Technology for Grid Storage*.
<https://www.navigantresearch.com/reports/innovations-in-power-conversion-technology-for-grid-storage>.
- Navigant Research. 2018. *Market Data: Small Commercial Energy Storage*.
<https://www.navigantresearch.com/reports/market-data-small-commercial-energy-storage>.
- Navigant Research. 2018. *Navigant Research Leaderboard: Lithium Ion Batteries for Grid Storage*.
<https://www.navigantresearch.com/reports/navigant-research-leaderboard-lithium-ion-batteries-for-grid-storage>.
- Navigant Research. 2018. *Energy Storage for Transmission and Distribution Deferral*.
<https://www.navigantresearch.com/reports/energy-storage-for-transmission-and-distribution-deferral>.
- Navigant Research. 2018. *Market Data: Large Commercial and Industrial Energy Storage*.
<https://www.navigantresearch.com/reports/market-data-large-commercial-and-industrial-energy-storage>.

- Navigant Research. 2019. *Market Data: Advanced Battery and Energy Storage Pricing Trends*.
<https://www.navigantresearch.com/reports/market-data-advanced-battery-and-energy-storage-pricing-trends>.
- National Renewable Energy Laboratory (NREL). *Evaluating the Technical and Economic Performance of PV Plus Storage Power Plants*. <https://www.nrel.gov/docs/fy17osti/68737.pdf>.
- NREL. 2017. *Installed Cost Benchmarks and Deployment Barriers for Residential Solar Photovoltaics with Energy Storage: Q1 2016*. <https://www.nrel.gov/docs/fy17osti/67474.pdf>.
- NREL. 2018. *2018 U.S. Utility-Scale Photovoltaics-Plus-Energy Storage System Costs Benchmark*.
<https://www.nrel.gov/docs/fy19osti/71714.pdf>.
- NREL. 2019. *Cost Projections for Utility-Scale Battery Storage*.
<https://www.nrel.gov/docs/fy19osti/73222.pdf>.
- NREL and United States Agency for International Development (USAID). 2019. “Greening the Grid. Utility-Scale Battery Storage: When, Where, Why and How Much?”
<https://cleanenergysolutions.org/sites/default/files/documents/battery-storage-webinar-feb-27-final.pdf>.
- New York State Energy Research and Development Authority (NYSERDA). 2018. *New York State Energy Storage Roadmap and Department of Public Service / New York State Energy Research and Development Authority Staff Recommendations*. Prepared by NYSERDA and the Department of Public Service, New York.
<https://www.nyserda.ny.gov/All%20Programs/Programs/Energy%20Storage/Achieving%20NY%20Energy%20Goals/The%20New%20York%20State%20Energy%20Storage%20Roadmap>.
- NYSERDA. 2017. *Baseline Market Evaluation Metrics for Energy Storage*, NYSERDA Report Number 17-##. Prepared by Research Into Action, Inc., OR.
- Pacific Northwest National Laboratory (PNNL). 2019. *Energy Storage Technology and Cost Characterization Report*. https://www.sandia.gov/ess-ssl/wp-content/uploads/2019/07/PNNL_mjp_Storage-Cost-and-Performance-Characterization-Report_Final.pdf.
- Pacificorp. 2016. *Battery Energy Storage Study for the 2017 IRP*. Prepared by DNV GL, PA.
- Tesla. 2018. “Powerwall.” <https://www.tesla.com/powerwall>.
- The Brattle Group. 2018. *The Economic Potential for Energy Storage in Nevada*. Prepared for Public Utilities Commission of Nevada and Nevada Governor’s Office of Energy.
http://files.brattle.com/files/14618_economic_potential_for_storage_in_nevada_-_final.pdf
- Wood Mackenzie. 2019. *U.S. non-residential storage system prices*.
- Wood Mackenzie & U.S. Energy Storage Association. 2020. *U.S. energy storage monitor*.
- World Energy Council. 2019. *Energy Storage Monitor: Latest trends in energy storage*.
https://www.worldenergy.org/assets/downloads/ESM_Final_Report_05-Nov-2019.pdf.