



NYSERDA

**2013-14 CAIR Annual Report
on the New York Battery
and Energy Storage
Technology Consortium**

Final Report

Table of Contents

Executive Summary	1
CAIR Financial Information	2
NY-Best Operations	3
Testing, Characterization, and Prototyping Capabilities	5
Battery Prototyping Center	6
NY-BEST Research and Development	6
Commercialization Progress	12
Priorities During the Next Year	13
Appendix A NY-BEST Members at Report Issuance	14
Appendix B: NY-BEST Board of Directors	15

Summary

Energy storage can play an important role in the reduction of nitrogen oxide (NOx) and greenhouse gases in two critical sectors – transportation and the electric grid. For instance, energy storage can capture and then deploy energy lost during braking in vehicles, including in electrified rail and subway, and store electricity until needed on the electric grid. Storage distributed throughout the electric system can also reduce the intermittency of solar electric and wind generated energy, helping these resources to serve as flexible assets when needed. Energy storage capacity can avoid the need for new transmission and distribution infrastructure, increase system efficiency and resiliency, and reduce the requirement for additional fossil fuel plants to meet periods of peak electric demand, which occurs sporadically. It can integrate with demand response and energy efficiency measures within buildings to achieve greater energy savings without sacrificing occupant comfort. Energy storage can also enable distributed generation to operate independently or “island” from the electric grid during an outage providing greater resiliency.

The New York Battery and Energy Storage Technology Consortium™ (NY-BEST) was established in 2009-10 to help position New York State as a global leader in energy storage technology for electric grid, transportation, and other large-scale storage applications. NYSERDA was charged with working with industry and academic partners to establish this industry-driven consortium, which is being seeded by NYSERDA with approximately \$25 million through Clean Air Interstate Rule (CAIR) proceeds. NY-BEST is a New York State not-for-profit corporation and is managed by a 17-member Board elected by the NY-BEST membership. In 2010, the Board hired Bill Acker as executive director and Capitol Hill Management Services to provide association management services to NY-BEST. These services continued in 2013-14.

NY-BEST employs four primary strategies to build the energy storage industry in New York State:

- Serving as an authoritative resource on energy storage, proactively communicating energy storage related news and information, and facilitating connections amongst stakeholders.
- Advancing and accelerating the commercialization process for energy storage technologies, from research and development, to products and widespread deployment.
- Educating policymakers and stakeholders about energy storage and advocating on behalf of the energy storage industry.¹

- Promoting New York’s world-class intellectual and manufacturing capabilities and providing access to markets to grow the energy storage industry in New York.

This annual report is prepared pursuant to the Program Plan developed with stakeholder input in 2009 and adopted by the NYSERDA Board and provides an update on NY-BEST progress, expenditures, and results for the year. To align this report with NY-BEST’s fiscal year, this annual report covers the 18-month period through December 31, 2014. NYSERDA priorities for NY-BEST during the next year are also presented.

Metrics used to assess the progress of NY-BEST are included for NY-BEST operations; testing, characterization, and prototyping capabilities; and research and development. Commercialization progress related to NY-BEST’s activities is also presented. Funds are also budgeted for three independent, external evaluations of the NY-BEST initiative. The first evaluation, a process evaluation, was conducted during this year and completed in first quarter 2015. This evaluation was designed to provide feedback to support NY-BEST program planning. The evaluation documented NY-BEST program activities and progress toward the consortium’s short- and mid-term outcomes. It also benchmarked NY-BEST in comparison to peer organizations and identified lessons about the consortium model that other groups may consider. This evaluation found that NY-BEST is making good progress in delivering valued services to its members and achieving its objectives. It is available at <http://www.nyserdera.ny.gov/About/Publications/Program-Planning-Status-and-Evaluation-Reports/Evaluation-Contractor-Reports/2015-Reports>. The second evaluation, a market characterization, is planned for the second half of 2015 to be followed by a market impact evaluation in 2016-2017.

Highlights of NY-BEST major accomplishments during 2013-14 included:

- The grand opening of the Battery and Energy Storage Technology Test and Commercialization Center (BTCC) located at Eastman Business Park in Rochester, which is providing unique testing and validation capabilities for companies in the battery and energy storage industry.
- A battery prototyping center was developed at Rochester Institute of Technology (and opened in March 2015) with a semi-automated battery pouch cell line for prototyping battery cells.
- NY-BEST has served an active participant in the Reforming the Energy Vision (REV) proceeding to fundamentally transform the way electricity is distributed and used in New York State and promote a cleaner, more resilient, and affordable energy infrastructure.

¹Any NY-BEST lobbying activities (i.e., attempts to influence decisions of government officials) are funded entirely with non-NYSERDA funding.

- NY-BEST membership grew 14 percent during the year to 149 companies and research institutions, including approximately 25 percent from outside of New York State which presents an excellent opportunity to attract new firms to the State.
- NY-BEST held four conferences and an investor conference with 626 participants in total. In addition, four informational webinars were presented spanning policy and markets with more than 360 individuals participating.
- NY-BEST helped members with introductions to potential customers, facilitated product development and commercialization partnerships, helped members with funding applications and investor pitches, and assisted members with understanding and navigating financial and regulatory requirements for energy storage.
- The first phase of a searchable Energy Storage Supply Chain Database was completed. It assists companies in the energy storage supply chain with locating suppliers, expert resources, product development capabilities, and manufacturing assets in New York State.
- 95 percent of the \$25.5 million in CAIR funds budgeted within the CAIR Program Plan have been expended or committed. This number includes a \$4.35 million contract with NY-BEST to partially support operations and management as the consortium becomes operationally self-sufficient; 70 percent of this operations contract has been expended as of December 31, 2014. Non-NYSERDA funds earned by NY-BEST was \$341,000. Through earned revenue, NY-BEST has expanded its financial reserves to approximately 4.5 months of operations to enable a smooth transition when NYSERDA funding is exhausted in approximately two years.

- In total, 43 NY-BEST research and development projects have been awarded and are in varying stages of completion. These projects include \$11,745,325 from NYSERDA in CAIR funding and \$15,402,101 in award recipient co-funding. An additional seven projects were awarded subsequent to this reporting period.

CAIR Financial Information

Financial data through December 31, 2014 is presented in Table 1, and details are provided in the remainder of this section.

NY-BEST Operations and Management includes a \$4,350,000 operations contract between NYSERDA and NY-BEST to partially support NY-BEST's operations over five to seven years as the consortium works toward self-sufficiency for its core member services. As of December 31, 2014, 70 percent of this operations contract has been expended with NYSERDA's proportion of total consortium expenditures continuing to decrease. The remaining funds under this contract are anticipated to partially support NY-BEST operations through 2016, at which time the consortium is expected to fund its core member services through non-NYSERDA funding. It should be noted that certain activities performed by NY-BEST are economic development in nature and do not naturally align with the types of services an individual member would support. In these cases, it is envisioned that grant funding including from NYSERDA may continue to support those targeted economic development and sector building efforts.

Table 1. Budgeted and Committed CAIR Funds as of December 31, 2014

Source: NYSERDA

	Budgeted	Expended/Committed ^a
NY-BEST Operations and Management	\$4,548,000	\$4,429,898
Research and Development Awards	13,585,000	13,585,000
Technology Transfer	500,000	0
Testing and Characterization Capabilities	3,445,114	3,445,114
NYSERDA Administration	2,211,000	2,017,248
Program Evaluation and Accountability	500,000	200,001
Brokerage Fees for NO _x Allowance Sales	266,736	266,736
New York State Cost Recovery Fee	443,000	360,043
Total	\$25,498,850	\$24,304,040

^a "Committed" includes funds already expended and those that have been committed for specific initiatives.

Research and Development Awards has been fully committed through two Program Opportunity Notices that sought seed stage projects and projects that transition promising storage technologies from proven technical feasibility into working prototypes.

Technology Transfer activities described in the CAIR Program Plan include teleconference, web conferences, and technical symposia featuring presentations of work funded by NY-BEST as well as leading-edge research, business and financial topics of interest to the community. To date, these activities have been accomplished by NY-BEST through the operating funds that NYSERDA provided for consortium operations. Each research project funded also includes technology transfer activities as part of the project scope. In the future, these funds may be reallocated for other purposes within the CAIR Program Plan.

Testing and Characterization Capabilities funding has been fully utilized for the BTCC.

NYSERDA Administration covers staffing and direct costs associated with managing the program including the research and development projects, as well as serving in a formative role during the first 21 months of NY-BEST's development until an executive director and staff were hired by the NY-BEST Board.

Program Evaluation and Accountability includes three independent, external evaluations of the NY-BEST initiative with a process evaluation completed in first quarter 2015, a market characterization schedule for late 2015, and an impact evaluation scheduled for 2016-2017.

Brokerage Fees for Nitrogen Oxides (NOx) Allowance Sales represents fees charged by Amerex in selling the CAIR allowances provided to NYSERDA. New York State's regulations that implemented the federal Clean Air Interstate Rule (CAIR) programs are set forth at 6 NYCRR Parts 243 and 244. Ten percent of the NOx emission allowances allocated to New York under these regulations were directed by the New York State Department of Environmental Conservation to the Energy Efficiency and Renewable Energy Technology Account and used to establish NY-BEST. During 2013-14, \$227,328 in gross receipts was received from selling additional CAIR allowances. These funds will be allocated and reported in the 2015 report. No additional CAIR allowances are expected as a result of CAIR transitioning into the EPA's Cross-State Air Pollution Rule during 2015.

New York State Cost Recovery Fee is a shared services fee assessed by the New York State Division of the Budget and billed to NYSERDA.

NY-BEST Operations

In December 2010, the NY-BEST Board hired Bill Acker to serve as executive director. The Board selected Capitol Hill Management Services to provide association management services and office space for NY-BEST in January 2011. John Cerveny was subsequently hired as director of resource development in March 2011. These services continued during the year.

NY-BEST's objective is to build a vibrant energy storage sector in New York State. Reaching this objective involves providing support at various stages of the product development and commercialization pipeline and proactively helping to form partnerships. NY-BEST is helping to facilitate commercial introduction of energy storage technologies in New York State, building the human capital and expertise needed to sustain a vibrant commercial energy storage industry, and leveraging NYSERDA's seed resources to create a sustainable organization that provides value to its members and to New York State.

NY-BEST's operational measures and progress during the year are presented in this section.

1. Increase in the number of members and retention of existing members

NY-BEST membership grew 14 percent in the past year to 149 members. Members represent all aspects of the energy storage sector, with academic institutions, research organizations, start-up companies, nonprofit organizations, small- and mid-sized enterprises, and large multinational corporations all well represented. During the year, the member retention rate was 82 percent, primarily reflecting startup companies discontinuing operations and service providers not renewing. Appendix A lists all members of NY-BEST. During the year, the annual membership fee in NY-BEST was \$1,500 for corporate organizational members; \$1,000 for academic institutions, nonprofit, and government organizations; and \$500 for start-up companies (defined as a company in the energy storage business having 25 or fewer employees). Table 2 presents total revenue earned by NY-BEST including from membership fees.

Table 2. NY-BEST Financial Summary (Accrual Basis; 2014 is unaudited) for the years ended December 31*Source: NY-BEST Financial Reports*

	2014	2013	2012
SOURCES OF FUNDS:			
Membership Dues	\$123,833	\$106,288	\$88,458
Conferences	\$81,155	\$41,023	\$36,241
Sponsorships	\$104,325	\$91,945	\$44,495
Non-NYSERDA Grants	\$31,932	\$127,380	\$98,248
NYSERDA Funds	\$757,540	\$778,033	\$796,166
TOTAL REVENUE	\$1,098,785	\$1,144,669	\$1,063,608
USES OF FUNDS:			
Labor	\$317,003	\$322,394	\$305,810
Association Management	\$326,000	\$326,000	\$265,220
Professional Services	\$67,449	\$161,747	\$220,566
Conferences	\$118,411	\$103,551	\$79,363
Travel	\$35,552	\$40,742	\$31,674
Marketing	\$2,315	\$2,070	\$24,444
Other Expenses	\$69,939	\$64,670	\$73,989
TOTAL EXPENSES	\$936,669	\$1,021,174	\$1,001,066
CHANGE IN NET ASSETS	\$162,116	\$123,495	\$62,542

2. Progress toward reaching self-sufficiency

Table 2 presents sources and uses of funds by NY-BEST during the year. In total, \$3,054,513 (or 70 percent) of the \$4,350,000 operating support contract between NYSEERDA and NY-BEST has been expended. The remaining funds are expected to support a portion of NY-BEST's operations for another two years, with NYSEERDA's contribution continuing to decline as earned revenue increases.

Non-NYSERDA funds earned by NY-BEST has consistently increased and is used to cover a portion of operating costs and build a reserve fund to enable a smooth transition to sustainability after NYSEERDA funding is exhausted. During the year, non-NYSERDA funds earned by NY-BEST increased to \$341,000. Membership dues, conferences, and sponsorships increased from \$169,000 to \$309,000 during the past three years. Non-NYSERDA Grants were primarily driven by a National Grid and RG&E cost reimbursable economic development grant for specific expenditures in 2012 and 2013. The goal is for NY-BEST to have one year's worth of operating cash on hand as reserves when the NYSEERDA operating funds are exhausted. As of December 31, 2014, total unrestricted net assets (essentially reserve funds) was \$366,000, which represents approximately 4.5 months of operations.

3. NY-BEST technology transfer activities during 2013-14

During the past year, NY-BEST continued to facilitate connections among energy storage supply chain and manufacturing resources. This facilitation included the launch of the first phase of NY-BEST's Energy Storage Supply Chain database and a second supply chain and manufacturing conference in Rochester, NY. The supply chain database is a searchable Web-based tool that allows interested companies and organizations to search and locate resources, assets, and suppliers in New York State.

In addition, NY-BEST worked closely with NYSEERDA and Consolidated Edison staff to facilitate participation in the NYSEERDA/Con Edison Demand Management Program which seeks to obtain 100 megawatts (MW) of energy efficiency and demand reduction permanent peak load reduction including 10 MW of electrochemical storage. NY-BEST assisted with conference development and promotion in partnership with Pace Energy and Climate Center in New York City, including presentations from technology providers and the NYC Buildings Department. NY-BEST also worked to streamline the siting process in NYC by participating in several meetings with the NYC Buildings and Fire Departments, as well as with NYSEERDA and Con Edison staff and NY-BEST members.

As part of the REV process, NY-BEST participated in the Markets and Policies and Platform Technologies working groups established by the New York State Department of Public Service staff to help inform the REV proceedings. NY-BEST shared information on energy storage technologies with other REV industry participants and stakeholders throughout the process and participated in a July 2014 Technical Conference for members of the New York State Public Service Commission.

Additional technology transfer highlights from the year included:

- Working with the U.S. Department of Energy and Pacific Northwest National Lab to participate in national efforts to complete testing and evaluation guidelines for energy storage technologies.
- Holding NY-BEST's annual conference, Capture the Energy 2014, which was attended by more than 230 participants during two days of presentations and discussions examining energy storage related policies, markets and technologies. The conference featured keynote addresses from Mark Little, Senior Vice President and Director of GE Global Research; Hugo Van Nispen, COO at DNV GL; and Leslie Whatley, Executive Vice President of Start-Up NY. Attendees gave the conference high marks in quality of presentations and networking opportunities.
- In addition to the Capture the Energy Conference, NY-BEST held three smaller conferences: Improving Building Performance and Reducing Energy Costs through Energy Storage and Combined Heat and Power, presented in partnership with Pace Energy and Climate Center in New York City; Energy Storage Manufacturing and Supply Chain Conference in Rochester; and Energy Storage Technology Conference, presented in partnership with the Joint Center for Energy Storage Research (JCESR) in Buffalo. NY-BEST also held an Investment Forum in New York City. Total attendance at these events was more than 626 individuals.
- NY-BEST presented four informational webinars with topics spanning policy landscape, markets for storage, REV, and the proposed Clean Energy Fund. More than 360 individuals participated in the webinars and several more viewed the recordings.
- NY-BEST also attended, exhibited, and/or presented at numerous industry conferences, including the ARPA-E Innovation Summit, Energy Storage Alliance's Annual Conference, Utility of the Future, New York Energy Week, Distributech, Annual Storage Week, LIFT Roundtable, Energy Storage North America, NYSERDA Expos in NYC, NY EXCEL, and the Alliance for Clean Energy New York.
- In an effort to keep members informed and continue to raise NY-BEST's profile, NY-BEST also provided timely communications through various mechanisms including the NY-BEST website, e-newsletters, e-communications, blogs, press releases, and social media.

Testing, Characterization, and Prototyping Capabilities

One of NY-BEST's key initiatives is helping companies and researchers access testing, characterization, and prototyping capabilities. These capabilities include leveraging existing assets throughout New York State and establishing a product commercialization center, known as the BEST Test and Commercialization Center (BTCC), to allow companies, researchers, and customers to test and validate new energy storage technologies for electric grid, transportation, and other applications. These capabilities are typically cost-prohibitive for any single entity to procure and maintain, and are not available in close geographic proximity.

In 2011, NY-BEST was awarded \$3.5 million through the Finger Lakes Regional Economic Development Council to establish the BTCC at Eastman Business Park in Rochester. This award included \$1 million from Empire State Development and \$2.5 million from NYSERDA, and is in addition to \$3.4 million in CAIR funds. The BTCC opened in April 2014 and is providing unique testing and validation capabilities to evaluate new energy storage technologies from individual cells to megawatt sized systems in operation. The BTCC is a wholly-owned subsidiary of NY-BEST and comprises 17,000 square feet of space. NY-BEST competitively selected DNV GL to operate the lab under an arrangement where DNV GL will staff and operate the BTCC, relocated an existing energy storage testing operation from Pennsylvania to Rochester, and will invest up to \$16 million in the BTCC over five years. The initial five-year contract term is renewable based upon performance and provides for revenue sharing back to NY-BEST based on gross revenues beginning in April 2015.

The BTCC's services include a suite of test, validation and independent certification capabilities that are necessary to introduce new energy storage technologies into the marketplace and accelerate integration of renewable and distributed energy resources. It includes equipment for testing secondary (rechargeable) battery cells and battery packs, as well as temperature test chambers and modular walk-in temperature test chambers. Offering testing from single cells to megawatt systems, the BTCC's services include product development, performance validation and certification testing, and a wide range of environmental testing and battery lifetime testing, including the ability to conduct on-site testing in the field. These services are designed to accelerate the adoption and growth of energy storage technologies.

Metrics used to evaluate the BTCC include:

- Use by members of NY-BEST and by non-members, and fees generated.
- Jobs at the BTCC such as technicians and equipment operators.
- Changes in Technology Readiness Levels and Manufacturing Readiness Levels for technologies examined at the BTCC.
- Commercialization success of products tested at the BTCC.

The lab's grand opening occurred on April 30, 2014 and the first test was conducted on May 28, 2014. Three full-time employees staff the lab including a director and two test engineers, supported by five other off-site staff (business development, operations, health and safety, and finance). During 2014, approximately six months of activity occurred as the BEST TCC executed contracts with customers and center utilization increased. Particular focus has been paid to visiting potential customers and providing lab tours. In total, eight tests were completed during this period and fifteen tests were in progress at year-end, primarily for members of NY-BEST. No tested products have yet been commercialized. A total of \$503,000 in testing revenue was earned. Revenue sharing back to NY-BEST from the BTCC began in April 2015, after this report. In addition, in March 2015, the BTCC received American Association for Laboratory Accreditation for International Organization for Standardization (ISO) 17025 Lab Quality.

Battery Prototyping Center:

Recognizing the need for battery and energy storage prototyping, a semi-automated pouch cell line and dry room was established at Rochester Institute of Technology (RIT) to provide prototyping capabilities to companies, researchers, and entrepreneurs. These capabilities were necessary to enable new materials and cell components to be validated in an industry-accepted battery or ultracapacitor cell "form factor." In particular, potential customers want to test new materials, electrolytes, and electrodes in a cell that resembles a commercial product. New York State committed \$1.1 million for the center, which opened in first quarter 2015, comprised of \$750,000 in NYSERDA funding through NY-BEST and \$350,000 in funding from Empire State Development (ESD).

Through agreements with New York State and NY-BEST, RIT will operate and own the facility with the input and guidance of an advisory board, and will provide staffing and additional investments in the facility. In addition, RIT will leverage its status as a research university to seek competitive grants and funding to use and expand the expertise and research capabilities of the Battery Prototyping Center. This facility is available on a discounted fee basis to NY-BEST members, RIT faculty and researchers, as well as to other companies and entities with battery prototyping needs.

NY-BEST Research and Development

NYSERDA awards and manages all research and development funding using NYSERDA's established solicitation process with input from the energy storage community and NY-BEST. These awards complement NYSERDA's existing energy storage programs by focusing on transitioning new energy storage technologies with proven technical feasibility into working prototypes.

In total, 43 NY-BEST research and development projects have been awarded and are in varying stages of completion. Each project that had been awarded through this reporting period is presented in this section. In total, these projects include \$11,745,325 from NYSERDA in CAIR funding and \$15,402,101 in award recipient co-funding. The following charts present the composition of these projects by underlying energy storage technology as well as by intended application and reflect the composition of the NY-BEST membership with primary focus on electric grid and transportation applications. A wide range of chemistries and systems, each possessing unique attributes best suited to a specific use case have been supported.

Figure 1. Research Projects by Underlying Chemistry

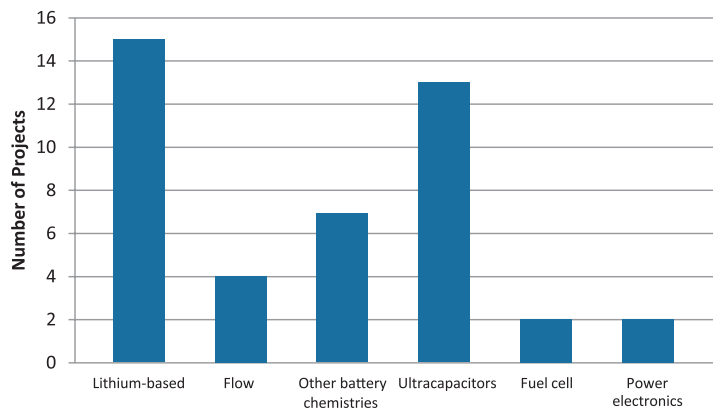
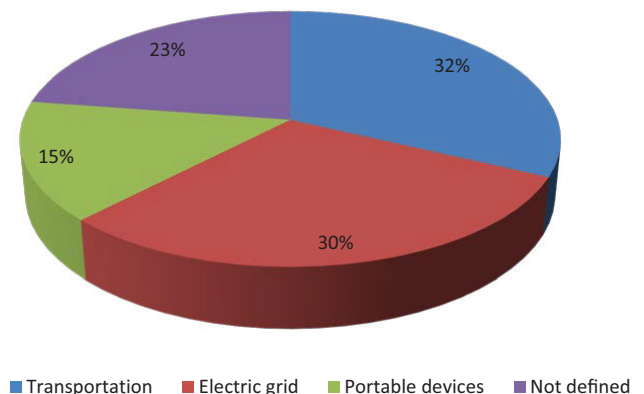


Figure 2. Intended End Use Applications



An additional seven projects were awarded subsequent to this reporting period.

Metrics used to evaluate research and development awards include publications, presentations at technical and business conferences, invention disclosures and patents, licensing agreements executed and licensing revenue, additional research funding received, research and development jobs supported, recognition awards and significant research accomplishments, and commercialization progress.

The following 16 projects were awarded in March 2010 under Program Opportunity Notice 1704, which supported seed and product development projects:

- Binghamton University (Binghamton): Dr. Stan Whittingham pursued a lithium air energy storage system for vehicles and stationary applications.

NYSERDA: \$200,000; Co-funding: \$78,410

Status: completed; work has been presented at 21 conferences and included in 6 publications

- Brookhaven National Laboratory (Upton): Dr. Feng Wang is examining lithium-titanate batteries for lower cost electric grid storage.

NYSERDA: \$200,000; Co-funding: \$100,000

Status: ongoing; work was presented at one conference and included in three publications

- Binghamton University (Binghamton): Dr. Stan Whittingham partnered with Brookhaven National Lab and Stony Brook University to develop improved batteries for lower cost electric grid storage examining lithium-ion batteries.

NYSERDA: \$152,890; Co-funding: \$147,000

Status: ongoing; work was presented at 13 conferences and included in two publications

- Stony Brook University (Stony Brook): Dr. Esther Takeuchi is examining new materials for lithium-ion batteries with improved performance and lower cost for electric grid storage.

NYSERDA: \$200,000; Co-funding: \$200,000

Status: ongoing; work was presented at eight conferences and included in five publications

- Cerion Enterprises (Rochester) explored nanoparticle materials for next-generation lithium-ion batteries, which could make the batteries smaller and lighter – important for transportation applications.

NYSERDA: \$200,000; Co-funding: \$151,072

Status: completed; work has been presented at four conferences, included in two publications, and resulted in five patent filings

- City University of New York (New York City) is pursuing a low-cost nickel-zinc flow battery that could be used in hybrid electric vehicles.

NYSERDA: \$200,000; Co-funding: \$50,000

Status: ongoing; this work leveraged almost \$2 million in ARPA-E and National Science Foundation funding and the technology has been licensed to Urban Electric Power, a startup company

- City University of New York worked with Columbia University (New York City) to pursue metacapacitors using a printable material to create high voltage, high energy, and high power density capacitors for energy storage.

NYSERDA: \$149,597; Co-funding \$1,649,865 including an ARPA-E award

Status: completed; a \$1.6 million ARPA-E award was received; the technology was presented at four conferences and included in seven publications

- SUNY Polytechnic (Albany): Dr. Pradeep Haldar and Dr. Manisha Rane-Fondacaro developed new electrolytes to improve performance of ultracapacitors.

NYSERDA: \$200,000; Co-funding: \$116,263

Status: completed; Eonics, a startup company, was formed to commercialize this technology and has attracted over \$3.5 million in grants and investments; six presentations were made and the technology was described in two publications

- Cornell University (Ithaca): Dr. Emmanuel Giannelis developed nonflammable battery electrolytes with improved safety and performance.

NYSERDA: \$200,000; Co-funding: \$213,652

Status: completed; results were presented at five conferences and included in two publications

- General Electric Co. (Schenectady), under the largest NY-BEST R&D award made under this first funding round, is partnering with Alfred University (Alfred), Clarkson University (Potsdam), Columbia University (New York City) and Stony Brook University (Long Island), to explore enhancements to the next generation of its sodium-metal halide batteries for uninterruptible power backup systems, electric grid applications and heavy-duty transportation.

NYSERDA: \$2,500,000; Co-funding: \$2,994,063

Status: ongoing; this work has been presented at several conferences and is being considered as the next generation of this chemistry is pursued

- General Motors (previously in Honeoye Falls, NY, and now in Detroit, MI), in conjunction with Cornell University (Ithaca) evaluated new materials for improved lithium-ion battery electrodes for automotive applications to increase performance and reduce cost.

NYSERDA: \$150,922; Co-funding: \$67,581

Status: completed; a provisional patent was filed for the underlying technology and was transferred to Cornell University

- Hollingsworth & Vose, Co. (Easton) explored a new advanced separator for more efficient valve-regulated lead-acid batteries used in start-stop hybrid electric vehicles.

NYSERDA: \$119,965; Co-funding: \$85,951

Status: completed; the new separators did not show adequate performance improvements to justify their cost and the project was terminated; the company is exploring other separator formulations

- Impact Technologies (Rochester) explored a novel method to increase the lifetime of batteries by assessing battery health through in-cell measurement techniques.

NYSERDA: \$99,766; Co-funding: \$27,115

Status: ongoing; the company has received over \$3 million in outside investment

- Ioxus (Oneonta) in conjunction with CUNY is exploring enhancements to its ultracapacitors by developing a novel electrode-electrolyte interface.

NYSERDA: \$200,000; Co-funding: \$200,000

Status: ongoing; Ioxus continues to grow, now employing over 50 staff at its manufacturing facility in Oneonta and having raised over \$21 million in venture capital.²

- Rensselaer Polytechnic Institute (Troy): Dr. Nikhil Koratkar developed nanoengineered silicon based electrodes that could enable greater power and energy density and reduce the cost of lithium-ion batteries.

NYSERDA: \$200,000; Co-funding: \$424,179

Status: completed; received a \$396,000 National Science Foundation grant to support follow-on work; project was presented at one conference and included in two publications

- Rochester Institute of Technology (Rochester): Dr. Gabrielle Gaustad evaluated methods that can help recycle and reuse lithium-ion batteries to minimize landfill waste and maximize reclamation.

NYSERDA: \$195,387; Co-funding: \$157,200

Status: completed; the project was presented at five conferences and included in two publications

The second research and development solicitation issued by NYSERDA (Program Opportunity Notice 2458) used the remaining R&D funds to transition energy storage technologies with proven technical feasibility at the lab scale into working prototypes to assess whether the technology has commercial potential. Demonstrating a working prototype is an important stage that can interest additional funders including private capital. Five proposal due dates were included.

Seven awards were made in July 2012 under Round 1 of PON 2458:

- Custom Electronics Inc. (Oneonta) explored a graphene electrolytic capacitor that could provide extra energy to ride through momentary electric fluctuations or interruptions on the electric grid.

NYSERDA: \$250,000; Co-funding: \$421,032

Status: completed; two patent applications were submitted

- SUNY Polytechnic (Albany) explored an ionic liquid electrolyte to enhance lithium-ion capacitors for improved short-term energy storage in hybrid vehicles and power electronics.

NYSERDA: \$249,979; Co-funding: \$251,170

Status: completed; a research agreement is being explored with a company partner

² <http://www.wbng.com/news/local/Only-US-Ultracapacitor-Manufacturer-Opens-New-Oneonta-Facility-125990298.html>

- Graphene Devices Ltd. (Williamsville/Rochester) developed a graphene-based high energy ultracapacitor with up to three times the energy density of current commercial devices at similar cost, which can be used in smart grid devices and hybrid vehicles.

NYSERDA: \$300,000; Co-funding: \$330,000

Status: completed; several patent applications were submitted; a \$1 million joint development agreement was executed with a capacitor manufacturer worth potentially several million dollars per year in electrode sales

- Ioxus (Oneonta) is developing thermally optimized ultracapacitors for hybrid vehicle applications.

NYSERDA: \$250,000; Co-funding: \$250,000

Status: ongoing

- Paper Battery Co. (Troy) developed a production prototype of its thin and flexible ultracapacitor to provide temporary backup power systems.

NYSERDA: \$250,000; Co-funding: \$353,000

Status: completed; the company has raised \$6.4 million in funding including a \$3 million Series A financing in June 2014 to move toward commercial production of their ultracapacitor technology for mobile electronics³; three patents were issued

- Primet Precision Materials (Ithaca) is developing a production process that could lower the manufacturing cost of key raw materials used in lithium-ion batteries.

NYSERDA: \$250,000; Co-funding: \$365,835

Status: ongoing

- Urban Electric Power (New York City) is developing a megawatt-hour battery for peak power reduction using a novel “flow-assisted” zinc anode battery with an advanced battery management system.

NYSERDA: \$249,847; Co-funding: \$249,847

Status: ongoing; the company has raised over \$2 million from investors⁴

Seven awards were made in February 2013 under Round 2 of PON 2458:

- Battery Energy Storage Systems (BESS) Technologies (Albany), a startup company from SUNY Polytechnic, collaborated with the Institute and Rensselaer Polytechnic Institute to evaluate a graphene-based electrode for lithium-ion batteries that can store more energy and charge faster than those currently deployed.

NYSERDA: \$218,000; Co-funding: \$218,000

Status: completed; the company received a \$250,000 angel investment subsequent to this reporting period

- Bettergy Corp. (Peekskill) is pursuing improvements to a low-cost zinc air-flow battery that could be used for grid storage applications.

NYSERDA: \$189,000; Co-funding: \$189,000

Status: ongoing; results were presented at two conferences; work is continuing under a \$385,000 ARPA-E grant

- Custom Electronics (Oneonta) is developing an ultracapacitor with increased energy storage potential to provide short bursts of power over very long lifetimes for industrial power electronic applications and hybrid vehicles.

NYSERDA: \$250,000; Co-funding: \$257,300

Status: ongoing

- Eos Energy Storage (New York City) is scaling a novel zinc battery with low-cost, high energy-density and an inherently safe design for electric grid storage applications.

NYSERDA: \$250,000; Co-funding: \$386,149

Status: ongoing; the company is using Incodema, Inc. in Western New York for contract manufacturing of its batteries; the company recently raised \$15 million in private capital

- NOHMS Technologies (Ithaca and Rochester) is developing and testing a new prototype for longer-lasting mobile phones.

NYSERDA: \$250,000; Co-funding: \$250,000

Status: ongoing; one patent application was submitted; \$600,000 in federal/industry research and development grants was obtained and \$1,350,000 in private capital has been raised; the project results have been presented at seven conferences

³ <http://www.paperbatteryco.com/news/paper-battery-company-closes-3m-series-a-financing-to-move-into-commercial-production>

⁴ <http://energy.gov/articles/taking-battery-technology-lab-big-city> <http://energy.gov/articles/urban-electric-power-takes-energy-storage-startup-grid-scale> <http://www.nyserdera.ny.gov/About/Newsroom/2013-Announcements/2013-08-06-Grand-Opening-of-New-West-Harlem-Rechargeable-Battery-Manufacturing-Plant.aspx>

- UTS Engineering (formerly Electromotive Designs) (Ronkonkoma) is pursuing a low-cost, easily-installed hybrid-electric add on system to recapture braking energy in buses and trucks using ultracapacitors manufactured by Ioxus in Oneonta, NY. The system will be tested by Verizon.

NYSERDA: \$249,980; Co-funding: \$315,740

Status: ongoing

- Watt Fuel Cell Corp. (Port Washington) is building a prototype capable of providing electricity and heat from a portable solid-oxide fuel cell for military applications and backup power during electric grid outages.

NYSERDA: \$249,704; Co-funding: \$812,696

Status: ongoing

Six awards were made in January 2014 under Round 3 of PON 2458:

- Custom Electronics, Inc. (Oneonta, NY) is working with Binghamton University to develop a new electric capacitor for power conditioning applications. This new capacitor will incorporate a flexible roll-to-roll manufacturing process and could provide high energy density, greater tolerance to temperature, and graceful aging characteristics.

NYSERDA: \$250,000; Co-funding: \$269,406

Status: ongoing; results have been presented at one conference

- Cornell University (Ithaca, NY) is working with company partner Proton to develop and demonstrate a regenerative fuel cell energy storage system based on an anion exchange membrane (AEM) designed at Cornell to produce hydrogen. This will seek to address a key obstacle in renewable hydrogen production from electrolysis by reducing the cost of expensive platinum catalysts.

NYSERDA: \$250,000; Co-funding: \$250,000

Status: ongoing

- Ambri (Cambridge, MA) will work with Consolidated Edison (NYC) and the BEST Test and Commercialization Center (Rochester, NY) to develop and test a working prototype of Ambri's novel Liquid Metal Battery comprising 6.25 kW and 25 kWh. Initial system development was funded by ARPA-E through a \$6.9 million award which helped form the underlying technology licensed by MIT to Ambri in 2010.

NYSERDA: \$250,000; Co-funding: \$627,900

Status: ongoing

- Columbia University (New York, NY) will scale an electrochemical technology coupled with a bioreactor, which was successfully developed under a \$1.5 million ARPA-E award, to convert electricity into energy stored in a liquid fuel. The technology, if successful, will produce biofuels from electricity and from CO₂ with minimal land and environmental burdens.

NYSERDA: \$249,367; Co-funding: \$271,621

Status: ongoing

- Widetronix (Ithaca, NY) worked with the Cornell Nanoscale Facility to enhance the power density of the Widetronix betavoltaic platform, which is a millimeter-scale semiconductor chip that converts electrons from an embedded isotope into electric power enabling decades of power. Target markets include those where the longevity, high power density, and robustness in harsh environmental conditions are important characteristics for critical monitoring needs.

NYSERDA: \$249,067; Co-funding: \$442,937

Status: completed; company received an \$800,000 angel investment and is pursuing joint development agreements

- Rensselaer Polytechnic Institute (Troy, NY) is working with Finch Paper (Glens Falls, NY) and JNC (Rye, NY) to explore high-energy density cathode materials for lithium-sulfur batteries using a green chemistry approach that uses a low-cost byproduct from the paper industry.

NYSERDA: \$122,009; Co-funding: \$122,026

Status: ongoing

Seven awards were made in August 2014 under Round 4 of PON 2458:

- Bettergy (Peekskill, NY) is developing a low-cost rechargeable Zn-MnO₂ battery (similar to a primary alkaline battery) for a projected sale price of less than \$100/kWh, a point at which widespread adoption for electric grid and transportation storage applications would be practical.

NYSERDA \$249,852 (50%); Co-funding \$249,852 (50%)

Status: ongoing

- Graphenix Development (Williamsville, NY) is working to commercialize a nanostructured graphene-based electrode for high power, high energy ultracapacitors for applications including hybrid vehicles (start/stop) and hybridized batteries. The company is also leveraging the roll to roll manufacturing capabilities at Eastman Business Park in Rochester.

NYSERDA \$249,998 (50%); Co-funding \$249,998 (50%)

Status: ongoing

- Combined Energies (Latham, NY) is partnering with Unique Technical Services (Ronkonkoma, NY) to develop a low-cost power conversion device to increase the life of electrochemical batteries in stationary and mobile applications. The team will initially target the airport ground support equipment market and then materials handling equipment and specialty mining vehicles and will field test the system under this project at a Southwest Airlines hub in New York State.

NYSERDA \$249,995 (48%); Co-funding \$269,613

Status: ongoing

- Lionano (Ithaca, NY) is a startup company seeking to commercialize a high-performance nano-engineered anode material for the Li-ion battery sector.

NYSERDA \$250,000 (47%); Co-funding \$282,177

Status: ongoing

- Eonix (Colonie, NY), a startup company from SUNY Polytechnic, is developing next-generation electrolytes that increase energy storage capabilities of ultracapacitors with increased voltage and a wider temperature range.

NYSERDA \$250,000 (50%); Co-funding \$250,000 (50%)

Status: under contract negotiation

- Custom Electronics (Oneonta, NY) is partnering with Unique Technical Services (Ronkonkoma, NY) to construct prototype devices for field-testing and develop a detailed commercialization plan for a high voltage graphene-based electrolytic capacitor for power-conditioning applications such as servers and electrical equipment.

NYSERDA \$250,000 (40%); Co-funding \$369,834

Status: ongoing

- Raymond Corporation (Greene, NY) is working with Navitas Systems (a lithium-ion manufacturer) to develop and test an advanced lithium-ion energy storage system for electric lift trucks. Compared to existing lead acid technology, this energy storage system could enable improved cold temperature performance, lower operating costs, more efficient opportunity charging during operator breaks, and increased productivity.

NYSERDA \$250,000 (37%); Co-funding \$434,617

Status: ongoing

Subsequent to this annual report period, seven awards were made in March 2015 under Round 5 of PON 2458 and are in contract negotiation:

- Urban Electric Power (New York City) – Zn-MnO₂ battery
- Bren-Tronics (Commack) – anti-idling battery system for rescue vehicles
- Applied Power Systems (Hicksville) – battery charger / low voltage power supply used on commuter rail cars
- Varta Microbattery (Rye) – AC-integrated coupled backup system for PV
- Enermat Technologies (Clifton Park) – graphene anodes for Li-ion batteries
- American Fuel Cell (Rochester) – manufacturing scale up of fuel cell membrane electrode assemblies
- PowerHub Systems (Blacksburg, VA) and Applied Power Systems (Hicksville, NY) – high-density silicon-carbide (SiC)-based power inverter

Commercialization Progress

Commercialization progress for members of NY-BEST is measured by outside funding received including grants and private investment, product sales and new products launched, licenses executed and licensing revenue, cost savings, capital expenditures, and jobs created and retained. Energy, economic, and environmental benefits realized by utilizing energy storage will also be assessed as part of the independent evaluations conducted in 2014-15 and 2017-18.

Commercialization progress related to research and development awards is included in the NY-BEST Research and Development section.

This section presents commercialization progress of NY-BEST members who were assisted by NY-BEST's staff during the year. This assistance included introductions to new partners, facilitating product development and commercialization partnerships, helping with investor pitches, identifying funding opportunities, and helping members understand and navigate financial and regulatory requirements for energy storage. NY-BEST members have achieved the following results, in part, as a result of these activities.

Investor Funding: In addition to advising and providing introductions and coaching throughout the year, NY-BEST continued its annual Energy Storage Investment Conference where selected NY-BEST members present to leading venture capital, angel, and institutional investor firms including GE's investment arm, Kleiner Perkins, and Braemar Energy Ventures. NY-BEST coached and helped eight member companies prepare for presentations at the NY-BEST Investor Conference on June 12, 2014 held in New York City. Although many of these relationships and negotiations take time to solidify, several NY-BEST members who have presented at a NY-BEST investor conference have raised funding in the past year, including Green Charge Networks (\$56 million – Series A round), Eos (\$25 million Series C round), Ambri (\$35 million Series C round), Ioxus (\$21 million Series C round), Paper Battery (\$3 million Series A) and NOHMs (\$1.35 million). Other funding efforts are in due diligence and/or not publicly disclosed.

Grant Funding: NY-BEST routinely provides advice and guidance for member companies in their funding applications and worked closely with over two dozen members to identify specific grant funding opportunities and help them prepare, edit, review, and submit more than 50 applications to federal, New York State, and nonprofit organizations during the year. A number of these were subsequently selected for funding totaling over \$10 million from organizations including NASA, U.S. DOE, ARPA-E, and the U.S. Navy. NY-BEST members receiving awards

included DNV GL, NOHMs, Bettergy, General Electric, and City University of New York.

Facilitating R&D and Product Development Partnerships:

NY-BEST plays an active role forging new partnerships among members through direct introductions and by providing numerous face-to-face networking opportunities throughout the year. Direct introductions between companies related to product development and R&D occurred 15 times over the past year. Important introductions were made for battery developers to companies in the supply chain to provide key materials, processing and/or expertise needed to move their products from the prototype stage into production. Examples where NY-BEST facilitated introductions include connecting a novel fuel cell developer to a key supplier and manufacturing partner; connecting a system integrator/project developer with an energy services company; and helping an emerging battery maker identify manufacturing partners to provide initial production capability.

Technical and Business Guidance/Early Stage Mentoring:

In the past year, NY-BEST provided more than three dozen established and start-up companies with substantive and, often, ongoing technical and business guidance. These companies included Ascension Industries, American Vanadium, Bettergy, Bren-tronics, Bosch, Con Edison and ConEd Solutions, Constellation, Convergent Power, Demand Energy Networks, Direct Gain, Eos Energy, FS Energy, General Compression, GE, Global Design Corporation, Green Charge Networks, IdleAir, Incodema, IPLAN Access, Joule Assets, Lionano, Metropolitan Transportation Authority, MicroOrganic Technology, Navitas Systems, NGK, NOHMs, Paper Battery Company, PowerPhase, Primus Power, Standard Hydrogen, Sun Edison, Tenvention, Triple Point Energy, Tumulow, UET, Voltaic, and WattJoule. This advising and services spanned areas as diverse as business development and market entry strategies (including siting requirements for energy storage in buildings in New York City) to connections to resource providers in legal, financial, technical and manufacturing arenas. Evidence of the outcomes is best measured in the continued growth of the NY-BEST membership and success of individual companies through product sales and new jobs that will be collectively captured beginning in 2015 through an annual member survey.

Priorities During the Next Year

NYSERDA's priorities for NY-BEST during 2015 include:

- Continue to build a self-sustaining organization that supports its core member services through non-NYSERDA funds.
- Contribute to a thriving energy storage industry in New York State measured by employment and sales growth at members, and greater numbers of companies participating in the energy storage value chain in New York State.
- Successfully grow the BTCC, maintaining a high level of facility utilization, and helping members bring new profitable energy storage products to market; expand the center's offerings as member needs evolve including adding battery safety testing.
- Helping to forge new product development and commercialization partnerships between members including expanding and leveraging the energy storage supply chain database.
- Playing an active role in helping to transition New York's electric system under REV.

Appendix A. NY-BEST Members at Report Issuance

1. Advanced Energy Center, Stony Brook University, SUNY
2. AES Energy Storage
3. Alfred University/CACT
4. The Alliance for Clean Energy NY
5. AMBRI
6. American Aerogel Corporation
7. American Fuel Cell
8. American Renewable Energy Associates
9. American Vanadium Corporation
10. Applied Power Systems
11. AppliedLogix, LLC
12. Arista Power
13. Arnold Magnetic Technologies
14. Ascension Industries, Inc.
15. BAE Systems Controls
16. BatteryInformer
17. BESS Technologies
18. Bettergy Corporation
19. Big Delta Systems
20. Binghamton University
21. Bond, Schoeneck and King, PLLC (BOND)
22. Braemar Energy Ventures
23. Bren-Tronics, Inc.
24. Brookhaven National Laboratory (BNL)
25. Center for Economic Growth (CEG)
26. Central Hudson Gas & Electric
27. Charge CCCV LLC
28. City University of New York
29. Clarkson University
30. Cloteam, LLC
31. Columbia University
32. Combined Energies, LLC
33. Consolidated Edison Company of New York, Inc.
34. Constellation, An Exelon Company
35. CooperHill
36. Cornell University
37. Corning Incorporated
38. CSA Group
39. CSS Nanotech
40. Cubit Power Systems
41. Curtis Instruments, Inc.
42. Custom Electronics, Inc.
43. Customized Energy Solutions
44. Delta Americas
45. Demand Energy Networks
46. Direct Gain Consulting, LLC
47. DNV GL
48. Dr. Ten
49. E2TAC
50. Eastman Business Park
51. ECG Consulting Group, Inc.
52. Electron Storage, Inc.
53. ETS
54. Enermat Technologies
55. EnerVault
56. Enstorage Inc.
57. EONIX
58. EOS Energy Storage
59. EWI
60. Expansion Energy, LLC
61. G4 Synergetics
62. General Electric
63. Genesis Power Inc.
64. Global Design Corporation
65. Graphene Devices
66. Green Charge Networks
67. Halotechnics
68. Hecate
69. Heslin Rothenberg Farley & Mesiti, P.C.
70. Highway MetalWorks
71. Hitachi
72. Hoffman Warnick, LLC
73. Hollingsworth & Vose
74. Hydrogenics Corporation
75. Hylie Products, Inc.
76. ICL-Industrial Products America, Inc.
77. Ideal Power Converters
78. Innovation Core SEI, Inc. (Sumitomo Electric Group)
79. Intertek Testing Services, Inc.
80. Invenergy
81. Ioxus, Inc.
82. IPLAN Access
83. ITM Power
84. Johnson Controls, Inc.
85. Landis + Gyr
86. LeChase Construction Services
87. LG CNS America Inc.
88. Lionano
89. Lumens Energy
90. Lux Research
91. MeOH POWER (MP)
92. MESH, LLC
93. MOEFLY-I
94. National Grid
95. NAVITAS SYSTEMS
96. NEC Energy Solutions
97. New York Institute of Technology
98. New York State Electric & Gas
99. NEXTERA ENERGY Resources
100. NGK-Locke, Inc.
101. NOHMs Technologies
102. Northeast Transportation Electrification Alliance
103. NOVOROCKS
104. O'Brien & Gere
105. O'Connell Electric
106. Oak-Mitsui Technologies, LLC
107. OneD Material, LLC
108. OPTIMATION
109. Pacific Northwest National Laboratory
110. Paper Battery Company
111. PowerHub Systems
112. PowerPHASE, LLC
113. Primet Precision Materials, Inc.
114. Primus Power
115. Raymond Corporation
116. Renewable Energy Systems
117. Rensselaer Polytechnic Institute
118. River Road Research
119. Rochester Gas and Electric
120. Rochester Institute of Technology
121. S&C Electric Company
122. SAFT America, Inc.
123. Samsung SDI
124. Sendyne
125. Sentient Corporation
126. Sharp Laboratories of America
127. Skyview Ventures
128. SolarCity
129. Solid Cell, Inc.
130. Stamford Power Ventures
131. SUDANO Consulting Inc.
132. SuperPower, Inc.
133. Sustainable Innovations, LLC
134. Syracuse University
135. Tesla Motors
136. Third Power
137. Turner Construction
138. UltraLife Corporation
139. UniEnergy Technologies, LLC
140. Unique Technical Services, LLC
141. University of Rochester
142. Urban Electric Power, Inc.
143. VARTA Microbattery Inc.
144. Veeco
145. Vionx Energy
146. Voltaiq
147. Watt Fuel Cell
148. Widetronix, Inc.
149. ZBB Energy Corporation

Appendix B: NY-BEST Board of Directors

The 17 member NY-BEST Board of Directors, elected by the membership, represent industry, the research community, end users, and government partners. Terms are staggered so that half of the Board seats are elected each year. The Board met five times during 2014. Officers and board members during 2014 are listed below. Those whose seats changed in 2015 after this reporting period are noted with an asterisk.

Michael Field, Raymond Corporation
Chair of the Board

Cathy Hill, CooperHill and Skidmore College
Vice Chair, At Large

Glen Merfeld, GE Global Research
Vice Chair, Industry

Stan Whittingham, Binghamton University, SUNY
Vice Chair, Academia

Paul Mutolo, Cornell University and Center for Future Energy Systems
Treasurer/Secretary

Aubrey Braz, Consolidated Edison Co.

Rick Fioravanti, DNV GL

Barry Watkins, CACT at Alfred University

Matt Fronk, Matt Fronk and Associates

Jim Misewich, Brookhaven National Laboratory

Wolf von Maltzahn, Rensselaer Polytechnic Institute *

Stuart Marwell, Curtis Instruments *

Fernando Gomez Baquero, BESS Technologies

Victor Cardona, Heslin Rothenberg Farley & Mesiti PC

Esther Takeuchi, Stony Brook University *

John Rhodes, NYSERDA (the President and CEO of NYSERDA serves as a permanent director)

Matthew Watson, Empire State Development (the Executive Director of NYSTAR serves as a permanent director)

NYSERDA, a public benefit corporation, offers objective information and analysis, innovative programs, technical expertise, and support to help New Yorkers increase energy efficiency, save money, use renewable energy, and reduce reliance on fossil fuels. NYSERDA professionals work to protect the environment and create clean-energy jobs. NYSERDA has been developing partnerships to advance innovative energy solutions in New York State since 1975.

To learn more about NYSERDA's programs and funding opportunities, visit nyserda.ny.gov or follow us on Twitter, Facebook, YouTube, or Instagram.

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State of New York

Andrew M. Cuomo, Governor

New York State Energy Research and Development Authority

Richard L. Kauffman, Chair | John B. Rhodes, President and CEO

