

ECG Consulting Group Inc.

Strategic Market Planning & Research • Technology Commercialization • Business Strategy & Development

Final Report

The Economic Impact of Developing an Energy Storage Industry In New York State

Prepared for: NY-BEST



Albany, New York

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I. Executive Summary

Broad economic, environmental, regulatory and technology trends are driving increasing interest in energy storage technologies and rapid growth in energy storage markets in all regions of the globe. The market for energy storage is driven by a variety of complex and interconnected factors. The rate of adoption of new energy storage technologies and the timing of market growth varies significantly by application, geography and location of use. Competitive value propositions, in terms of performance and cost, are critical to achieving high levels of market penetration in every application.

Furthermore, regulatory policies which significantly impact market development vary significantly from country to country, and by location within countries. For example, current U.S. regulations focus on reducing nitrogen oxide, sulfur dioxide, mercury emissions and particulates while corresponding European regulations focus on CO₂ reduction. Renewable Portfolio Standard requirements vary by state within the U.S. and by country within Europe. Consequently, competitive economics are highly dependent on location and regulatory policy. The value of frequency regulation in U.S. markets, for example, depends almost completely on regulatory policy and reimbursement requirements.

For all markets, employment in New York totals 2,992, with nearly \$600 million in global sales. In traditional markets, New York companies have global sales of over \$500 million and are expected to grow from approximately 2,700 people in 2012 to approximately 3,700 by 2020, a 4.1% annual growth rate. New York companies include leading suppliers of:

- Components for traditional lead acid auto batteries used in Starting Lighting and Ignition (SLI) applications
- Industrial and fork lift trucks
- Implantable medical batteries and ultracapacitors
- Lightweight, portable Li-ion batteries for military equipment power applications
- PEM and solid oxide fuel cells

Based upon ECG's analysis, New York's future battery and energy storage companies will likely focus on two emerging market opportunities that have significant growth potential. They are:

- Electricity storage market encompassing grid-connected (utility side of the meter) and customer connected (customer side of the meter) applications; this market is projected to grow from \$5.7 billion in 2012 to more than \$26 billion by 2020 and \$72 billion by 2030; and
- Transportation battery market, driven by projected growth in sales of hybrid electric vehicles, plug-in hybrid electric vehicles and battery electric vehicles that are projected to grow from \$5.2 billion in 2012 to more than \$25 billion by 2020 and \$73 billion by 2030

ECG developed an economic development impact model that projected the size and growth of the electricity storage and transportation battery markets and modeled New York state companies' potential

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share of U.S. and global energy storage industry markets. ECG conducted the analysis under two scenarios: *Base Case* and *Optimistic Case*.

In the *Base Case*, New York State develops a strong economic development program focused on the emerging battery and energy storage industry and implements incentives to help develop existing New York companies and attract significant new companies to the state. The objective is to build New York State into a center of excellence for energy storage and to develop a stronger industry that can win a larger share of the global and North American markets.

In the *Optimistic Case*, New York State implements even stronger economic development actions and a broader range of larger economic development incentives to attract or develop companies who are or can become #1, #2 and #3 market share leaders in several battery and energy storage market segments. Specific *Base Case* and *Optimistic Case* assumptions are described in on the following pages and presented in more detail in Section IV, Part C of this report.

In the *Base Case* scenario, revenues of New York companies could reach \$2.5 billion in 2020 with 10,000 jobs. In the *Optimistic Case*, revenues of New York companies could reach \$3.7 billion, more than 45% higher than in the *Base Case*. Employment increases correspondingly to nearly 14,400 jobs in 2020. Beyond 2020, significant growth is forecast to continue to 2030 which could result in greater employment growth to approximately 30,000 jobs in the *Base Case* and 45,000 jobs in the *Optimistic Case*. See Exhibit 1 below and on the next page for a summary of the economic impact results.

Exhibit 1
Economic Impact of Developing Energy Storage Industry
New York Revenues & Employment: Base Case & Optimistic Scenarios

Base Case: New York Company Revenues & Employment		Units	2012	2015	2020	2025	2030	CAGR 2012-2020
Revenues	Global Electricity Storage Market	\$M	598	\$175	\$1,222	\$3,167	\$5,394	56.0%
	Global Transportation Battery Market	\$M		\$132	\$559	\$1,586	\$2,278	44.7%
	Traditional Markets	\$M		\$602	\$740	\$923	\$1,171	4.1%
	Total Base Case Revenues	\$M		\$598	\$908	\$2,521	\$5,676	\$8,842
Employment	NY Jobs in Electricity Storage Market	Jobs	2,992	759	4,380	10,233	16,582	49.7%
	NY Jobs in Transportation Battery Market	Jobs		571	2,003	5,124	7,002	38.8%
	Traditional Markets	Jobs		3,008	3,699	4,614	5,853	4.1%
	Total Base Case Employment	Jobs		2,992	4,339	10,082	19,972	29,437

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Optimistic Case: New York Company Revenues & Employment		Units	2012	2015	2020	2025	2030	CAGR 2012-2020
Revenues	Global Electricity Storage Market	\$M	\$598	\$315	\$2,045	\$5,165	\$8,806	66.4%
	Global Transportation Battery Market	\$M		\$177	\$939	\$2,939	\$4,246	54.4%
	Traditional Markets	\$M		\$602	\$740	\$923	\$1,171	4.1%
	Total Optimistic Case Revenues	\$M		\$598	\$1,093	\$3,724	\$9,028	\$14,222
Employment	NY Jobs in Electricity Storage Market	Jobs	2,992	1,367	7,328	16,689	27,070	59.6%
	NY Jobs in Transportation Battery Market	Jobs		767	3,367	9,497	13,053	48.1%
	Traditional Markets	Jobs		3,008	3,699	4,614	5,853	4.1%
	Total Optimistic Case Employment	Jobs		2,992	5,142	14,394	30,800	45,976

Source: ECG Consulting Group Analysis

In the *Optimistic Case* above, New York State implements even stronger economic development actions and a broader range of larger economic development incentives to attract or develop companies who are or can become #1, #2 and #3 market share leaders in several battery and energy storage market segments. In modeling this scenario, it was assumed that New York State:

- Takes more vigorous energy storage economic development action relative to other states and countries
- Provides incentives to encourage R&D to help lower the cost and improve the performance of energy storage technologies
- Establishes 3rd party test, demonstration, validation and commercialization facilities
- Provides economic development incentives to encourage location of manufacturing in NYS
- Offers programs to encourage broader development and demonstration of energy storage technologies for a variety of grid-connected applications and technologies
- Includes energy storage targets in the New York State Renewable Portfolio Standard
- Provides buy-down incentives to encourage early deployment of new energy storage technologies
- Changes NYS Article X siting law to allow pre-approved permitting and siting of energy storage facilities
- Changes NYS regulations to encourage the purchase of energy storage by utilities and Independent Power Producers (IPPs)
- Removes outdated regulations that are an impediment to energy storage, e.g. codes forbidding multiple meters in buildings or resale of electricity

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NY-BEST and New York State need to recognize that the speed of taking action is very important because the energy storage markets are expected to grow rapidly and other states and countries are also competing to attract and develop companies that can successfully compete in these emerging rapidly growing markets.

NY-BEST members believe that New York State has a significant potential opportunity to participate in the rapid growth of the global energy storage industry. Many members stated that NY-BEST and New York State should work closely together to aggressively leverage New York State's capabilities and support economic development to position New York State businesses as leaders in the global energy storage business.

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II. Introduction

The New York Battery and Energy Storage Technology (NY-BEST™) Consortium was established in 2010 to position New York State as a global leader in the energy storage industry. NY-BEST's vision is to lead the development and deployment of transformative energy storage solutions to foster sustainable energy use by linking New York State's world-class industries, companies and research institutions with global energy markets. New York State, through the New York State Energy Research and Development Authority (NYSERDA) is providing approximately \$25 million in seed funding for NY-BEST and its related programs through New York's participation in the Clean Air Interstate Rule.

NY-BEST's mission is to catalyze and grow a vibrant, world-class energy storage industry, primarily focused on transportation, grid storage and power electronics applications. NY-BEST's primary objectives are to:

- Serve as a center for communication, education and interaction amongst stakeholders
- Leverage New York's world-class intellectual and manufacturing capabilities and market leadership
- Support and accelerate the commercialization process from research and development to products and widespread deployment
- Advocate for policies that promote the energy storage industry

Energy storage and related technologies supported by the consortium include those that store electric energy directly (e.g. batteries, ultracapacitors), components of these technologies, related technologies (e.g. fuel cells), and systems/products that incorporate these technologies throughout the value chain.

NY-BEST engaged ECG Consulting Group to conduct a study on "*The Economic Impact of Developing an Energy Storage Industry in New York State*". The overall objectives of the study are to help NY-BEST better understand the global energy storage markets, the economic, regulatory and technology trends that are driving the development of these markets, the industry capabilities and resources that exist in New York State today to serve them and the options that are available to NY-BEST and New York State to help further develop the industry in New York State. The study provides a high-level economic analysis of the potential benefits, focusing on New York company revenues and employment that could result from developing the energy storage industry in New York State.

Throughout the study, ECG leveraged information provided by NY-BEST members, industry participants and a variety of global market and technology research sources. ECG's market analyses are based on conservative market projections made by reputable market research organizations to determine the most likely projections for the development of the global energy storage markets and the industry that can be developed in New York State to serve them.

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III. Methodology

ECG utilized a combination of both primary and secondary research to achieve the 3 main objectives of this project. The project objectives are:

- 1) Assess the global energy storage market
 - Identify key market, technology and regulatory trends
 - Segment the energy storage market (e.g. by application, technology etc.)
 - Determine size & growth of the global markets for energy storage products & services
- 2) Assess the existing New York State energy storage industry resources and capabilities
 - Determine the market segments served, number of jobs created, revenues generated, current and projected market share of the global market by New York State-based companies under different scenarios
 - Determine Research and Development (R&D) needs
 - Assess attractiveness of opportunities for New York State and NY-BEST economic development activities
- 3) Determine the high-level economic impact of developing the energy storage industry in New York State
 - Analyze potential economic impact (investment, jobs & revenues)

ECG's economic impact analysis is based on reviewing and analyzing market and technology research, interviewing NY-BEST members and other organizations and leveraging its business strategy and technology commercialization experience in the energy industry with global market leaders, technology developers and R&D organizations.

ECG reviewed and analyzed over 20 market and technology research publications that analyzed the electricity storage and transportation battery markets. These reports helped ECG develop a comprehensive market perspective from multiple vantage points. ECG's market analyses are based on conservative market projections made by reputable market research organizations to determine the most likely projections for the development of the global energy storage markets and the industry that can be developed in New York State to serve them.

ECG also conducted more than 25 interviews with NY-BEST members and other industry participants whose experience and perspective helped shape our findings and conclusions. Many of the actions NY-BEST and New York State can take to accelerate the growth of the industry in the State were developed based on these interviews. Companies interviewed are in Exhibit 2 on the following page:

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Exhibit 2 **NY-BEST Member Interviews**

Applications	Company	
	Type	Name
Grid Energy Storage	Utility	Consolidated Edison Company of NY
		National Grid USA
	ISO	New York Independent System Operator
Transportation	Project Developer	AES Energy Storage, LLC
	Transit Authority	NY City Transit Authority
	Auto OEM	Ford Motor Company
		General Motors
Truck OEM	Smith Electric Vehicles	
Storage Device OEM	Battery OEM	Raymond Corporation
		A123 Systems
		Bren-Tronics, Inc.
		GE Energy Storage
	Samsung SDI	
Components, Materials & Others	Ultracapacitor OEM	Ultralife Batteries Inc.
	Component OEM	loxus
		Oak-Mitsui Technologies, LLC
	Battery Materials OEM	Hollingsworth & Vose Company
Momentive Performance Materials		
NOHMS Technologies Inc.		
	Contract Manufacturer	Ascension Industries

Source: NY-BEST, ECG Consulting Group Inc.

ECG then developed an economic development impact model that projected the size and growth of the electricity storage and transportation battery markets and modeled New York state companies' potential share of U.S. and global energy storage industry markets. ECG conducted the analysis under two scenarios: *Base Case* and *Optimistic Case*. The findings, conclusions and recommendations of our work are presented in the following section of this report.

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IV. Project Findings & Conclusions

ECG's study provides a summary of the global energy storage market trends, the existing New York State energy storage industry resources and capabilities and an analysis of the high-level economic impact of developing the energy storage industry in New York State.

A. Market Trends & Drivers

Broad market, regulatory and technology trends are driving increasing global interest in energy storage technologies and growth in energy storage markets. These trends fall into four major categories as outlined below:

1) *Traditional Battery Market Trends* (vary by market segment)

- Military is seeking lighter, higher performance rechargeable batteries for portable radios, computers
- Military programs are seeking to standardize battery configurations, chargers, manage inventory & cost
- Traditional auto SLI battery trend is to more advanced cell construction (AGM) and start/stop technology; European mandates are coming to the U.S. market
- Industrial truck users are evaluating fuel cells and looking for lighter weight options and have become more aware of the "cost of energy"

2) *Electricity Storage Market & Regulatory Trends*

- Existing NO_x, SO_x, ozone and other emission standards as well as new and proposed standards for mercury and CO₂ are driving electricity producers and industrial firms to reduce emissions and improve source efficiencies
- U.S. Renewable Portfolio Standards (RPS) are driving significant growth in renewable energy on the grid
- Leading indicators... FERC Pay for Performance regulations created wholesale frequency regulation market, California Self Generation Initiative Program (SGIP) is driving distributed generation market

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3) *Transportation Battery Market & Regulatory Trends*

- Rising fuel prices and increasing interest in energy independence are driving increased demand for electric and hybrid electric vehicles
- Leading indicators... New EPA Corporate Average Fuel Economy (CAFE) standards are driving manufacturers to produce more fuel efficient vehicles

4) *General Technology & Long-term Trends*

- Improving energy storage/power/cycling abilities; declining size, weight and cost
- R&D focusing on new chemistries, technologies and significantly higher levels of quality control
- Systems adopting mixed modes of energy storage, e.g. battery/ultracapacitor hybrids
- Systems leveraging better, smaller, more pervasive communications and computational abilities
- Acting in an environmentally conscious manner and being more aware of energy usage options
- Growing use of intelligent and energy saving devices, e.g. iPhones, regenerative brakes, robots, unmanned aerial vehicles
- Use of public/private partnerships and centers of excellence to develop technologies, industries and markets

The market for energy storage is driven by a variety of complex and interconnected factors. The rate of adoption of new energy storage technologies and the timing of market growth varies significantly by application, geography and location of use. Competitive value propositions, in terms of performance and cost, are critical to achieving high levels of market penetration in every application. Electricity storage technologies compete with different alternatives, depending on the application, for example:

- Battery and flywheel frequency regulators compete with better power plant control systems
- Medium-scale electricity storage systems compete with gas turbines and demand response
- Renewable energy integration storage systems compete with improved Transmission and Distribution (T&D) systems

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Transportation batteries also compete with different alternatives. For example:

- Light-duty vehicle batteries compete with improved clean diesel, natural gas, and fuel cell systems
- Medium and heavy-duty vehicle batteries compete with hydraulic energy storage systems.

Furthermore, regulatory policies which significantly impact market development vary significantly from country to country, and by location within countries. For example, U.S. regulations focus on NO_x, SO₂, Hg and particulates while corresponding European regulations focus on CO₂ reduction. RPS standards vary by state within the U.S. and by country within Europe. Consequently, competitive economics are highly dependent on location and regulatory policy. The value of frequency regulation in U.S. markets, for example, depends almost completely on regulatory policy and reimbursement requirements.

The value proposition for electricity storage depends on who pays for the device and who receives the value. Price and availability of coal, diesel and natural gas vary widely from location to location. In a “pockets of demand” market development scenario, different energy storage applications will penetrate different markets at different rates. A global perspective is critical to understand overall market demand/growth. Continuing advances in technology, reductions in cost and improvements in regulatory policies and incentives will ultimately drive strong market growth.

Global Electricity Storage Market

Electricity storage markets include applications on the customer and utility sides of the meter. In 2012, the total global electricity storage market is currently estimated at \$5.7 billion with annual growth of approximately 21.3% per year through 2020 and 10.7% thereafter. 24% of the market is in North America. See Exhibit 3 on the following page:

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Exhibit 3 Global Electricity Storage Markets

Market Segment	Geographic Scope	Units	CAGR		CAGR		2012	2015	2020	2025	2030
			2013-2020	52.1%	2021-2030	9.0%					
Community Energy Storage	North America	\$M	2013-2020	52.1%	2021-2030	9.0%		\$9	\$160	\$294	\$428
	Rest of World	\$M	2013-2020	59.4%	2021-2030	8.1%		\$6	\$149	\$263	\$367
	Total World	\$M	2013-2020	55.3%	2021-2030	8.6%		\$14	\$309	\$557	\$795
Residential Energy Storage	North America	\$M	2013-2020	56.1%	2021-2030	19.8%		\$1	\$26	\$71	\$169
	Rest of World	\$M	2013-2020	60.0%	2021-2030	21.2%		\$4	\$119	\$353	\$881
	Total World	\$M	2013-2020	59.3%	2021-2030	20.9%		\$6	\$145	\$424	\$1,050
Commercial Buildings, UPS	North America	\$M	2012-2020	5.2%	2021-2030	4.7%	\$916	\$980	\$1,375	\$1,865	\$2,215
	Rest of World	\$M	2012-2020	5.2%	2021-2030	4.7%	\$2,748	\$2,940	\$4,124	\$5,594	\$6,644
	Total World	\$M	2012-2020	5.2%	2021-2030	4.7%	\$3,664	\$3,920	\$5,498	\$7,459	\$8,859
Commercial Buildings, Ice Based	North America (RT)	\$M	2012-2020	32.1%	2021-2030	18.0%	\$22	\$37	\$200	\$597	\$1,131
	North America (CU)	\$M	2012-2020	14.5%	2021-2030	19.7%	\$4	\$5	\$13	\$32	\$80
	North America	\$M	2012-2020	30.0%	2021-2030	18.1%	\$26	\$42	\$213	\$629	\$1,211
	Rest of World (RT)	\$M	2012-2020	14.5%	2021-2030	19.7%	\$4	\$5	\$13	\$32	\$80
	Rest of World (CU)	\$M	2012-2020	14.5%	2021-2030	19.7%	\$13	\$16	\$39	\$97	\$239
	Rest of World	\$M	2012-2020	14.5%	2021-2030	19.7%	\$18	\$21	\$53	\$130	\$319
	Total World (RT)	\$M	2012-2020	30.0%	2021-2030	18.1%	\$26	\$42	\$213	\$629	\$1,211
	Total World (CU)	\$M	2012-2020	14.5%	2021-2030	19.7%	\$18	\$21	\$53	\$130	\$319
	Total World	\$M	2012-2020	25.2%	2021-2030	18.4%	\$44	\$64	\$266	\$759	\$1,530
Commercial Buildings, TOU, DCM...	North America	\$M	2012-2020	32.5%	2021-2030	25.0%	\$75	\$113	\$712	\$2,173	\$6,630
	Rest of World	\$M	2012-2020	32.5%	2021-2030	25.0%	\$225	\$338	\$2,136	\$6,518	\$19,891
	Total World	\$M	2012-2020	32.5%	2021-2030	25.0%	\$300	\$450	\$2,848	\$8,690	\$26,521
Energy Storage on the Grid	North America	\$M	2012-2020	37.8%	2021-2030	8.9%	\$204	\$437	\$2,652	\$4,742	\$6,873
	Rest of World	\$M	2012-2020	33.3%	2021-2030	6.4%	\$1,530	\$3,087	\$15,213	\$21,169	\$27,202
	Total World	\$M	2012-2020	33.9%	2021-2030	6.9%	\$1,733	\$3,524	\$17,865	\$25,911	\$34,075
Total Electricity Storage	North America	\$M	2012-2020	19.7%	2021-2030	12.5%	\$1,221	\$1,581	\$5,137	\$9,773	\$17,526
	Rest of World	\$M	2012-2020	21.7%	2021-2030	10.2%	\$4,520	\$6,396	\$21,794	\$34,026	\$55,303
	Total World	\$M	2012-2020	21.3%	2021-2030	10.7%	\$5,741	\$7,977	\$26,931	\$43,800	\$72,829

Note: RT: rooftop units; CU: custom systems

Source: Pike Research, ECG Consulting Group Analysis

Community and residential energy storage are emerging segments of the electricity storage market. By 2020, these markets are expected to grow to more than \$450 million at annual growth rates that exceed 50% per year in all regions of the world. In North America, the market is forecast to grow to \$186 million. Commercial buildings UPS markets are more mature and are projected to grow at 5.2% per year to \$5.5 billion in 2020. Approximately \$1.4 billion of the market, or 25%, is in North America. Ice-based commercial systems are an emerging market, initially growing 25% globally to more than \$260 million in 2020, with the fastest growth at 30% per year in North America. Commercial building time of use (TOU), demand control management (DCM) and similar systems are project to grow 32.5% annual through 2020 to \$2.8 billion. 25% of the market is in North America. Energy storage on the grid for renewables integration, T&D support and VAR control is currently a \$1.7 billion per year global market, growing at approximately 34% per year. Almost 85% of the market is outside of North America.

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Global Transportation Battery Market

Transportation battery & charger global markets include light duty cars & trucks and medium/ heavy duty vehicles. In 2012, the total global market is approximately \$5.2 billion with projected growth through 2020 of 22% per year. Growth varies by segment with nearly 20% of the market in North America. See Exhibit 4 below:

Exhibit 4 Global Transportation Battery and Charger Markets

Market Segment	Geographic Scope	Units	CAGR		CAGR		2012	2015	2020	2025	2030
			2012-2020	18.4%	2021-2030	9.2%					
Light Duty Vehicle Batteries	North America	\$M	2012-2020	18.4%	2021-2030	9.2%	\$943	\$1,624	\$3,630	\$6,510	\$9,089
	Rest of World	\$M	2012-2020	21.0%	2021-2030	10.4%	\$2,887	\$4,609	\$13,230	\$25,640	\$37,452
	Total World	\$M	2012-2020	20.4%	2021-2030	10.2%	\$3,829	\$6,233	\$16,860	\$32,150	\$46,542
EV Charging Equipment	North America	\$M	2012-2020	26.0%	2021-2030	13.1%	\$133	\$290	\$844	\$1,911	\$3,064
	Rest of World	\$M	2012-2020	26.1%	2021-2030	13.1%	\$686	\$1,371	\$4,381	\$9,942	\$15,963
	Total World	\$M	2012-2020	26.1%	2021-2030	13.1%	\$819	\$1,660	\$5,225	\$11,853	\$19,028
MD & HD Truck Batteries	North America	\$M	2012-2020	21.2%	2021-2030	7.4%	\$81	\$136	\$374	\$661	\$810
	Rest of World	\$M	2012-2020	25.7%	2021-2030	9.6%	\$450	\$809	\$2,797	\$5,653	\$7,505
	Total World	\$M	2012-2020	25.0%	2021-2030	9.4%	\$531	\$945	\$3,171	\$6,314	\$8,315
Total Transport Battery	North America	\$M	2012-2020	19.6%	2021-2030	9.8%	\$1,156	\$2,050	\$4,849	\$9,082	\$12,964
	Rest of World	\$M	2012-2020	22.5%	2021-2030	11.0%	\$4,023	\$6,789	\$20,407	\$41,235	\$60,920
	Total World	\$M	2012-2020	21.9%	2021-2030	10.8%	\$5,179	\$8,839	\$25,256	\$50,317	\$73,884

Source: Pike Research, ECG Consulting Group Analysis

Light duty vehicle propulsion battery markets are currently at \$3.8 billion per year, growing at approximately 20% per year to \$16.9 billion in 2020. Approximately 21% of the market is in North America. Medium and heavy-duty vehicle propulsion battery markets are project to grow by 25% per year to \$3.2 billion in 2020. Only 12% of this market is in North America, 88% is in the rest of the world. Electric vehicle charging equipment is currently at approximately \$820 million per year in 2012, growing at approximately 26.1% per year to \$5.2 billion in 2020, with approximately 16% of the market in North America and 84% in the rest of the world.

Globally, the leading battery manufacturers in Asia have the largest manufacturing capacities and the largest accumulated experience supplying cells to the transportation battery markets. In North America, Michigan has made the largest investment to develop the transportation battery markets, along with the battery R&D, test facilities and other automotive supply chain participants. Part of the investment has been to attract leading global players to operate in Michigan, e.g. LG-Chem.

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B. Existing New York State Energy Storage Industry

New York State has key advantages which include its strong universities and R&D capabilities, highly developed and technical workforce, proximity to the electricity supply chain and low electricity prices (some areas).

New York State is home to world-class academic institutions, R&D facilities and major global companies. New York companies in the energy storage industry include leading suppliers of: components for traditional lead acid auto batteries used in starting, lighting & ignition (SLI) applications, industrial and fork lift trucks, implantable medical batteries and ultracapacitors, lightweight, portable Li-ion batteries for military equipment power applications and PEM and solid oxide fuel cells. New York universities including Alfred, Cornell, RIT, RPI and SUNY; corporate labs including GE Global R&D and GM Battery & Fuel Cell Facility; and national laboratories including Brookhaven provide a world class technology base that are supporting the development of new energy storage technologies and helping to spawn new businesses.

In 2012, New York companies in traditional markets generated sales of over \$500 million and employed over 2,600 people. By 2020, these companies, growing at 4% annually, will generate sales of approximately \$740 million and employment of approximately 3,700. See Exhibit 5 below:

Exhibit 5 *Global Battery & Energy Storage Markets* *New York Company Current & Projected Employment*

Market	Market Segment	Units	2012	2015	2020	2025	2030	CAGR 2012-2020
Traditional Markets	Automotive Lead Acid Batteries	Jobs	90	120	193	311	500	10.0%
	Industrial Fork Lift Trucks	Jobs	100	108	122	138	156	2.5%
	Medical Batteries & Ultracaps	Jobs	300	347	443	566	722	5.0%
	Military Batteries (Portable)	Jobs	620	668	755	855	967	2.5%
	Fuel Cells	Jobs	670	722	816	924	1045	2.5%
	Materials	Jobs	172	185	210	237	268	2.5%
	R&D Supporting New Technologies	Jobs	306	354	452	577	736	5.0%
	Others	Jobs	415	504	707	1,008	1,458	6.9%
NY Company Sales to Traditional Markets		\$M	\$535	\$602	\$740	\$923	\$1,171	4.1%
NY Jobs in Traditional Markets		Jobs	2,673	3,008	3,699	4,614	5,853	4.1%

Source: NY-BEST, ECG Consulting Group Analysis

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New York companies participate throughout the energy storage value chain. Automotive starting, lighting & ignition (SLI) batteries are the largest traditional market. A major growth area is start/stop battery upgrades. It is a current growth market in Europe and is likely to emerge in the U.S. in 2-5 years. Major OEMs including Exide, Johnson Controls and Yuasa operate in New York but do not manufacture here.

Some New York companies, like Hollingsworth & Vose, are leading component suppliers. Industrial fork lift truck manufacturers, e.g. Raymond Corp., are important influencers/users of batteries and potentially fuel cells. Other OEMs manufacture implantable batteries & ultracapacitors for pacemakers, pumps and other devices. Military batteries, manufactured by Bren-Tronics and Ultralife, are a growth market. Trends include standardization, improved performance, lighter weight, longer life. Fuel cells, e.g. GM Fuel Cell Facility, Plug Power, are candidates to replace batteries in some mobile applications, e.g. industrial trucks and potentially in future generations of plug-in hybrid electric vehicles.

GE Energy Storage Technologies recently completed construction of a new \$100 million state-of-the-art battery plant in Schenectady, NY that will initially create approximately 350 jobs in the region. In July 2012, GE announced that they are doubling the capacity of the plant and will create an additional 100 jobs. New York State has partnered with GE in this project by pledging more than \$15 million in incentives. The new industrial energy storage device, a sodium metal halide battery called *Durathon*, will be marketed to customers in the rail, marine, mining, telecommunications and utility sectors.

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C. High-Level Economic Impact of Developing The Energy Storage Industry in New York State

Based upon ECG's analysis, New York's future battery & energy storage companies will likely focus on two emerging market opportunities that have significant growth potential. They are:

- Electricity storage market encompassing grid-connected (utility side of the meter) and customer connected (customer side of the meter) applications; this market is projected to grow from \$5.7 billion in 2012 to more than \$26 billion by 2020 and \$72 billion by 2030; and
- Transportation battery market, driven by projected growth in sales of hybrid electric vehicles, plug-in hybrid electric vehicles and battery electric vehicles that are projected to grow from \$5.2 billion in 2012 to more than \$25 billion by 2020 and \$73 billion by 2030

ECG developed an economic development impact model that projected the size and growth of the electricity storage and transportation battery markets and modeled New York state companies' potential share of U.S. and global energy storage industry markets. ECG conducted the analysis under two scenarios: *Base Case* and *Optimistic Case*.

In the economic development model, for the two new/emerging markets, New York state companies' projected share of global and U.S. markets varied by scenarios. The assumed market shares are consistent with ECG's client experience in a broad range of energy industry markets. See Exhibit 6 on the following page.

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Exhibit 6
Energy Storage Economic Development Model
Key Assumptions: Market Share

Case	Sector	Geographic Market Share		New York Companies Projected Market Share				
				2012	2015	2020	2025	2030
Base	Grid-Connected & Grid-Related Energy Storage	NY Share of N.A.	All Segments Exc. UPS	2.50%	5.00%	10.00%	15.00%	15.00%
			UPS	1.25%	5.00%	10.00%	15.00%	15.00%
		NY Share of ROW	All Segments Exc. UPS	0.50%	1.50%	3.25%	5.00%	5.00%
			UPS	0.25%	1.50%	3.25%	5.00%	5.00%
	Transportation Energy Storage	NY Share of N.A.	Light Duty	0.50%	1.25%	2.50%	5.00%	5.00%
			Medium/Heavy Duty	1.00%	5.00%	10.00%	15.00%	15.00%
		NY Share of ROW	Light Duty	0.50%	1.25%	1.55%	2.00%	2.00%
			Medium/Heavy Duty	1.00%	2.75%	4.00%	5.00%	5.00%
Optimistic	Grid-Connected & Grid-Related Energy Storage	NY Share of N.A.	All Segments Exc. UPS	2.50%	7.00%	17.00%	25.00%	25.00%
			UPS	1.25%	5.00%	15.00%	25.00%	25.00%
		NY Share of ROW	All Segments Exc. UPS	0.50%	3.50%	5.50%	8.00%	8.00%
			UPS	0.25%	3.50%	5.50%	8.00%	8.00%
	Transportation Energy Storage	NY Share of N.A.	Light Duty	0.50%	4.00%	7.00%	10.00%	10.00%
			Medium/Heavy Duty	1.00%	5.00%	12.50%	20.00%	20.00%
		NY Share of ROW	Light Duty	0.50%	1.00%	2.25%	4.00%	4.00%
			Medium/Heavy Duty	1.00%	3.50%	5.50%	8.00%	8.00%

Source: ECG Consulting Group Analysis

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Revenues per employee were assumed to be \$200,000 in 2012 and grow based on productivity increases. See Exhibit 7 below.

Exhibit 7
Energy Storage Economic Development Model
Key Assumptions: Revenues per Employee

	2012	2015	2020	2025	2030
Revenues Per Employee (\$ in Thousands)	\$200	\$230	\$279	\$310	\$325
Jobs Per Million Dollars of Sales	5.0	4.3	3.6	3.2	3.1

Source: ESA/KEMA, Fortune, ECG Consulting Group Analysis

In 2012, revenues per employee reflect low production volumes and job-shop oriented manufacturing processes. As the industry grows, production processes will mature and will be more automated, resulting in higher productivity.

Base Case Assumptions and Results

In the *Base Case*, New York State develops a strong economic development program focused on the emerging electricity storage and transportation battery industries and implements incentives to help develop existing New York companies and attract significant new companies to the state. The objective is to build New York State into a center of excellence for energy storage and to develop a stronger industry that can win a larger share of global and North American markets.

In the *Base Case* scenario, revenues of New York companies could reach \$2.5 billion in 2020 with 10,000 jobs. See Exhibit 8 on the following page.

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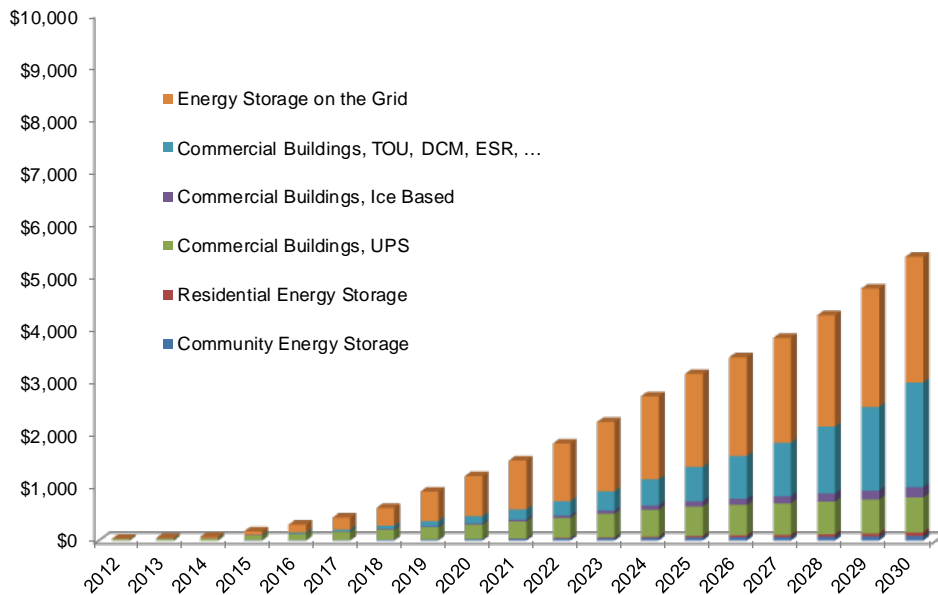
Exhibit 8 ***Economic Impact of Developing Energy Storage Industry*** ***New York Revenues & Employment: Base Case Scenario***

Base Case: New York Company Revenues & Employment		Units	2012	2015	2020	2025	2030	CAGR 2012-2020
Revenues	Global Electricity Storage Market	\$M	598	\$175	\$1,222	\$3,167	\$5,394	56.0%
	Global Transportation Battery Market	\$M		\$132	\$559	\$1,586	\$2,278	44.7%
	Traditional Markets	\$M		\$602	\$740	\$923	\$1,171	4.1%
	Total Base Case Revenues	\$M		\$598	\$908	\$2,521	\$5,676	\$8,842
Employment	NY Jobs in Electricity Storage Market	Jobs	2,992	759	4,380	10,233	16,582	49.7%
	NY Jobs in Transportation Battery Market	Jobs		571	2,003	5,124	7,002	38.8%
	Traditional Markets	Jobs		3,008	3,699	4,614	5,853	4.1%
	Total Base Case Employment	Jobs		2,992	4,339	10,082	19,972	29,437

Source: ECG Consulting Group Analysis

In the *Base Case*, New York company sales to global electricity storage markets approach \$1.2 billion per year by 2020. See Exhibit 9 below. The largest applications are load levelling and peak shifting in commercial facilities and renewables integration on the grid. The model indicates that employment in New York companies serving the electricity storage markets can exceed 4,300 jobs by 2020.

Exhibit 9 ***Base Case - New York Company Sales to Global Electricity Storage Market*** ***(Dollars in Millions)***



Note: NY Company 2012 numbers include ~60 jobs in IPPs, ~45 in utilities and ~350 in utility scale battery OEMs

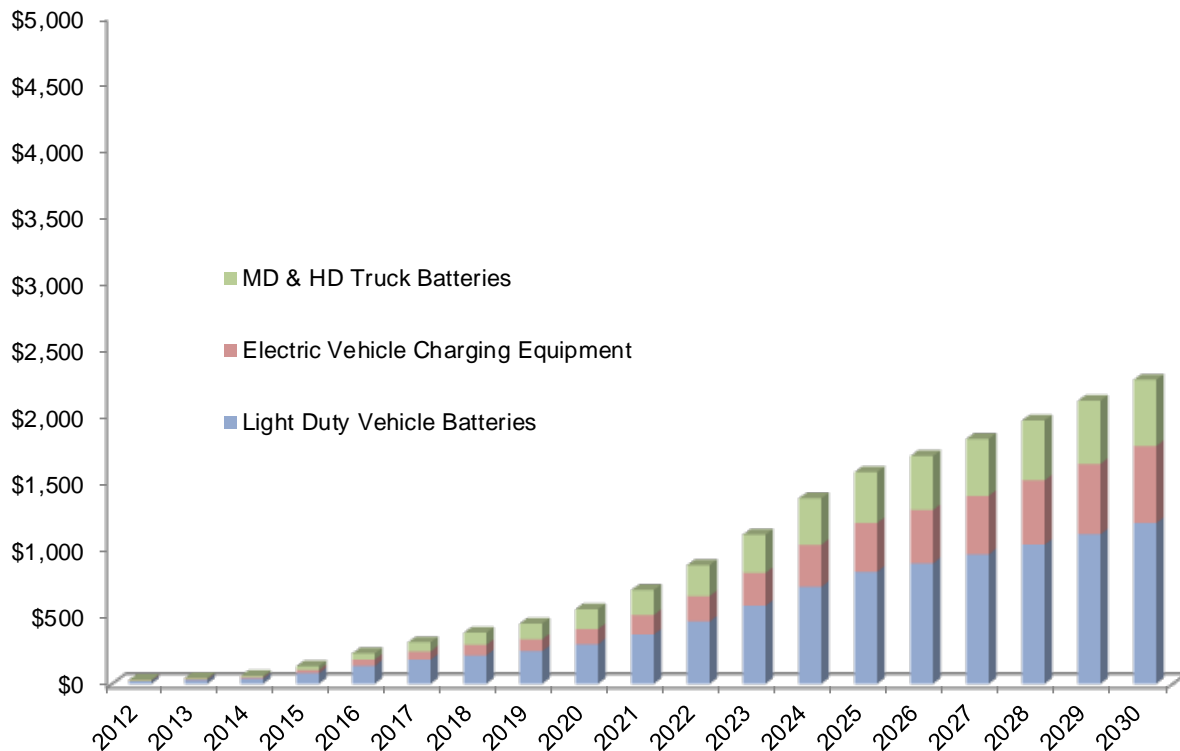
Source: ECG Consulting Group Analysis

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In the Base Case, New York company sales to global transportation markets can approach \$560 million per year by 2020. See Exhibit 10 below. The largest applications are for light duty HEV/PHEV/BEV batteries and charging equipment. The model indicates that employment in New York companies serving these transportation battery and charger markets can approach 2,000 jobs by 2020.

Exhibit 10
Base Case - New York Company Sales to Global Transportation Battery & Charger Markets
(Dollars in Millions)



Source: ECG Consulting Group Analysis

In both electricity storage and transportation battery markets, the risk of not reaching the projected levels of sales and employment growth increase if other States and/or other countries take more aggressive action to encourage development of the industry in their jurisdictions.

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Optimistic Case Assumptions and Results

In the *Optimistic Case*, New York State implements even stronger economic development actions and a broader range of larger economic development incentives to attract or develop companies who are or can become #1, #2 and #3 market share leaders in several battery and energy storage market segments. In modeling this scenario, it was assumed that New York State:

- Takes more vigorous energy storage economic development action relative to other states and countries
- Provides incentives to encourage R&D to help lower the cost and improve the performance of energy storage technologies
- Establishes 3rd party test, demonstration, validation and commercialization facilities
- Provides economic development incentives to encourage location of manufacturing in NYS
- Offers programs to encourage broader development and demonstration of energy storage technologies for a variety of grid-connected applications and technologies
- Includes energy storage targets in the New York State Renewable Portfolio Standard
- Provides buy-down incentives to encourage early deployment of new energy storage technologies
- Changes NYS Article X siting law to allow pre-approved permitting and siting of energy storage facilities
- Changes NYS regulations to encourage the purchase of energy storage by utilities and Independent Power Producers (IPPs)
- Removes outdated regulations that are an impediment to energy storage, e.g. codes forbidding multiple meters in buildings or resale of electricity

In the *Optimistic Case*, revenues of New York companies increase by ~45% to \$3.7 billion from \$2.5 billion in the *Base Case*. In 2020, employment in the *Optimistic Case* increases correspondingly to nearly 14,400 jobs in 2020. See Exhibit 11 below.

Exhibit 11 ***Economic Impact of Developing Energy Storage Industry*** ***New York Revenues & Employment: Optimistic Scenario***

Optimistic Case: New York Company Revenues & Employment		Units	2012	2015	2020	2025	2030	CAGR 2012-2020
Revenues	Global Electricity Storage Market	\$M	\$598	\$315	\$2,045	\$5,165	\$8,806	66.4%
	Global Transportation Battery Market	\$M		\$177	\$939	\$2,939	\$4,246	54.4%
	Traditional Markets	\$M		\$602	\$740	\$923	\$1,171	4.1%
	Total Optimistic Case Revenues	\$M	\$598	\$1,093	\$3,724	\$9,028	\$14,222	25.7%
Employment	NY Jobs in Electricity Storage Market	Jobs	2,992	1,367	7,328	16,689	27,070	59.6%
	NY Jobs in Transportation Battery Market	Jobs		767	3,367	9,497	13,053	48.1%
	Traditional Markets	Jobs		3,008	3,699	4,614	5,853	4.1%
	Total Optimistic Case Employment	Jobs	2,992	5,142	14,394	30,800	45,976	21.7%

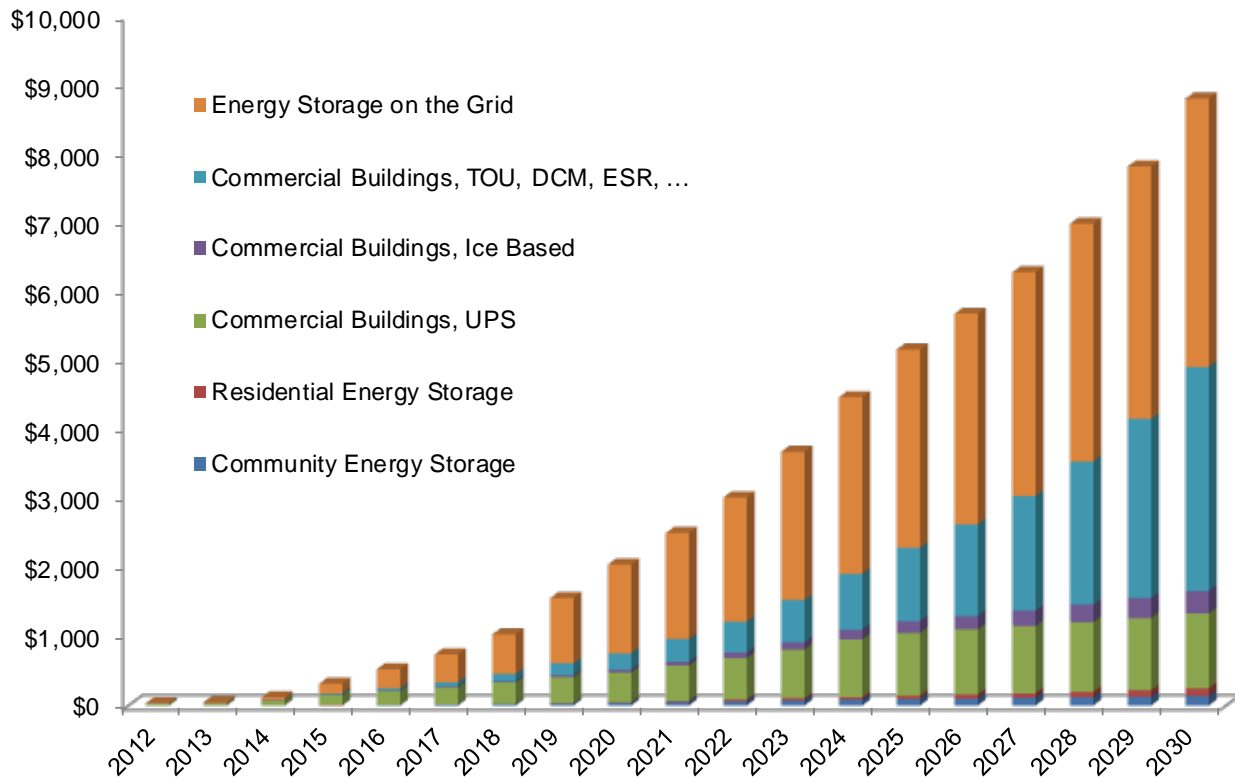
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Source: ECG Consulting Group Analysis

In the *Optimistic Case*, New York company sales to global electricity storage markets approach \$2.0 billion per year by 2020. See Exhibit 12 below. Employment in New York companies serving electricity storage markets approaches 7,300 jobs by 2020.

Exhibit 12
Optimistic Case - New York Company Sales
to Global Electricity Storage Markets
(Dollars in Millions)



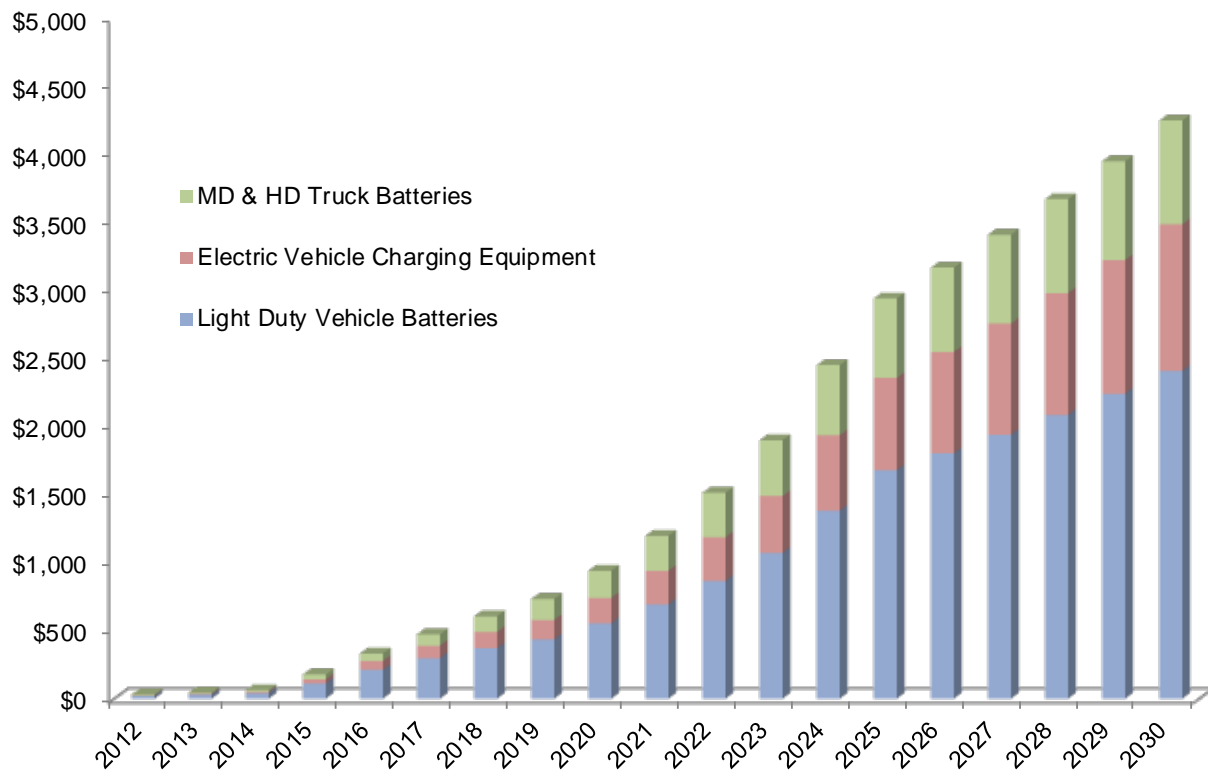
Source: ECG Consulting Group Analysis

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In the *Optimistic Case*, New York company sales to global transportation battery markets approach \$940 million per year by 2020. See Exhibit 13 below. Employment in New York companies serving the transportation battery and charger markets is approximately 3,300 jobs by 2020.

Exhibit 13
Optimistic Case - New York Company Sales
to Global Transportation Battery & Charger Markets
(Dollars in Millions)



Source: ECG Consulting Group Analysis

In summary, in the *Optimistic Case*, revenues of New York companies increase by ~45% to \$3.7 billion from \$2.5 billion in the *Base Case*. In 2020, employment in the *Optimistic Case* increases to 14,400 jobs versus 10,000 in the same year for the *Base Case*. See Exhibits 14 and 15 on the following page.

It is important to note that our study shows the “potential” economic impact (revenues & jobs) that New York companies can have if:

- Global markets grow as forecasted by our market research sources
- Global regulations, technology cost reductions and rising fuel costs drive forecasted growth
- New York can successfully attract and retain global and North American market share leaders

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Exhibit 14

New York Energy Storage Industry Revenues & Employment - Base Case

Base Case: New York State Company Sales & Jobs		Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sales	Global Electricity Storage Market	\$M	\$35	\$47	\$69	\$175	\$299	\$434	\$617	\$930	\$1,222	\$1,518	\$1,842	\$2,252	\$2,743	\$3,167	\$3,484	\$3,852	\$4,283	\$4,792	\$5,394
	Global Transportation Battery Market	\$M	\$29	\$44	\$59	\$132	\$227	\$310	\$382	\$451	\$559	\$702	\$889	\$1,117	\$1,389	\$1,586	\$1,706	\$1,835	\$1,973	\$2,120	\$2,278
	Traditional Markets	\$M	\$535	\$556	\$578	\$602	\$626	\$652	\$680	\$709	\$740	\$772	\$807	\$843	\$882	\$923	\$966	\$1,013	\$1,062	\$1,115	\$1,171
	Total Base Case Revenues	\$M	\$598	\$647	\$706	\$908	\$1,152	\$1,397	\$1,680	\$2,090	\$2,521	\$2,992	\$3,538	\$4,213	\$5,014	\$5,676	\$6,157	\$6,700	\$7,318	\$8,027	\$8,842
Jobs	NY Jobs in Energy Storage Markets	Jobs	174	223	311	759	1,240	1,732	2,371	3,449	4,380	5,281	6,254	7,497	8,950	10,233	11,144	12,200	13,432	14,877	16,582
	NY Jobs in Transportation Markets	Jobs	145	210	268	571	943	1,239	1,469	1,673	2,003	2,444	3,018	3,720	4,534	5,124	5,459	5,813	6,187	6,584	7,002
	Traditional Markets	Jobs	2,673	2,779	2,890	3,008	3,132	3,262	3,400	3,545	3,699	3,861	4,033	4,216	4,409	4,614	4,832	5,064	5,310	5,573	5,853
	Total Base Case Employment	Jobs	2,992	3,212	3,469	4,339	5,315	6,234	7,239	8,667	10,082	11,586	13,306	15,433	17,893	19,972	21,435	23,077	24,930	27,034	29,437

Exhibit 15

New York Energy Storage Industry Revenues & Employment - Optimistic Case

Optimistic Case: New York State Company Sales & Jobs		Units	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
Sales	Global Electricity Storage Market	\$M	\$35	\$47	\$119	\$315	\$527	\$740	\$1,031	\$1,557	\$2,045	\$2,502	\$3,018	\$3,682	\$4,473	\$5,165	\$5,683	\$6,285	\$6,990	\$7,821	\$8,806
	Global Transportation Battery Market	\$M	\$29	\$44	\$62	\$177	\$331	\$472	\$605	\$731	\$939	\$1,196	\$1,511	\$1,898	\$2,450	\$2,939	\$3,165	\$3,408	\$3,668	\$3,947	\$4,246
	Traditional Markets	\$M	\$535	\$556	\$578	\$602	\$626	\$652	\$680	\$709	\$740	\$772	\$807	\$843	\$882	\$923	\$966	\$1,013	\$1,062	\$1,115	\$1,171
	Total Base Case Revenues	\$M	\$598	\$647	\$759	\$1,093	\$1,484	\$1,865	\$2,316	\$2,998	\$3,724	\$4,470	\$5,336	\$6,424	\$7,804	\$9,028	\$9,815	\$10,706	\$11,720	\$12,883	\$14,222
Jobs	NY Jobs in Energy Storage Markets	Jobs	174	223	538	1,367	2,187	2,956	3,960	5,778	7,328	8,706	10,246	12,256	14,597	16,689	18,178	19,905	21,919	24,282	27,070
	NY Jobs in Transportation Markets	Jobs	145	210	281	767	1,374	1,885	2,322	2,713	3,367	4,161	5,131	6,319	7,993	9,497	10,126	10,794	11,504	12,256	13,053
	Traditional Markets	Jobs	2,673	2,779	2,890	3,008	3,132	3,262	3,400	3,545	3,699	3,861	4,033	4,216	4,409	4,614	4,832	5,064	5,310	5,573	5,853
	Total Base Case Employment	Jobs	2,992	3,212	3,709	5,142	6,693	8,103	9,682	12,036	14,394	16,729	19,411	22,790	26,999	30,800	33,137	35,764	38,734	42,111	45,976

Source: NY-BEST, ECG Consulting Group Analysis

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D. Member Interview Results

NY-BEST members believe that New York State has a significant potential opportunity to participate in the rapid growth of the global energy storage industry. Many members stated that NY-BEST and New York State should work closely together to aggressively leverage New York State's capabilities and support economic development to position New York State to be a leader in the global energy storage business.

Some of the key initiatives that members highlighted are modeled in the *Optimistic Case*. In this scenario, New York State implements even stronger economic development actions and a broader range of larger economic development incentives to attract or develop companies who are or can become #1, #2 and #3 market share leaders in several battery and energy storage market segments. In modeling this scenario, it was assumed that New York State:

- Takes more vigorous energy storage economic development action relative to other states and countries
- Provides incentives to encourage R&D to help lower the cost and improve the performance of energy storage technologies
- Establishes 3rd party test, demonstration, validation and commercialization facilities
- Provides economic development incentives to encourage location of manufacturing in NYS
- Offers programs to encourage broader development and demonstration of energy storage technologies for a variety of grid-connected applications and technologies
- Includes energy storage targets in the New York State Renewable Portfolio Standard
- Provides buy-down incentives to encourage early deployment of new energy storage technologies
- Changes NYS Article X siting law to allow pre-approved permitting and siting of energy storage facilities
- Changes NYS regulations to encourage the purchase of energy storage by utilities and Independent Power Producers (IPPs)
- Removes outdated regulations that are an impediment to energy storage, e.g. codes forbidding multiple meters in buildings or resale of electricity

NY-BEST and New York State need to recognize that the speed of taking action is very important because other states and countries are also competing for these emerging rapidly growing energy storage markets.

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Members also suggested that NY-BEST should encourage New York State to take additional actions that will help them compete in global markets. Some of these key actions include:

- Evaluate/implement in New York several initiatives developed by the California Energy Storage Alliance, such as:
 - Net Zero Energy Buildings with rooftop solar or geothermal sources
 - Distributed generation incentives and backup capabilities for DG sources
- Incentivize New York utilities to keep per capita energy consumption flat, e.g. CA, MA programs
- Provide government incentives which emphasize performance measures and results and avoid selecting technology winners, e.g.:
 - Incentivize dollars saved, KWH saved, CO₂ emissions reduced, etc.
 - Avoid specifying technologies, e.g. Li-ion, Zn-Br, fuel cells, flywheels
- NY State should develop new energy initiatives, engage with key companies in the industry and incentivize businesses to locate in New York State

Members suggested that NY-BEST should represent member companies at federal and national meetings, conferences, etc. and encourage the federal government to take additional actions to help them compete in global markets. Some key actions include extending buy American legislation to require DOD to give preference in procurement to domestically manufactured battery cells, encourage the federal government to provide incentives that emphasize performance measures/results and avoid selecting technology winners and encourage other states and countries to include energy storage in their RPS legislation.

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E. Conclusions

New York State has a unique opportunity to leverage its industrial base to position itself as a global leader in the emerging, and rapidly growing, global energy storage industry. Today, many New York companies possess the requisite skills, capabilities and market position to become leaders in this industry. In both the *Base and Optimistic Cases*, our economic development analysis assumes that New York State is able to grow or attract key competitors in most segments of the energy storage business.

There is significant revenues and employment growth potential in New York State as a result of pursuing this opportunity. In the *Base Case* scenario, revenues of New York companies could reach \$2.5 billion in 2020 with 10,000 jobs. In the *Optimistic Case*, revenues of New York companies could reach \$3.7 billion, more than 45% higher than in the *Base Case*. Employment increases correspondingly to nearly 14,400 jobs in 2020. Beyond 2020, significant growth is forecast to continue to 2030 which could result in greater employment growth to approximately 30,000 jobs in the *Base Case* and 45,000 jobs in the *Optimistic Case*.

To position itself as a global leader, New York State will need to help develop its existing companies and attract key competitors to the state with significant incentives which are critical to achieving the potential economic development benefit as outlined in our study. There are four key types of incentives which need to be implemented. They are:

- Economic development investment to develop and/or attract global market share leaders and/or key competitors (Albany Nano model)
- Tax incentives to encourage operating economics
- Technology R&D incentives to foster development of improved capabilities and lower cost technologies, e.g. test facilities, demo facilities, university R&D etc.
- Regulations which significantly increase demand, e.g. RPS, Article 10, elimination of outdated regulations

Finally, it is important to note that achieving the economic development potential as outlined in both the *Base and Optimistic Cases* requires near-term actions by New York State. Any delays or reduction in the magnitude of regulations & incentives will have a corresponding reduction in the magnitude and timing of the economic benefit. It is our belief that all the potential energy storage and economic benefits are obtainable if the market projections are realized, New York State aggressively implements a broad mix of strong incentives, New York companies build their global competitiveness and these companies locate their growth in employment in New York State.