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Energy Storage Roadmap for Northeast Ohio 2019: Executive Summary

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Energy Storage Roadmap for Northeast Ohio

EXECUTIVE SUMMARY
2019



Prepared by



Teamneo

ADVISORY GROUP:

GENEROUS SUPPORT
PROVIDED BY:



GLX Power Systems Inc



In 2011 Team NEO commissioned the development of a technology development “Roadmap” to help guide the region in the development of its growing Energy Storage industry. Based upon a survey of regional assets and projected industry growth, the 2011 Roadmap proposed a seven-year strategy for cluster development, after which time the strategies would be re-evaluated in light of changes to assets and markets. Accordingly, in 2018, Team NEO commissioned this new 2019 Roadmap.

A great deal has changed in the energy storage industry since 2011. The way in which people interact with energy in living our lives has continued to undergo fundamental shifts that have become ever more conspicuous. The changing dynamics of not only how the energy we use is generated, but also of how and when it must be deployed to meet our increasing—and increasingly complex—demand for electric power are accelerating the need for more advanced, economical forms of energy storage.

This 2019 Energy Storage Roadmap examines the trends that are driving growth in energy storage for the electric power grid, transportation, and consumer electronics applications. The report also highlights the commercial and structural assets that Northeast Ohio currently possesses that could enable it to capture an increasing share of what is projected to be a \$100 billion market by 2025. While disruptive market forces are causing the ground to shift for the advanced energy industry, this shift will present opportunities for Northeast Ohio to capitalize on innovative technologies being developed regionally that would enable the realization of appreciably greater economic growth.

This 2019 Roadmap provides a background on Energy Storage technologies and the role the region currently plays in their development. The Roadmap also provides a vision for how existing local assets can be leveraged in conjunction with funding opportunities for technology innovation to capture a larger share of this high-growth market. The goal of the 2019 Roadmap is to propose how assets and strategies that can be together deployed to establish the region as an energy storage activity hub.

Roadmap Advisory Group & Project Team

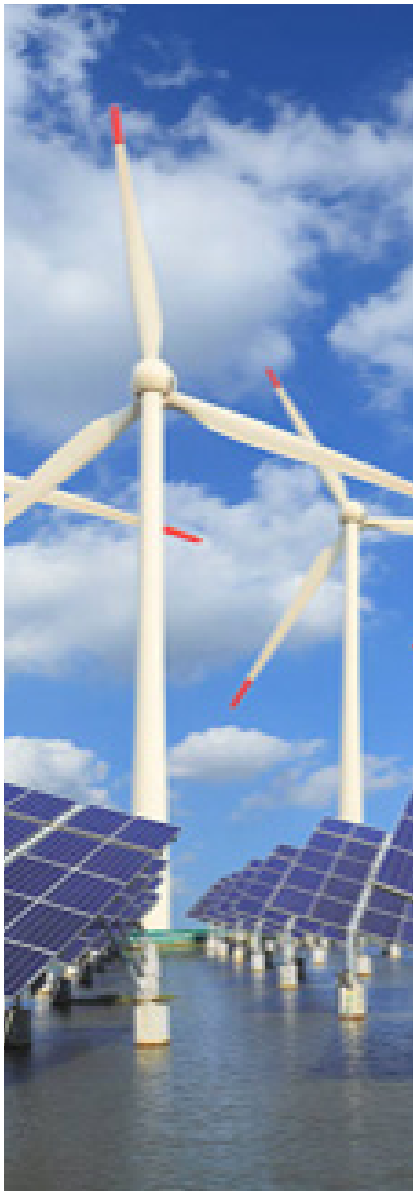
The Advisory Group includes members from leading academic and research institutions, prominent OEMs and aggregators, and key non-profit organizations and commercial testing labs. The role of the Advisory Group has been to provide guidance and recommendations to the Project Team throughout the road mapping process.

ADVISORY GROUP

MEMBERS	ORGANIZATION
Thomas Doehne	NASA Glenn Research Center
Ryan Franks	CSA Group
Jim Green	CSA Group
Grant Goodrich	Great Lakes Energy Institute at Case Western Reserve University
Patrick Kelly	FirstEnergy
Kent Kristensen	GLX Power Systems
Dave Mayewski	Rockwell Automation
Rick Stockburger	Brite Energy Innovators, or BRITE (formerly known as Tech Belt Energy Innovation Center, or TBEIC)
Don Wingate	Schneider Electric

PROJECT TEAM

MEMBERS	ORGANIZATION
Jay Foran	Team NEO
Bill Hagstrand	Team NEO
Mark Henning	Energy Policy Center at Cleveland State University
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Melinda McNutt	Team NEO
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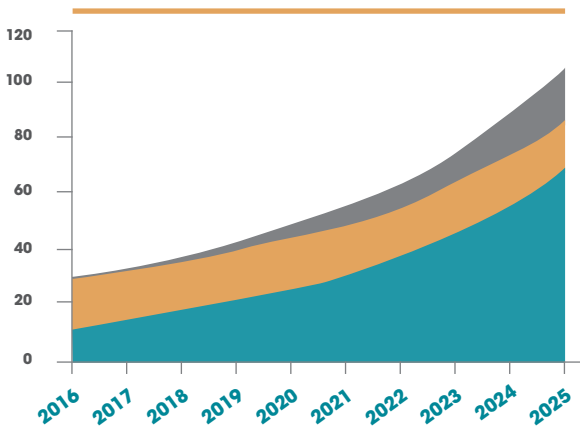




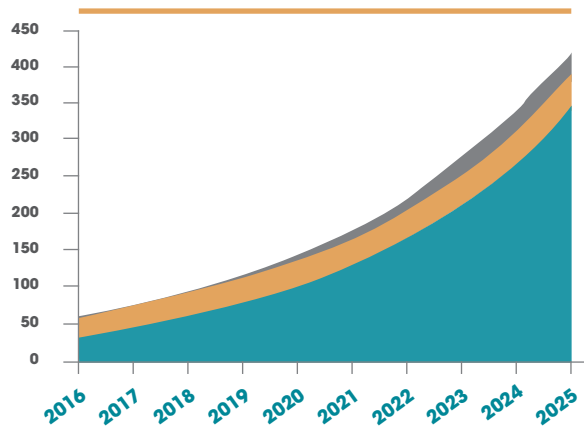
Global Energy Storage Market by 2025

The market for energy storage is projected to be more than \$100 billion by 2025. While consumer electronics devices have traditionally driven demand for energy storage, the largest share of the market in the short to medium term will stem from transportation applications and what has been called the *electric vehicle revolution*. Stationary storage for electric power grid applications is the newest energy storage sector, but the one expected to realize the highest growth rates over the next 5-7 years.

Total Energy Storage Revenues (\$ Billions)



Total Energy Storage Market (GWh)



■ Transportation ■ Consumer Electronics ■ Stationary

Energy Storage Industry in Northeast Ohio

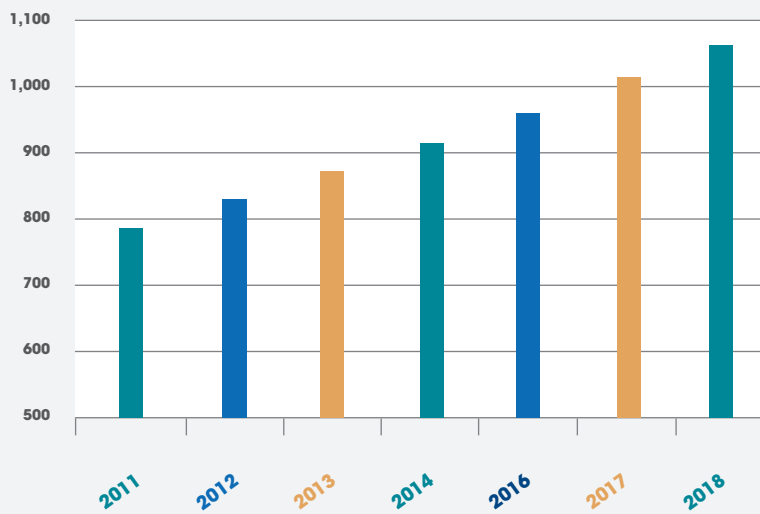
Northeast Ohio possesses an accumulation of entities that support the development and deployment of all manner of energy storage technologies. Together, these structural assets comprise an energy storage ecosystem that encourages the growth of innovative technologies and companies in the region.

In the middle of this ecological community are its commercial energy storage assets, consisting of nearly 80 companies. Half of these are involved in “core” energy storage activities, as identified in the 2011 Roadmap as those activities that “contribute the highest value to energy storage,” either economically or in how the storage is made. For example, core activities include anode, cathode or electrolyte manufacturing, while

noncore activities include battery management systems. Core activity growth in Northeast Ohio since 2011 has outpaced the national job growth rate for total nonfarm employment over the same period (1.8%), averaging around 4.1% annually (see graph below). Noncore employment is greater than core employment. For instance, energy storage related balance-of-plant activities employed 3,000 in Northeast Ohio, while core employment was around 1,000. Yet these jobs are typically more broad than just energy storage—they may relate to grid or other activities. More and more, however, it appears that those who produce supporting components and auxiliary systems to help facilitate the delivery of energy to end-use applications have become the center of gravity for Northeast Ohio’s Energy Storage cluster. These companies that are on the front line of bringing novel products to market.



Northeast Ohio Employment for Core Energy Storage Activities



Source Roadmap Project Team

Some of these Northeast Ohio companies engaged in commercial energy storage activities provide more than just the development and production of energy storage technologies; they also are adept at implementing smart manufacturing methods into the production process and value chain of other companies.

This regional concentration of expertise in the Industrial Internet of Things (IIoT) is itself a structural asset that can enable other **energy storage firms to increase revenues, lower costs, and maximize operational performance.**

Northeast Ohio's energy storage assets — both commercial and structural representing areas of strength for the region — were identified using a variety of third-party company databases such as Pitchbook, D&B Hoovers, Reference USA, Thomas Register, and the Ohio Manufacturers Directory, as well as by consulting Team NEO's own internally maintained partner lists. Additionally, NASA Glenn Research Center had previously prepared an asset map of companies in Ohio to identify areas of high concentration for energy storage technology. Portions of NASA's asset map were incorporated into a compiled list of assets for the 2019 Roadmap that was then verified by the Advisory Group.



Embedded within Northeast Ohio’s energy storage companies are the people whose skills drive innovation and new market growth. The region has a significant workforce advantage compared to other regions in the country where energy storage is considered by experts to be “happening now.” Northeast Ohio possesses a concentration of human capital in key occupational areas that compares favorably to other regions identified as hosting energy storage clusters.

Relative Concentration of Chemical Engineers

AREA NAME	LOCATION QUOTIENT ¹
Cleveland, OH	1.64
Akron, OH	1.31
San Francisco, CA	0.96
Detroit, MI	0.62
Grand Rapids, MI	0.62
Charlotte, NC	0.52

Relative Concentration of Materials Engineers

AREA NAME	LOCATION QUOTIENT ¹
Akron, OH	2.36
Cleveland, OH	1.48
Detroit, MI	1.32
Grand Rapids, MI	1.18
San Francisco, CA	1.05
Charlotte, NC	0.53

KEY 1.0 = National Average / Source: Bureau of Labor Statistics

A location quotient greater than 1.2 generally indicates specialization compared to the U.S. overall.

Cost of Living by Metro Area

AREA NAME	PRICE OF GOODS, SERVICES & HOUSING COMPARED TO NATIONAL AVERAGE
Akron, OH	10% lower
Cleveland, OH	9.8% lower
Charlotte, NC	6.5% lower
Grand Rapids, MI	6.5% lower
Detroit, MI	4.1% lower
San Francisco, CA	24.7% higher

Source: Bureau of Economic Analysis

Likewise, the cost of living – another critical factor in attracting labor and investment – is relatively modest in Northeast Ohio.

Compared to those other regions indicated as having energy storage clusters, the average cost of goods, services, and housing is lowest in Northeast Ohio.

Taking Stock of Northeast Ohio's Energy Storage Cluster

One common strategy for examining the status of an emerging technology is to use a "Strengths, Weaknesses, Opportunities and Threats" analysis. Such a "SWOT" analysis for energy storage was employed for Northeast Ohio's energy storage cluster.

<p>STRENGTHS</p> <ul style="list-style-type: none">• World-class research institutions• Entrepreneurial culture• Skilled labor – concentration of key occupations• Strong manufacturing base	<p>WEAKNESSES</p> <ul style="list-style-type: none">• Lack of system integrators that bring together core and ancillary energy storage pieces for end-use applications• Uneven coordination with other regional innovation clusters• Lack of adequate early-stage funding for capital-intensive energy storage development
<p>OPPORTUNITIES</p> <ul style="list-style-type: none">• 17% projected annual growth, leading to a \$100 billion market by mid-2020s• Other regional innovation clusters in NE Ohio can enable more efficient energy development and production• Limiting factors of the incumbent Li-ion technology, including supply constraints for key commodities and technological performance limits	<p>THREATS</p> <ul style="list-style-type: none">• Global competition• State-level regulatory uncertainty for stationary grid storage• Better coordinated and funded industry-institutional strategy by other regions in the U.S.

While Asia and other parts of the U.S. are projected to continue to lead in manufacturing capacity for the incumbent lithium-ion technology that dominates many energy storage applications, particularly for electric vehicles, this will not necessarily prevent Northeast Ohio from capturing a greater share of the global market for energy storage. Conventional lithium-ion faces an uncertain future given supply constraints for key elements such as cobalt. Additionally, lithium-ion chemistries that currently pervade the market cannot improve much further having reached their theoretical performance limits for key factors such as energy density.

Northeast Ohio will have the opportunity to leverage disruptive energy storage technologies being developed in the region as part of a strategy to “get in on the ground floor” with projected high-growth market sub-segments that will eventually supplant the incumbent incarnation of lithium-ion technology. Solid-state batteries, for instance, sometimes referred to as the “holy grail” of battery storage, are expected by market analysts to see greater than 60% annual growth in revenues through the mid-2020s. The use of polymer-based electrolytes in these types of batteries would likely give Northeast Ohio an edge in capturing some of this growth given the region’s expertise in polymer sciences and the abundance of cheap natural gas—a feedstock for polymers—or Ohio in general.

The region’s advanced manufacturing base will also allow it to capitalize on market opportunities for disruptive energy storage technologies. For example, the emergence of wearable technology, including ingestible and implantable medical devices, will drive the need to develop not only new forms of energy storage technology, but also thinner, more flexible form factors that can still deliver a high level of performance. Additive manufacturing and the printing process of roll-to-roll manufacturing are likely to play a significant role in making flexible, thin-film batteries for these wearable applications at the lowest possible cost. Northeast Ohio possesses assets with knowledge and experience in these 2D and 3D manufacturing processes that could position it as a leader within the Flexible, Printed, & Thin Film Batteries sub-segment where 35% annual growth in revenues is expected by market analysts through 2025.

Energy Storage Cluster Mission

Support the timely development and delivery of needed products and services for the energy storage market, while creating jobs and growing the regional and state economies.

Energy Storage Cluster Goals

- Build opportunities for increased collaboration between energy storage organizations and institutions
- Accelerate innovation
- Collaborate with economic development organizations
- Identify and develop opportunities for funding in areas related to energy storage
- Support energy storage as a key component of renewable energy
- Drive economic growth through demonstration, deployment and adoption of energy storage products and services



Strategies for Realizing an Energy Storage Hub in Northeast Ohio

Further Develop and Support Culture of Entrepreneurship.

- 1 / Obtain JobsOhio R&D Grant. This program facilitates new strategic corporate R&D centers in Ohio, where Energy Storage is expressly included among eligible industries.
- 2 / Increase available seed and early stage capital funding. State and philanthropic funding in addition to that already invested by JumpStart would significantly help local entrepreneurship.
- 3 / Re-fund Third Frontier. This multi-billion dollar state-backed initiative supporting applied research and early-stage capital formation was critical to the success of Northeast Ohio's medical technology cluster and could be similarly important to growing the region's Energy Storage cluster.
- 4 / Develop and fund incubators. These organizations increase the likelihood of success for young firms by de-risking entrepreneurial activity and providing important business support services to help startups grow.
- 5 / Develop a center of excellence for energy storage. Federal grants are available for these entities. Similarly, the Ohio Chamber of Commerce has proposed four hubs of innovation for Ohio, one of which — smart infrastructure — prominently includes energy storage and could be established in Northeast Ohio.

Programs That Spur Project Investment and Deployment of Energy Storage Technology.

- 1 / Develop a Cleveland Green Bank. Green Banks make funding available to support loans for renewable energy projects through guarantees and gap financing. Renewable energy relies on energy storage.
- 2 / Maintain Ohio renewable energy and energy efficiency portfolio standards.
- 3 / Develop state-level regulatory laws that encourage energy storage deployment.

Recruit and Retain Prominent Energy Storage Faculty and Researchers.

- 1 / Technology-intensive companies tend to locate near the best universities allowing for collaboration with "star" scientists and recruitment of promising students.
- 2 / Startup companies spun off from universities often establish operations near those same institutions.
- 3 / Leverage Ohio Eminent Scholars Program and Third Frontier program to endow energy storage-specific faculty chair positions at Northeast Ohio universities.
- 4 / Fill endowed faculty positions by recruiting eminent researcher-entrepreneurs from other regions.

Expand the Scope of Energy Storage Cluster's Organizational Network.

- 1 / Augment leadership. Team NEO has heretofore driven innovation efforts in Energy Storage for Northeast Ohio. Brite Energy Innovators, or BRITE (formerly known as Tech Belt Energy Innovation Center, or TBEIC), as the principal energy incubator in Ohio, is positioned to take on a leadership role for this Cluster. Additionally, JobsOhio and local chambers of commerce will provide important guidance.
- 2 / Employ synergistic outreach. Energy storage will be critical to a broad range of industries in Ohio. The energy storage community should establish ties with new, emerging technology groups that are acutely sensitive to high-quality, reliable electric power. Such groups include those within IIoT and smart manufacturing, blockchain, flexible and wearable electronics, and clean fuel technology. Cross-industry dialogue should be formalized through a general technical clearinghouse such as the Cleveland Engineering Society to foster networking



The changing dynamics of not only how the energy we use is generated, but also of how and when it must be deployed to meet our increasing – and increasingly complex – demand for electric power are accelerating **the need for more advanced, economical forms of energy storage.**

Energy Storage Roadmap Key Takeaways

- 1 /** Northeast Ohio possesses a workforce concentration in areas critical to energy storage research, including chemical and materials engineering, that compares favorably to other regions in the U.S. Northeast Ohio also hosts over 75 private companies in the business of energy storage.
- 2 /** New opportunities in energy storage will be largely driven by applications. Technological change will accelerate as companies develop new products to satisfy the demand for more energy and higher power densities delivered from ever-smaller devices. Northeast Ohio's advanced manufacturing base, in areas such as additive manufacturing and the industrial internet of things, can provide collaboration opportunities for businesses in this constantly evolving market landscape.
- 3 /** A key driver of innovation-based economic development is a region's universities and research centers, especially when start-up companies spin off from these institutions. Northeast Ohio is home to NASA Glenn Research Center, Case Western Reserve University, the University of Akron and other institutions that are at the forefront of developing new technologies and materials for energy storage applications. Test laboratories are also available at these institutions, as they are at the Independence, Ohio-based CSA Group—a global leader in product testing, inspection, and certification—and at Brite Energy Innovators, or BRITE (formerly known as Tech Belt Energy Innovation Center, or TBEIC) in Warren, Ohio.
- 4 /** The best strategy for Northeast Ohio to expand its national leadership role in energy storage is to continue to showcase these assets, while focusing resources on emerging storage technology, such as that found in energy storage applications. Startup assistance from organizations such as BRITE, the Ohio Third Frontier and the business accelerator JumpStart (which has deployed over \$50 million in seed or pre-seed capital to Northeast Ohio entrepreneurs) will need to be continued and expanded. Additionally, Team NEO, BRITE and other groups with an economic development mission can provide cluster leadership and facilitate industry-research institution and cross-industry collaboration. This will be especially important for identifying opportunities that emerge from related regional technology clusters,

For additional information about the Energy Storage Cluster:
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