2017 New York Clean Energy Industry Report

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

LETTER FROM NYSERDA PRESIDENT AND CEO

I am pleased to present the results of the inaugural New York Clean Energy Industry Report—our first annual comprehensive look at the impact New York State polices have had on the growth of the clean energy industry in our State. Under Governor Andrew M. Cuomo's leadership, New York has doubled-down on its commitment to clean energy and its fight against climate change. This report provides direct evidence that these efforts are paying off—for workers and communities, small and homegrown businesses, as well as global-leading companies across our State. These results are exciting, and employers predict we are poised to see even greater growth ahead.

New York State leads the nation in both its vision and approach to clean energy and climate policy. Governor Cuomo's **Reforming the Energy Vision** (REV) strategy has established a groundbreaking new framework to build a clean, resilient, and affordable energy system for all New Yorkers. The marquee **Clean Energy Standard** is the most comprehensive and ambitious renewable energy goal in our State's history and requires 50% of New York's electric supply come from renewable energy sources by 2030, including a targeted 2.4 gigawatt goal for offshore wind deployment. New York State has authorized a 10-year, $5 billion **Clean Energy Fund**, which is expected to lead to private-sector investments and deliver energy savings across the State.

Collectively, these commitments are propelling New York State forward to a clean energy powered economy that is already significant and rapidly growing. Among the most important indicators are:

- 146,000 New Yorkers are working in the clean energy industry across the State.
- Clean energy jobs are present in every county and region, from Long Island to Buffalo and the Southern Tier to the North Country.
- Between the last quarters of 2015 and 2016, **clean energy employment grew by 3.4%**, compared to the statewide average of 1.9%. In fact, the clean energy sector now employs more workers than the thriving biotech and agriculture industries combined.
- Of all clean energy technologies, **jobs in renewable energy are growing the fastest** with 6% growth in 2016 and an expected 12% growth in 2017. This outpaces job additions in the other major areas of New York State's economy and will continue to surge as we follow the trajectory to 50% renewable energy.

We are encouraged by these strong signs, which indicate that a healthy, vibrant clean energy industry has emerged in our State. But there is more work to be done. According to this Report, more than 75% of clean energy employers reported difficulty hiring in 2016, and the needs for skilled workers are acute in sectors like energy efficiency. This report will serve as a critical tool to shape our programs and initiatives to address workforce development issues in the years ahead.

Exciting things are happening in New York State. And at NYSERDA, we expect this report and future installments will provide an annual tool for measuring the tangible economic validators of our efforts. Over time, we seek to prove that climate action and economic growth go hand-in-hand, that leading the nation's energy transition will create the clean energy and innovation-based jobs of the future, and that the economic and environmental benefits that result from these efforts will be shared by all New Yorkers.

Alicia Barton — President and CEO, NYSERDA

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EXECUTIVE SUMMARY

The 2017 New York Clean Energy Industry Report was commissioned by The New York State Energy and Research Development Authority (NYSERDA) to understand the size, scope, and breadth of the State's clean energy economy. This multi-year, longitudinal research study will analyze data on clean energy jobs, employer needs, and existing assets to produce useful insights as the State seeks to meet its nation-leading climate goals while creating jobs and economic opportunity.

With approximately 146,000 workers across the State, New York's clean energy economy accounts for an important and growing segment of the statewide labor market. Of these total clean energy jobs in the State more than 82,000 spend most of their time[1] in clean energy. Between the last quarters of 2015 and 2016, clean energy employment grew by 3%—faster than overall economy-wide job growth. As clean energy demand and market expansion continue to sustain business and job growth, employers expect that the clean energy workforce will expand by another 7% by the end of 2017.

> Between the last quarters of 2015 and 2016, clean energy employment grew by 3%—faster than overall economy-wide job growth.

Clean energy job growth spans a diverse set of technologies and comes alongside aggressive policy standards that highlight the State's overarching vision to create a clean, resilient, and affordable energy system. Governor Andrew M. Cuomo's nation-leading policies focused on Reforming the Energy Vision[2] including the Clean Energy Standard,[3] Clean Energy Fund,[4] and the Regional Greenhouse Gas Initiative,[5] provide the enabling framework for ground-breaking market transformation and clean energy job creation. Moreover, in August of 2017, the Governor joined the nine Regional Greenhouse Gas Initiative states in making an announcement to update the multi-state cooperative effort by reducing the cap on power plant emissions an additional 30% below 2020 levels by 2030. This further reduction sets the regional cap at a level 65% below the 2009 starting level.[6]

In 2017, Governor Cuomo announced that New York State would co-lead the charge on the formation of the U.S. Climate Alliance. The U.S. Climate Alliance is a bipartisan group of states committed to upholding the objectives of the 2015 Paris Climate Agreement in order to achieve the U.S. goal of reducing carbon dioxide emissions by 26% to 28% from 2005 levels by 2025.[7]

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[1] Please see call-out box on page 13 of the report for more information on Clean Energy Labor Intensity.
[2] See: https://rev.ny.gov/
[3] The Clean Energy Standard requires the State reach 50% of renewable energy generation by 2030.
[4] See: https://www.nyserda.ny.gov/About/Clean-Energy-Fund
[5] See: https://www.rggi.org/rggi_benefits/program_investments/new_york
[6] https://www.governor.ny.gov/news/governor-cuomo-announces-multi-state-effort-further-reduce-greenhouse-gas-emissions-electric
[7] https://www.governor.ny.gov/news/new-york-governor-cuomo-california-governor-brown-and-washington-governor-inslee-announce

Clean energy employment is spread across several major technology categories which include:

Energy Efficiency

includes lighting, ENERGY STAR® appliances (including HVAC), insulation, advanced building materials, renewable heating and cooling, and other efficient technologies

Renewable Electric Power Generation

includes solar, wind, geothermal, low-impact hydropower, and other renewable generation technologies

Grid Modernization and Storage

includes smart grid, microgrid, demand response management, and grid storage

Renewable Fuels

includes biofuels such as wood pellets and ethanol

Alternative Transportation

includes electric, hybrid, plug-in hybrid, and fuel cell/hydrogen vehicles, battery storage, as well as natural gas and other alternative fuel buses

Clean Energy Employment by Technology		
Technology	Total Employment	Majority of Time Workers Spent on Clean Energy Activities
Energy Efficiency	110,582	51%
Renewable Electric Power Generation	22,409	77%
Grid Modernization and Storage	1,412	76%
Renewable Fuels	2,965	81%
Alternative Transportation	8,409	53%

ENERGY EFFICIENCY

To date, energy efficiency firms and workers account for most of employment activity.[8] Of the approximately 110,000 workers employed in energy efficiency, 51%—or 56,841 workers—spend most of their time working with energy efficiency technologies. As the backbone of the State's clean energy economy, these firms are more likely to work with already highly commercialized technologies and expect to add another 7,000 employees to their workforce by the end of 2017. Therefore, the sector has relatively lower innovative activity and fewer firms have sought equity or grant funding during the last quarters of 2015 through 2016. With only 6% of firms indicating they work primarily with non-commercial products, early-stage investments[9] comprise a small segment of deal flow to the energy efficiency sector.

> Majority-time workers are those that spend more than 50% of their time working on clean energy activities.

RENEWABLE ENERGY

Renewable Electric Power Generation firms support more than 22,000 workers across the State.[10] Given long-term policy support, this sector exhibits a high proportion of majority-time workers—77%, or 17,324 employees, are reported to spend the majority of their time working with renewable energy technologies. Between 2015 and 2016, the sector grew the most out of all technologies and employers expect to see an approximate growth of 2,700 employees by the end of 2017. While policy support ensures the deployment of commercial technologies, recent increases in early-stage innovation funding activity across the renewable electric generation sector hint at the potential for a wave of technology innovation. For example, about half of all firms reported seeking equity, or grant funding, and two in 10 indicate that they work mostly with products still under development, suggesting more innovation may be on the horizon. Additionally, as the price of storage declines and opportunities emerge for pairing energy storage with generation technologies, solar photovoltaics and other renewables may receive an additional boost from the storage market.

GRID MODERNIZATION AND STORAGE

The grid modernization and storage sector employs approximately 1,400 workers and has the most innovation activity across all technology segments.[11] This growing technology sector is building an economic engine to drive continued expansion in clean energy innovation in the State. About 35% of firms report that they work primarily with non-commercial products, and 62% applied for funding between the last quarters of 2015 and 2016. The grid modernization and storage sector shows promising activity in overall and early-stage innovation funding trends in recent years. This is the only technology segment to see an increase in total deals as well as overall and early-stage funding in the years post-American Recovery and Reinvestment Act (ARRA) from 2012-2016. As an indicator, growth in early stage funding suggests that this segment is an active and growing part of New York's clean energy economy.

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[8] Energy efficiency employment also includes heating, cooling, and building envelope. These workers support goods and services that reduce electricity demand pursuant to EPA's Energy Star Standards of Department of Energy Efficiency Standards or refers to establishments that are involved with heating, ventilation, and air conditioning (HVAC) from Renewable Energy sources or work that increases the Energy Efficiency of HVAC systems.

[9] Early-stage investments include Seed, Series A, and Series B funding rounds.

[10] Renewable electric power generation workers support the process of generating electric power from clean energy sources whether connected to a distribution grid or not.

[11] Grid modernization and storage includes all workers that support development or installation of technologies that store electricity or carry electricity from suppliers to demand sites; specific clean energy technologies include storage, smart grid, and micro grid.

RENEWABLE FUELS

Renewable fuels, including biofuels and wood, support almost 3,000 jobs across the State and are the only technology that showed an employment decline between the last quarters of 2015 and 2016. However, employers project a rebound of 4% by the end of 2017.[12] With little to no early-stage investment activity over the last couple years, business activity is mostly dependent on commercially-available fuel technologies, as over half of firms indicate that their primary product is in either the first sales and commercial availability stage or shipping product stage.

ALTERNATIVE TRANSPORTATION

Lastly, alternative transportation is a growing component of New York's clean energy industry.[13] Of the 8,409 jobs in the sector, 53%, or 4,439, workers spend the majority of their time supporting clean transportation technologies. The sector showed slight growth and is expected to add another 500 jobs by the end of the year. With 64% of employers indicating their customers are primarily outside the State, alternative transportation firms are the most export-focused of all technology segments. Raising capital does not appear to be high priority, as 54% of transportation firms surveyed indicated that they did not seek financing and mentioned that there was little to no need for capital at this time. The other 46% reported they were seeking funding to support this capital intensive industry.

There is an increasing need for a robust source of clean energy trained workers in New York State.

New York's clean energy economy is growing rapidly, but data suggests this surge is outpacing the supply of trained clean energy workers in the State, increasing the need for a robust source of trained workers. In 2016, many clean energy businesses seeking to satisfy workforce demand note they had trouble finding qualified applicants. Hiring difficulty is seen across the board for each of the major technologies. The most challenging positions to fill include engineers, installers or technicians, and sales representatives—occupations critical to multiple segments, including product development, commercialization, distribution, and maintenance. This challenge for employers poses a unique opportunity for the State to engage in targeted workforce development and training.

Clean energy jobs are spread throughout the State, with some notable clusters of activity found around major metropolitan areas. Nevertheless, clean energy jobs exist in every region driven in part by the nature of the technology segments and where activity naturally occurs as a result. Clean energy jobs associated with the deployment of energy efficiency technologies, or solar installation for example, are more clustered around population centers and urban areas. Many clean energy firms are small businesses that serve local communities, distributed across the State. When employment data is viewed in context of the total number of jobs across all industries, Long Island, the Finger Lakes, and Mid-Hudson regions show the largest concentration of employment, followed by the Capital Region and Central New York. Clean energy jobs exist in various specialty construction firms (e.g. electrical contractors, plumbing and HVAC, building remodelers, etc.), contract manufacturers, consultants, and other types of companies. Across the Northeast, these jobs have been found to pay competitive wages.[14] Targeted initiatives throughout the State are generating demand for clean energy jobs, and actively training workers around the State to supply the clean energy workforce.

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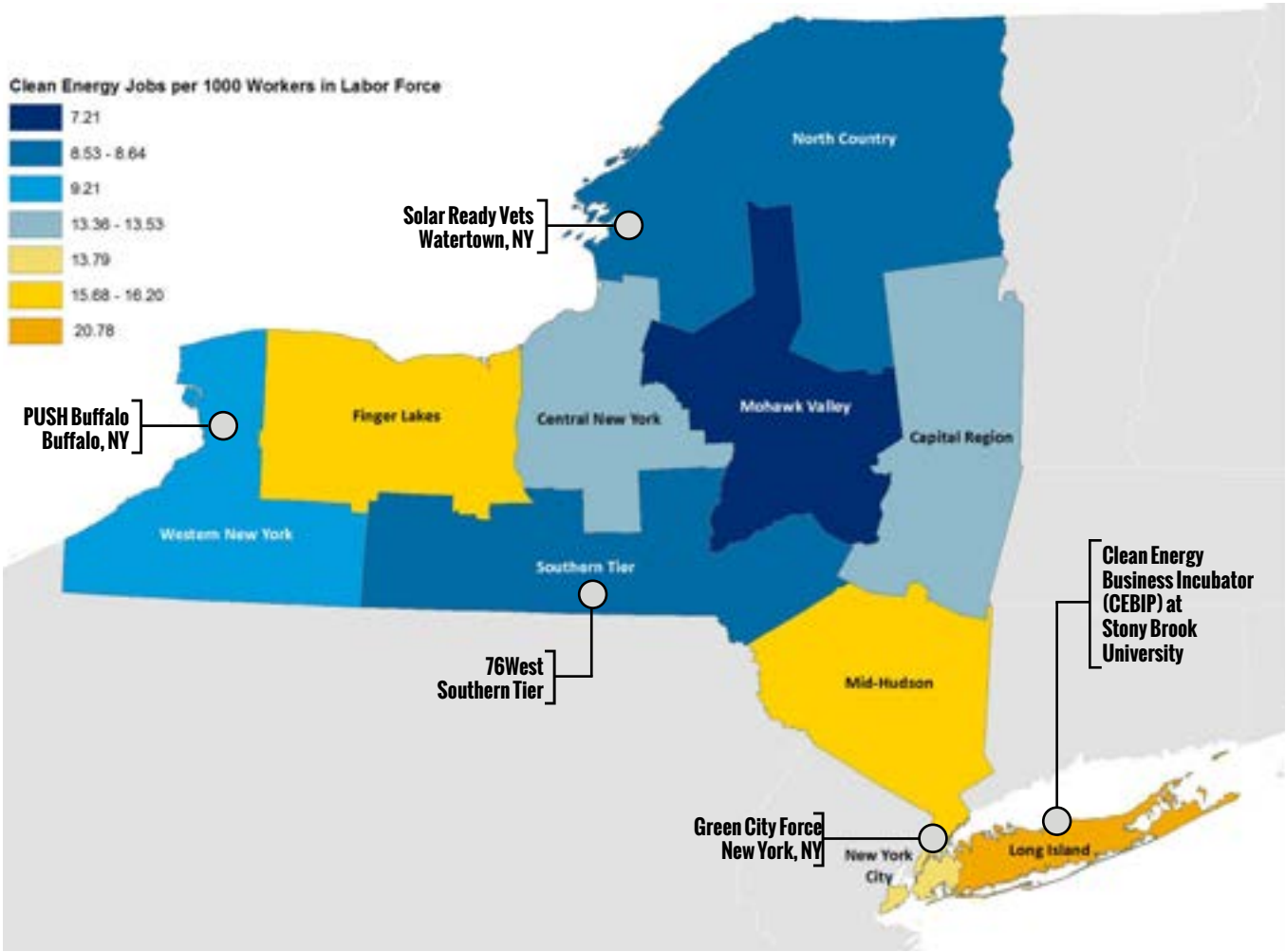
[12] *Renewable fuels employment includes all workers engaged in fuel production from renewable sources such as woody and non-woody biomass, which includes fuel made from materials such as straw, manure, vegetable oil, animal fats, etc.*

[13] *Alternative transportation workers include individuals engaged in the research, manufacturing, or repair of clean energy-related transportation such as hybrid, plug-in hybrid, electric, natural gas, hydrogen, or fuel cell vehicles.*

[14] *Rhode Island Clean Energy Industry Report 2017; Vermont Clean Energy Industry Report, 2014-2017; Massachusetts Clean Energy Industry Report, 2015-2016.*

Targeted initiatives throughout the State are creating demand for clean energy jobs and training workers to supply the clean energy workforce.

Clean Energy Employment by Regional Economic Development Councils



The spread of technology and business activities is a good indicator of a region's current and future areas of economic growth. New York's clean energy sector is a healthy mix of both emerging and commercial technologies, with continuous employment opportunity across a variety of trades, including installation, research and engineering, sales, and manufacturing. Notably, the professional and business services sector has become an increasingly important component of the clean energy economy. These workers account for the second largest value chain activity, after installation, and provide an array of clean energy-related research, consulting, legal, information technology, and design services. Public support is especially important for this growing value chain activity to ensure the State remains competitive in both the national and global clean energy markets. As technologies such as solar and wind move toward market maturity, installation and professional service firms are working to grow the market for new commercial technologies and improve synergies between existing technologies. As in any growing sector, these firms face challenges as they reported difficulties finding qualified workers and the need for investment capital to grow and sustain business operations.

New York supports a healthy ecosystem of vendors and suppliers that encourage product demand. This ecosystem is important for boosting State activity in the clean energy market space, and for maintaining both a national and global competitive edge. Despite a small manufacturing and trade sector, more than half of all clean energy employers report their products are sourced primarily from in-State suppliers. Additionally, 74% of firms report the majority of their customers are in-State. However, there is also export-oriented activity with 5% of firms serving mainly international clients. Not surprisingly, more nascent technology sectors like alternative transportation and grid modernization report the highest out-of-state market activity, indicating the State exports both goods and knowledge to broader national and global markets.

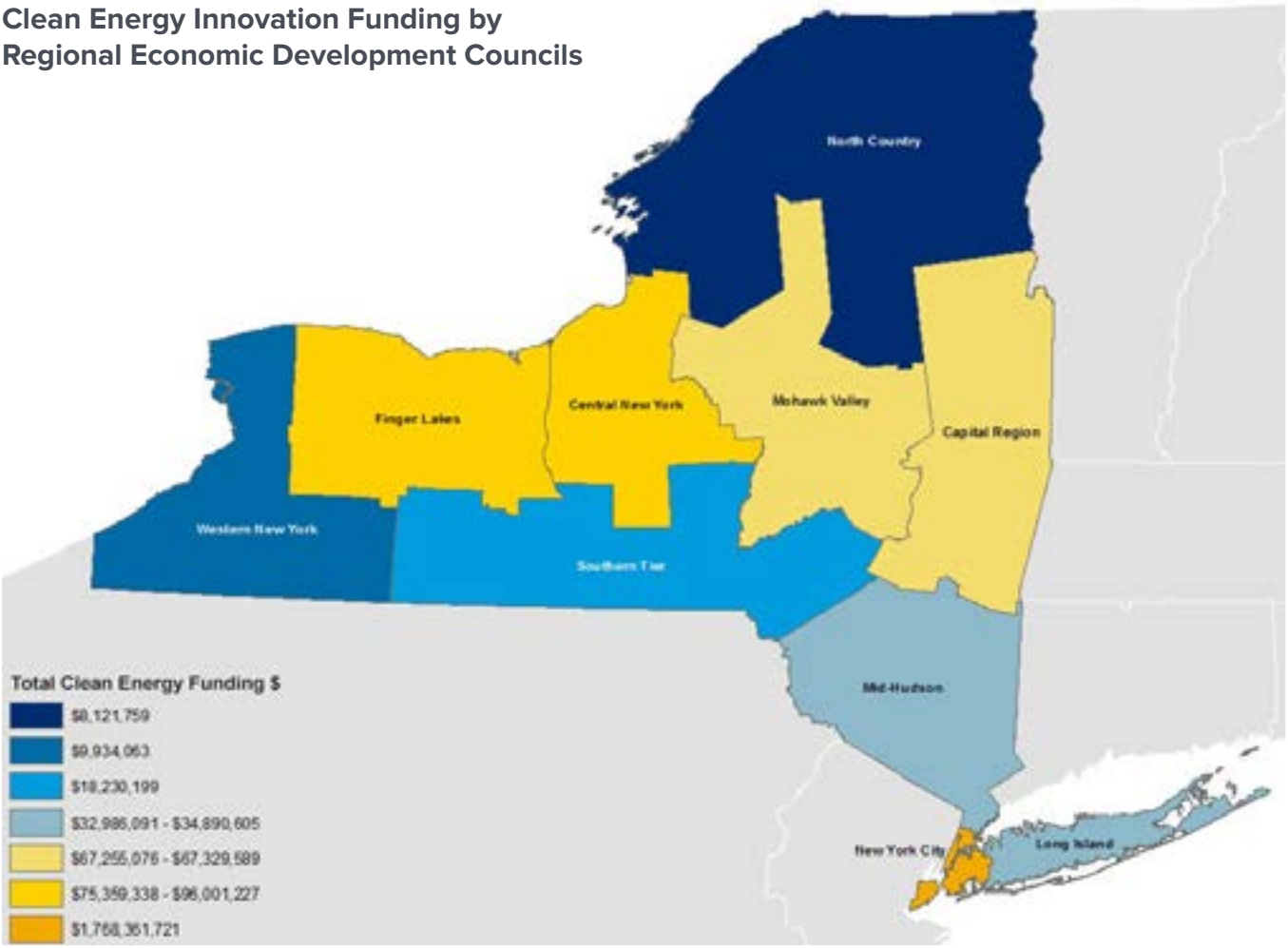
New York State is a national leader in clean energy investments.

New York State is a national leader in clean energy investments—a broad term with multiple definitions, including rebates and incentives to consumers as well as public expenditures for municipal projects. In addition to specific innovation as defined in this report,[15] the State invests significant resources in clean energy, highlighted by its nation-leading Green Bank, as well as many other policy and program initiatives managed by NYSERDA and other State-based entities. Its efforts have made the State a fast-growing market for solar, wind, energy efficiency, and other innovation and deployment activities.

While these overall expenditures contribute to the growth of the clean energy economy in the State, this report focuses on a specific subset of investments called "innovation funding." As such, included investment dollars are limited to the funding of clean energy organizations engaged in the research and development of new technologies and applications. This type of innovation funding is much smaller in scale than, and can be masked by, project expenditures. It also measures very different kinds of activities and companies, generally with much riskier profiles, but greater potential reward.

[15] *This is consistent with the definition of clean energy establishment used to generate employment data. Data include investment in venture backed companies included in Cleantech Group's i3 database and NYSERDA grants and other funding classified as focused on innovation.*

Clean Energy Innovation Funding by Regional Economic Development Councils



Despite declining federal innovation funding and global decreases in clean energy investments overall, companies across the State have been successful at attracting capital with NYSERDA playing a critical role in supporting innovation. New York has a vibrant innovation ecosystem and assets such as university research centers, start-up companies, incubators, and accelerators, with notable concentrations in Buffalo, Rochester, Albany, New York City, Long Island, the Mid-Hudson Valley, and the Southern Tier. From a technology perspective, grid modernization and storage are important technology strengths in the State's clean energy innovation economy.

The clean energy economy in New York is strong and growing, driving demand for skilled workers across new trades and technologies. The future of the clean workforce is bright and the Clean Energy Industry Report will measure this exciting and thriving sector of New York's clean future.

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INTRODUCTION

This 2017 New York Clean Energy Industry Report was commissioned by NYSERDA to understand the size, scope, and breadth of the State's clean energy economy. Existing data including the recently released U.S. Energy and Employment Report[16] with State-level data appendices[17] provide useful context for energy jobs in the State, but lack sufficient detail to develop a granular review of the clean energy economy. Prior to the release of this report, existing data have not had detailed information on professional and business services and innovation activity, nor have they included geographic granularity with job estimates for the economic regions and counties across the State. Recognizing these limitations, NYSERDA commissioned a multi-year, longitudinal research study to expand, clarify, and analyze data on clean energy jobs, employer needs, and existing assets to produce useful insights for New York as it seeks to achieve climate goals and create jobs and economic opportunity across the State.

Encompassing renewable energy, energy efficiency, grid modernization and storage, renewable fuels, and alternative transportation, the research for this report includes data collected from 667 employers across New York State. This report uses data from the U.S. Energy and Employment report, and supplemental surveys to further analyze existing federal data on energy jobs in the State. The supplemental survey work also provides insights into clean energy employer funding needs, workforce challenges and opportunities, and expected growth. The combined data allow for a deeper understanding of the State's clean energy-related professional and business services sector (including finance, consulting, information technology, and other service areas), as well as investment needs of companies across the State.

Calls were made to approximately 24,300 establishments and 15,200 emails were sent to potential survey respondents.

Data in this report was developed using both primary and secondary data sources. The employer survey component was administered over the phone and online to employers throughout the State to determine if they conduct any clean energy-related activity. In all, calls were made to approximately 15,400 establishments and 15,200 emails were sent to potential survey respondents. The sample is split into both known and unknown categories. The known includes establishments previously identified as energy-related, while the unknown is a stratified sampling of firms, represented by North American Industry Classification System (NAICS) industry code, establishment size, and geography. All establishments are surveyed census-style, and survey responses were used to extrapolate the proportion of clean energy-related employment within traditional industries such as construction, manufacturing, trade, and research services. These incidence rates by industry were then used to calculate total employment by technology and value chain activity. Further primary data collection was conducted for the energy efficiency employee environment and early-stage clean energy companies. Secondary data on investments, innovation, and policy were culled from various government and proprietary sources and are cited throughout the report.

[16] *2017 U.S. Energy and Employment Report, Department of Energy.*
[17] *2017 U.S. Energy and Employment, State Reports, Department of Energy.*

The report filters clean energy establishments and employees by major technology and sub-technology segments, defined as follows:

Energy Efficiency

includes lighting, ENERGY STAR® appliances (including HVAC), insulation, advanced building materials, renewable heating and cooling, and other efficient technologies

Renewable Electric Power Generation

includes solar, wind, geothermal, low-impact hydropower, and other renewable generation technologies

Grid Modernization and Storage

includes smart grid, microgrid, demand response management, and grid storage

Renewable Fuels

biofuels such as wood pellets and ethanol

Alternative Transportation

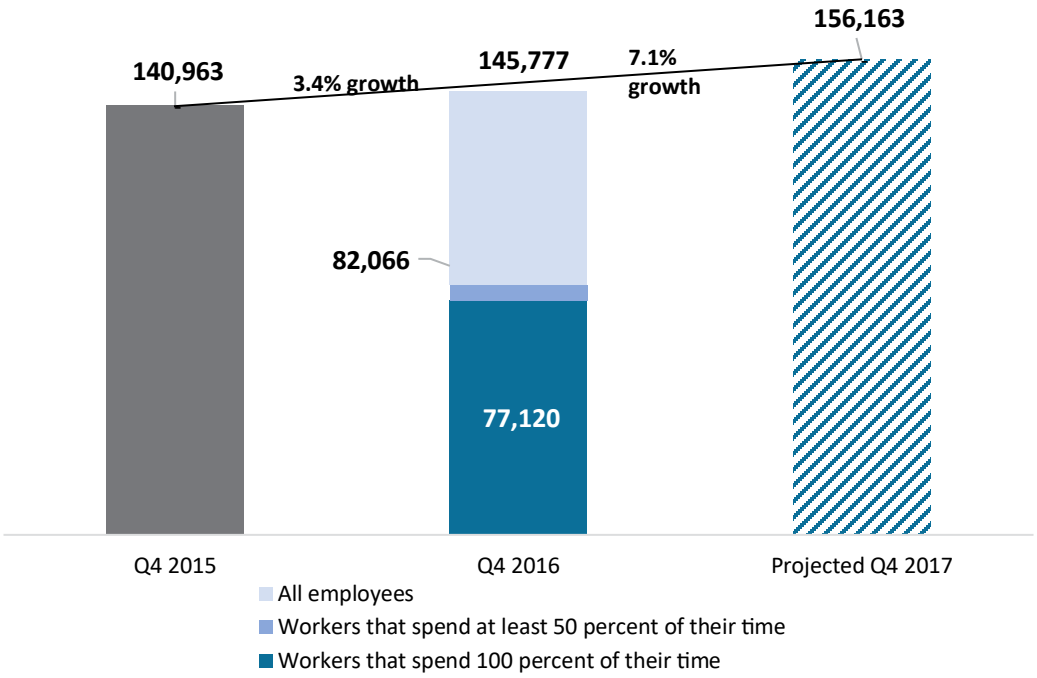
includes electric, hybrid, plug-in hybrid, and fuel cell/hydrogen vehicles, battery storage, as well as natural gas and other alternative fuel buses

INDUSTRY OVERVIEW

OVERALL EMPLOYMENT

Clean energy employment grew by 3.4%, compared to the statewide average of 1.9%, between the last quarters of 2015 and 2016.[18] In total, New York State's clean energy economy employs nearly 146,000 workers, an increase of 4,815 jobs from the last quarter of 2015. Employers expect to add another 10,400 workers for a growth rate of 7% by the end of 2017 (Figure 1). As of December 2016, the clean energy workforce accounts for 1.6% of the State's overall labor force.[19]

Figure 1. Clean Energy Employment Growth, Q4 2015 – Q4 2017 Projected

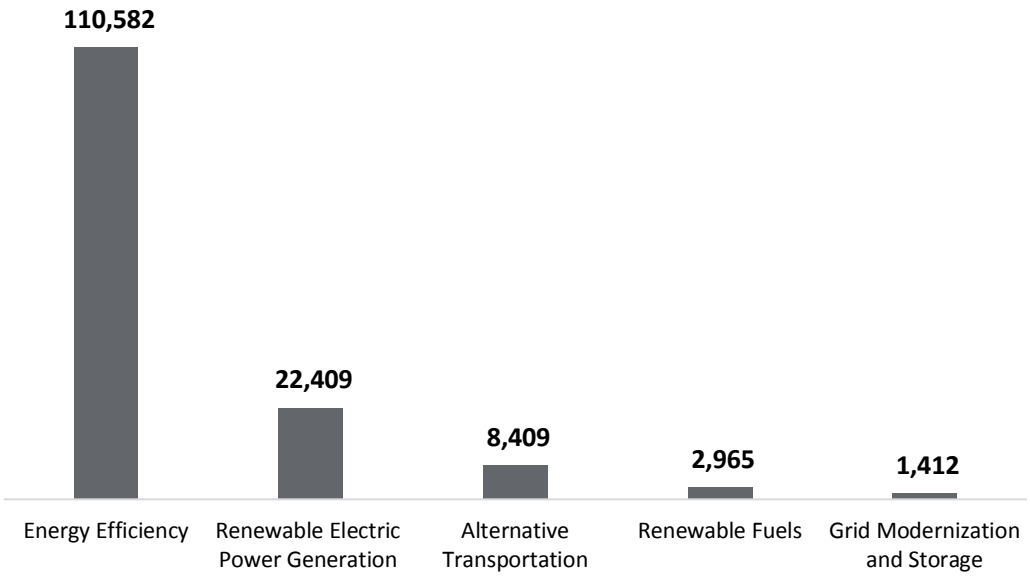


With more than three-quarters of total employment, energy efficiency workers account for the majority of clean energy activity across the State. Renewable electric power generation technologies employ about 15% of the workforce, followed by alternative transportation, renewable fuels, and grid modernization and storage technologies (Figure 2).

[18] *The following primary employment data cited in this report is based on a comparison of the 2015 and 2016 U.S. Energy and Employment Report. Additional details covering hiring difficulty, investment needs, value chain activity, and customer and vendor relations was extracted from supplemental survey work conducted for 2017 NYS Clean Energy Industry Report. For the remainder of this report, all primary data is based on these surveys unless otherwise noted. Any secondary data sources used, such as that for investments and deals, is cited where appropriate.*

[19] *Bureau of Labor Statistics, Quarterly Census or Employment and Wages (BLS QCEW)*

Figure 2. Clean Energy Employment by Technology, Q4 2016



Both observed and projected employment growth is not surprising considering the State's firm commitment to clean energy initiatives. As part of Reforming the Energy Vision (REV) Governor Cuomo has called for aggressive State action requiring 50% of electricity in New York State come from renewable energy resources by 2030; a reduction in greenhouse gas emissions by 40% below the 1990 level by 2030 and 80% by 2050; and a 23% decrease in energy consumption in buildings from 2012 by 2030.

To set the stage for energy market transformation, Governor Cuomo tasked the New York Public Service Commission, NYSERDA, the New York Power Authority (NYPA), and the Long Island Power Authority (LIPA) to work together in modernizing New York's energy system under his REV strategy.

40% reduction of greenhouse gas emissions from 1990 levels by 2030 and 80% by 2050.

50% of New York State's electricity will come from renewable energy sources by 2030.

23% decrease in energy consumption in buildings from 2012 levels by 2030.

At NYSERDA, the **Clean Energy Standard** (CES), **Clean Energy Fund** (CEF), and the **Regional Greenhouse Gas Initiative** (RGGI) function as supporting policies to propel the State's clean energy economy forward. The CES provides a framework to source 50% of statewide electricity from renewable energy technologies by 2030. The CEF is a 10-year, $5 billion funding commitment that further supports REV through strategic investment in market transformation solutions targeted at deploying energy efficiency and renewable energy at scale. The CEF is designed to reduce the cost of clean energy by accelerating the adoption of energy efficiency to reduce load while increasing renewable energy to meet demand. The Regional Greenhouse Gas Initiative further supports this transformation through the investment of proceeds from quarterly regional carbon allowance auctions into energy efficiency, renewable energy, and other key market transformation initiatives.

Major commitments to clean energy initiatives have been made by NYPA to accelerate energy-saving improvements in State facilities, such as financing approximately $800 million in cost-effective energy efficiency projects through 2017. The financing will be directed toward the largest, most inefficient buildings to help reduce energy consumption in State buildings by 20%. NYPA also initiated a Five Cities Energy Plan for Albany, Buffalo, Rochester, Syracuse, and Yonkers aimed at reducing overall energy costs and consumption, strengthening the reliability of each city's energy infrastructure, and creating jobs in clean energy industries.[20] Similarly, LIPA continues to forge ahead on its efficiency and renewable energy programs.[21]

Similarly, New York has been a leader in the State Efficiency Scorecard issued by the American Council for an Energy-Efficient Economy (ACEEE).[23] The ACEEE scorecard examines State policies and programs that promote and improve energy efficiency standards. Policy areas include utility and public benefits programs, building energy codes and compliance, and appliance and equipment standards. The ACEEE has consistently ranked New York in the top 10 between 2007 and 2017, and in the top five leading states in six out of 10 years, demonstrating New York's sustained commitment to driving progress in energy efficiency.

Clean Energy Labor Intensity

Employment data for this report captures all employees from qualifying clean energy firms that spend any portion of their time supporting the research, development, production, manufacture, distribution, or installation of clean energy products and services. This includes support services such as consulting, finance, tax, and legal services related to clean energy technologies.

As such, employment totals in this report should not be equated to full-time equivalents, but instead taken as a total quantification of the State's clean energy economy. To better understand labor intensity, survey data provides both a 50% and 100% employment threshold for workers that spend half or all of their time supporting the clean energy portion of business. Clean energy labor intensity refers to these proportions of the workforce considered "full-time" clean energy workers that spend all of their labor hours working with clean energy technologies. This measure of intensity indicates the degree to which firms are engaged in the clean energy market. For renewable generation firms, labor intensity is often very high, as solar or wind firms typically specialize in these technologies. However, for traditional construction firms who are entering the energy efficiency market, labor intensity is lower since part of firm revenue is still derived from other activities not related to clean energy. When tracked over time, this metric is particularly useful to gauge state's clean energy economy and if its individual technology segments are becoming more specialized.

[20] See generally: New York State Government (http://www.nypa.gov/innovation/programs/buildsmart-ny); and, (https://www.governor.ny.gov/news/governor-cuomo-launches-build-smart-ny-initiative-executive-order)

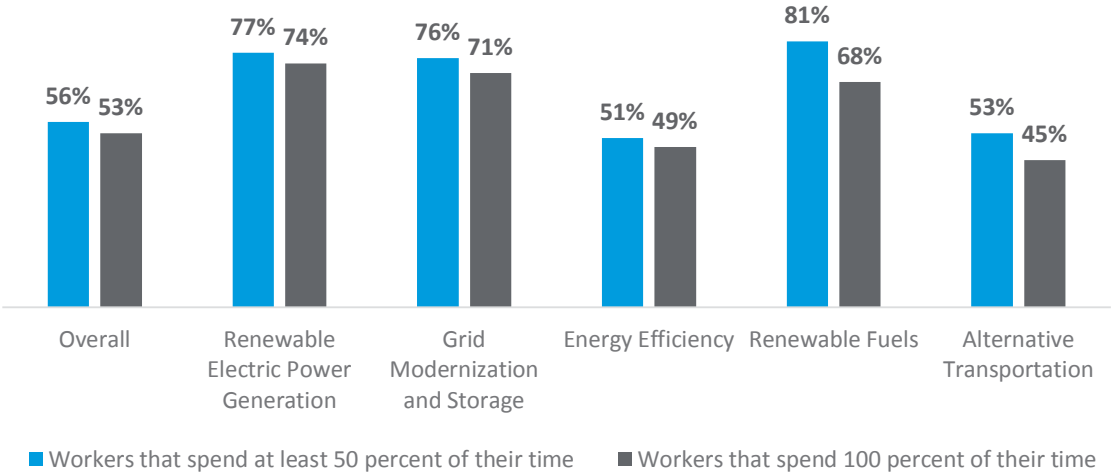
[21] See generally: 2017 Energy Efficiency and Renewable Plan, PSEG Long Island, December 21, 2016.

[22] 2017 U.S. Clean Tech Leadership Index, Clean Edge. Indicators include clean energy utility scale generation (wind, solar, etc.), total registered hybrid and electric vehicles, LEED building deployment smart meter market penetration, total clean tech policies enacted (regulations & mandates, incentives), clean energy venture capital investment, clean energy patents granted, etc.

[23] State Energy Efficiency Scorecard, American Council for an Energy-Efficient Economy (ACEEE) (http://aceee.org/state-policy/scorecard)

As reported by employers, 53% of all clean energy workers spend all of their time supporting their firm's clean energy portion of business; this translates to approximately 77,120 "full-time" clean energy employees across the State. Clean energy labor intensity varies by technology, with the renewable energy generation sector having the greatest proportion of full-time workers, followed by grid modernization and storage, and renewable fuels. Approximately three-quarters of the renewable energy generation and grid modernization workforce dedicate all of their labor hours working with these technologies. Both energy efficiency and alternative transportation employers report that fewer than half of their workers spend all of their time on clean energy-related work (Figure 3).

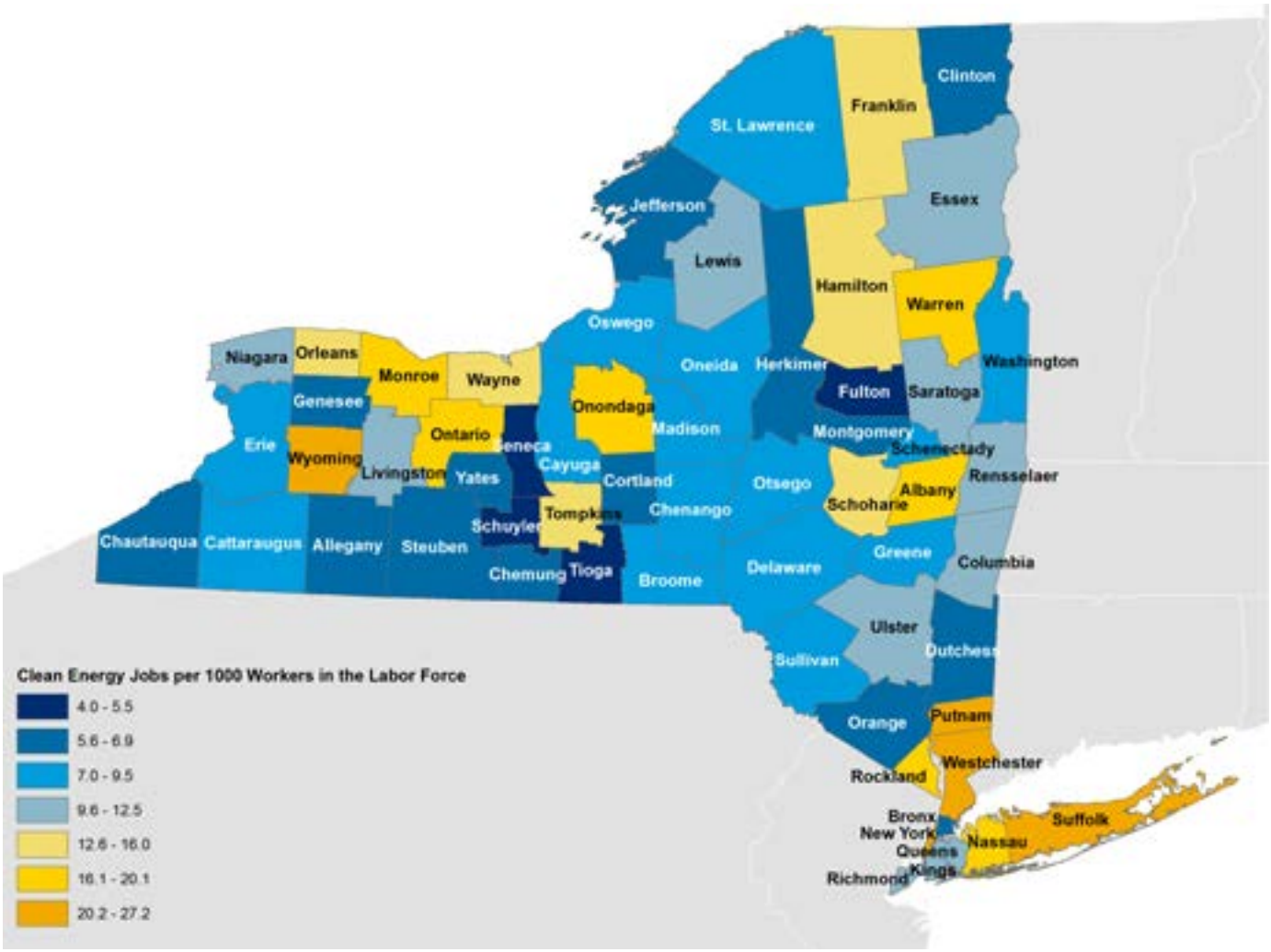
Figure 3. Labor Intensity Thresholds by Technology



Clean Energy Jobs by Region

The geographic distribution of clean energy jobs varies by concentration across the State. Wyoming, Putnam, Westchester, New York, and Suffolk counties have the highest concentration—between 20.2 and 27.2 clean energy workers for every 1,000 individuals in the labor force (Figure 4). Analysis shows that key drivers can be attributed to specific technologies by county. For example, Wyoming, Putnam and New York counties enjoy a high degree of employment driven by energy efficiency activity, whereas Warren County enjoys particularly high employment driven by renewable energy. Suffolk county shares a high degree of employment by both technologies. In general, Long Island, the Finger Lakes, Mid-Hudson, and New York City have the highest concentration of clean energy workers overall. Secondarily, the eastern edge of the State along the Capital Region as well as Central New York also have a relatively high concentration of clean energy workers (Figure 5).

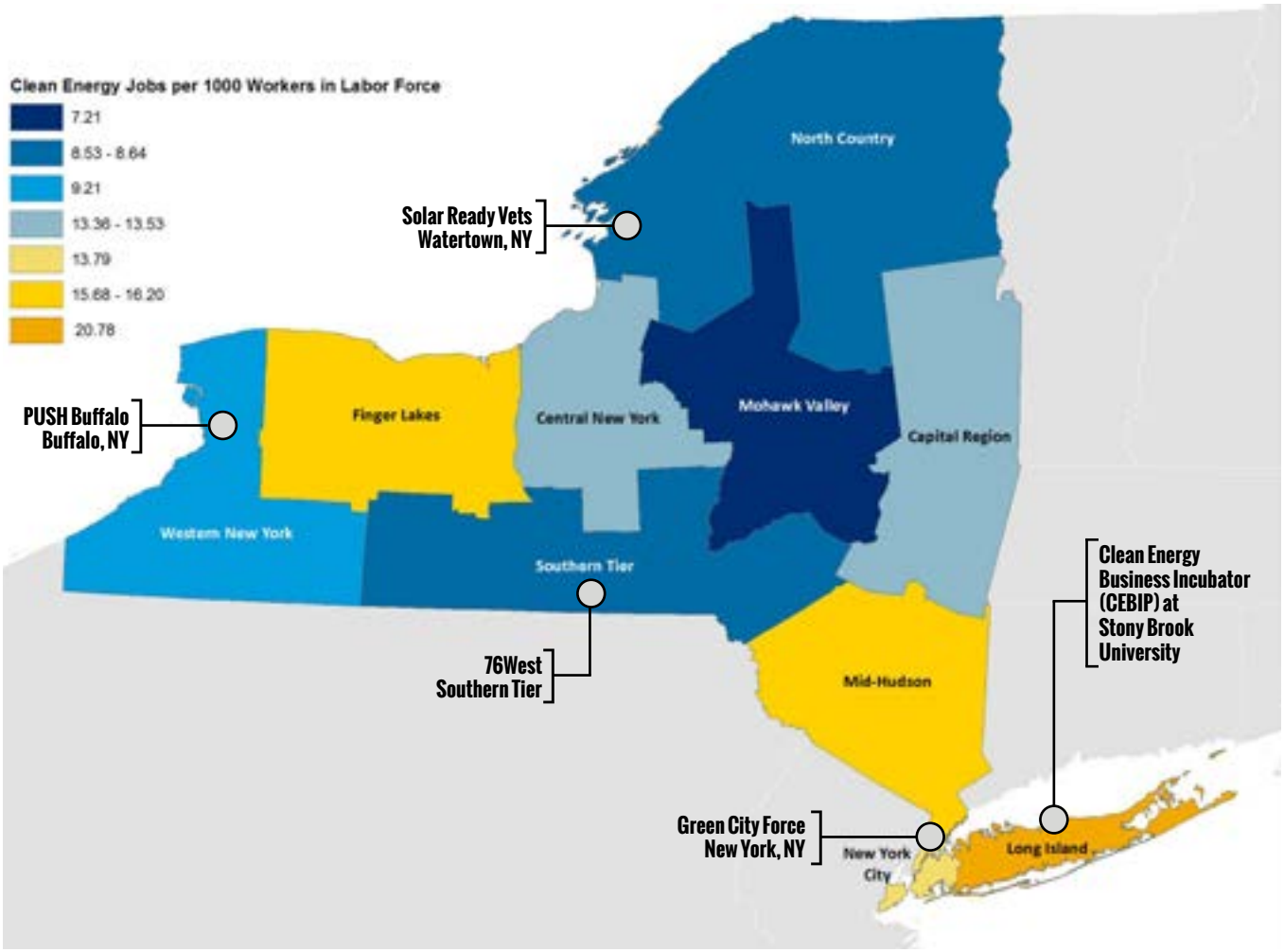
Figure 4. Clean Energy Employment per 1,000 Workers in Labor Force by County[24]



[24] *Employment data is based on the 2016 U.S. Energy and Employment Report published by the Department of Energy and this 2017 NYS Clean Energy Industry Report.*

In addition to the suite of aggressive clean energy policies in the State, targeted clean energy initiatives throughout the State are generating jobs and preparing workers to enter the clean energy economy. Examples of some of these initiatives include: Solar Ready Vets, a program targeted at training for military veterans transitioning to civilian life, preparing them for rewarding careers in the solar sector; PUSH Buffalo, a Community Based Outreach organization that is working to scale up energy efficiency retrofits in Buffalo; Green City Force, a New York City based clean energy job training initiative for under privileged youth; 76West, a competition focused on growing entrepreneurs and attracting resources from the U.S. and around the world to build clean energy businesses and jobs in NY's Southern Tier; and the Clean Energy Business Incubator (CEBIP) at Stony Brook University, created to provide assistance and resources for developers of disruptive renewable and clean energy technologies.

Figure 5. Clean Energy Employment per 1,000 Workers in Labor Force by Regional Economic Development Council[25]



[25] *Employment data is based on the 2016 U.S. Energy and Employment Report published by the Department of Energy and this 2017 NYS Clean Energy Industry Report.*

CLEAN ENERGY MARKET, VALUE CHAIN, AND LABOR SUPPLY

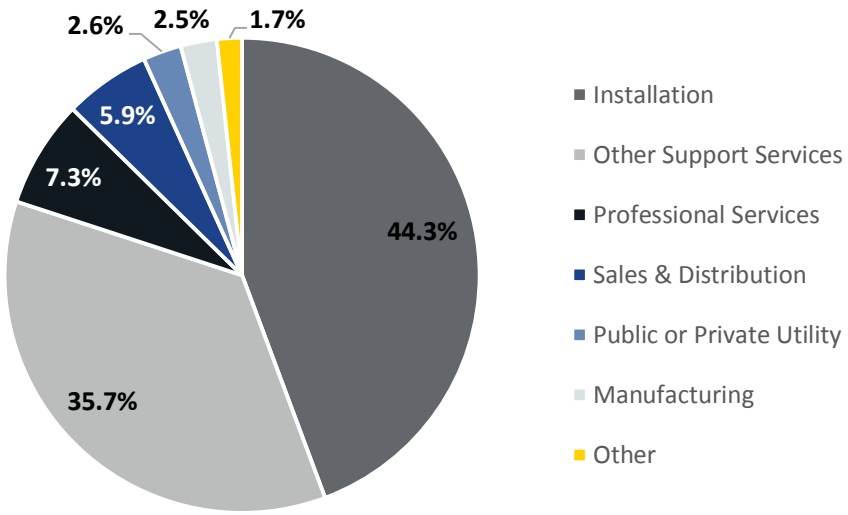
The Clean Energy Value Chain

The clean energy value chain represents the underlying industries that support the local economy, such as manufacturing, wholesale trade and logistics, and professional services. Tracking a growing industry's value chain provides insights into innovation activity, highlights regional strengths, and identifies potential areas for public support that could better link the region's clean energy activities. For example, a region with particularly strong research, manufacturing, and trade can support local demand for goods and services as well as present an opportunity to export this expertise to outside of the region. In particular, strong research and development activity for nascent technologies can demonstrate a state's or region's competitive advantage.

In New York, installation firms and workers comprise the bulk of the State's clean energy economy. This is likely the result of high employment activity in the energy efficiency and renewable generation sectors and the State's demonstrated commitment to deploying technologies to meet its ambitious climate policy goals.[26] About 44% of clean energy establishments are primarily involved in the installation, maintenance, or repair of clean energy technologies and systems (Figure 6). These firms employ roughly 83,800 workers, followed by professional services at 18,266 workers. As an increasingly important component of the clean energy value chain and overall clean energy economy, the professional and business service sector can also be used as a proxy or indicator for innovative activity.

It is difficult to comprehensively identify what subset of professional service workers are actually engaged in research and development. A direct employment count of all research and development-related NAICS codes indicates that about 1,118 individuals are directly employed in this particular area within the clean energy industry. However, it should be noted that this number is not perfectly accurate because large firms in other industries, such as manufacturing, are likely to have a research and development division counted under the manufacturing NAICS code instead. Future reports can provide a more complete analysis by adjusting the methodology to capture research and development activity within manufacturing, engineering, and other industries.

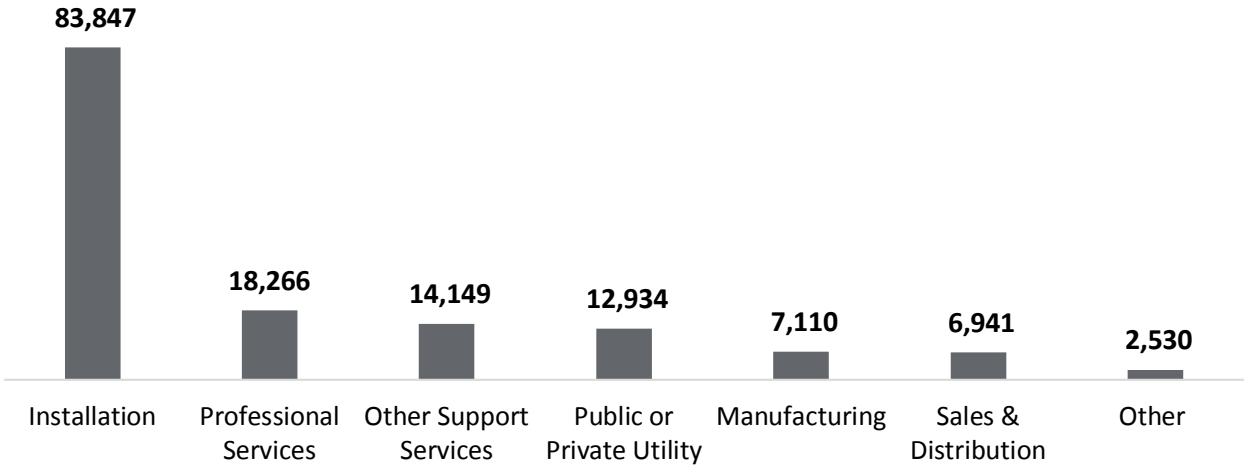
Figure 6. Clean Energy Establishments by Value Chain, Q4 2016[27]



[26] *For more information, please see the Energy Efficiency section in the Clean Energy Technologies chapter.*

[27] *"Other support services" includes primarily NAICS 81 (Repair and Maintenance), as well as some administrative support and waste management firms (NAICS 56). "Other" includes anything not otherwise classified, e.g., nonprofits (NAICS 81), management of companies and enterprises (NAICS 55), and other unclassifiable industries by NAICS code.*

Figure 7. Clean Energy Employment by Value Chain, Q4 2016[28]



Clean Energy Markets

Clean energy markets are impacted by a confluence of factors, including local, regional, national, and global drivers. Many clean energy firms in the State, particularly those focused on installation and maintenance, are most heavily impacted by changes to the local economy. Manufacturers and other exporters are less dependent on local markets as they are more greatly impacted by national or global market trends.

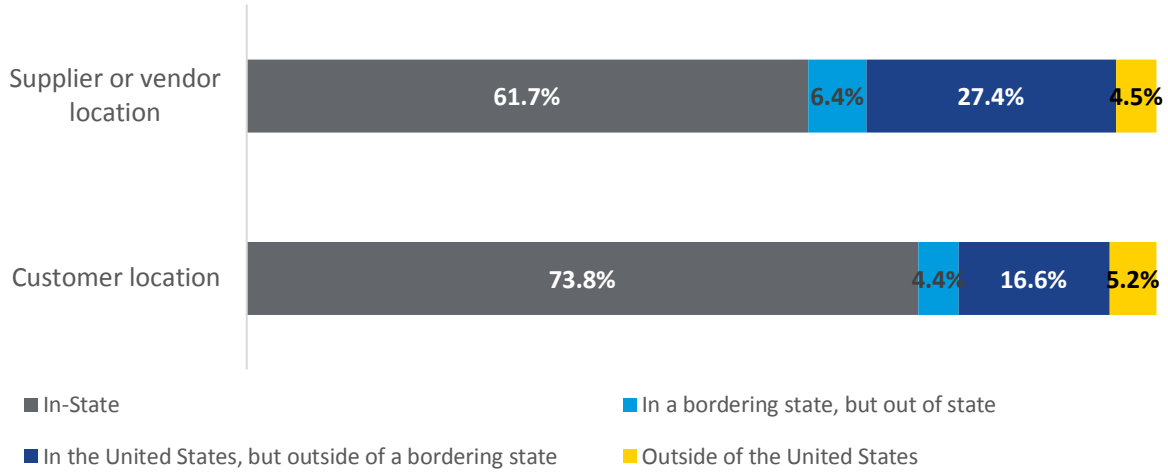
Tracking clean energy markets is important for several reasons. Firms focused on local activities tend to be the biggest beneficiaries of State policies (e.g., a solar installer benefits directly from increased consumer incentives) and provide the most employment opportunities. At the same time, exporters and innovators attract outside capital, fueling the economic growth of the State. Understanding the flow of goods and services provides insight into key areas of leakage—parts of the supply chain that could be served by New York firms, but are currently being served by out-of-state suppliers.

All industries have some leakage throughout their supply chains, particularly with a competitive international exchange for products and services. Leakage across most industries and regions tends to be especially apparent in finished product manufacturing, consulting and other professional services, and finance. Specifically, New York could leverage its existing strength in key industries with a particular focus on pilot and contract manufacturing and advanced materials, as well as wholesale trade and logistics capabilities, to meet the needs of clean energy employers in the State. Capturing this leakage represents a significant opportunity to expand the clean energy economy and businesses could benefit from increased connectivity to the clean energy marketplace.

New York's clean energy economy is mostly local, with the majority of customer and vendors located within the State. Three-quarters of firms report primarily in-State customers, likely driven by the large energy efficiency installation sector. The State's clean energy employers report some global market activity, with approximately 5% of firms exporting products and services to international clients. Export-oriented activity is most likely the result of research and innovation, as firms export knowledge to global markets (Figure 8).[29]

[28] See previous footnote for what "other" and "other support services" include.
[29] For additional detail, please see the individual technology sections in the Clean Energy Technologies chapter.

Figure 8. Customer and Vendor Location

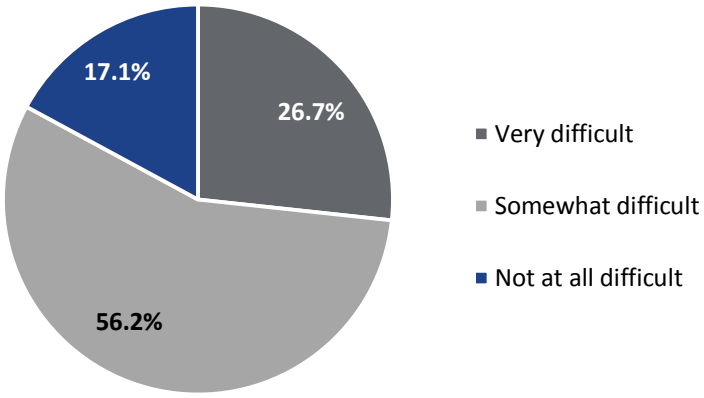


Clean Energy Labor Supply

Employer-reported hiring difficulty is an important measure of qualified labor supply. Context is important when reviewing such data, particularly given the significant decline in the State and national unemployment rate combined with the rapid growth of the industry over the past several years. With fewer skilled workers available, training programs must provide more varied and comprehensive education to employees today than in years past. As difficulty finding qualified applicants creates bottlenecks and can impede economic growth, efforts to train unemployed and underemployed New Yorkers in clean energy fields could hasten the growth of the industry and provide more opportunity to residents.

In New York, clean energy employers report significant difficulty finding qualified workers. Over three-quarters of employers note that hiring has been difficult over the last 12 months. For these firms, the most difficult positions to fill included engineers, installers or technicians, and sales positions; each occupation is critical to various segments of the value chain, including product development, commercialization, distribution, and maintenance. Employers note they had the most trouble finding applicants with occupation-specific skillsets and relevant prior experience (Figure 9).[30]

Figure 9. Hiring Difficulty



[30] *For more information on hiring difficulty by technology, please refer to the Clean Energy Technologies chapter.*

PROFESSIONAL AND BUSINESS SERVICES DEEP DIVE

Professional and business services encompass a variety of clean energy support activities including research, consulting, design, legal support, and software development.

Approximately 45% of all clean energy professional service firms support the industry through architecture, engineering, and related services, while research and development firms comprise more than one-fifth (22%) of the sector.

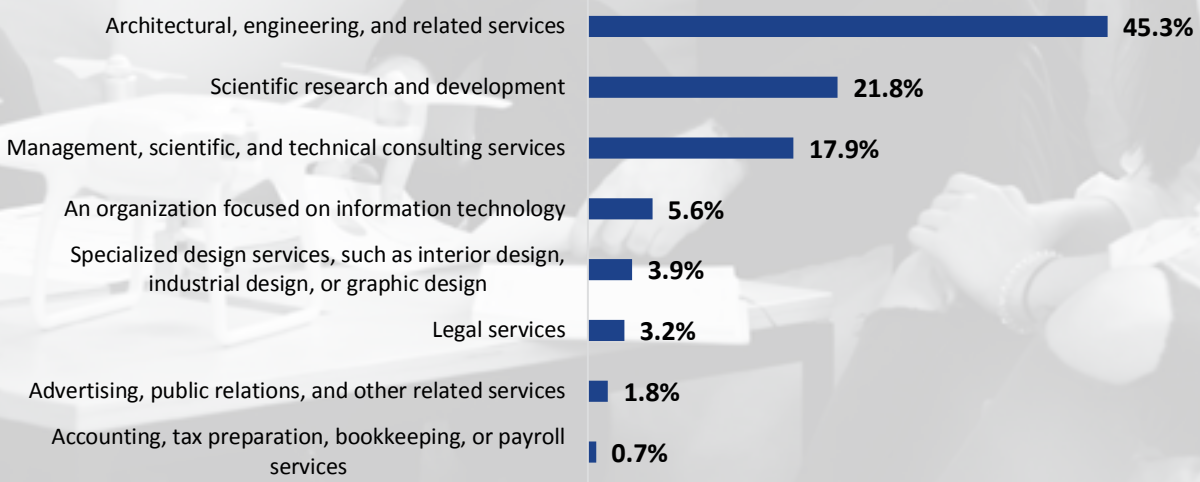
The largest subsectors of clean energy professional and business services in the State are the architecture and engineering industry, followed by scientific research and development. Approximately 45% of all clean energy professional service firms support the industry through architecture, engineering, and related services, while research and development firms comprise more than one-fifth (22%) of the sector (Figure 10). This high activity across research and development is indicative of a clean energy economy that supports innovation, likely for growing markets such as the grid modernization and storage sector. In fact, six in 10 research and development firms report they primarily work with products still under development, and 8% of research firms report they mostly serve international clients. Architecture and engineering firms work with both commercial products and those still under development, indicating this subsector likely spends more time supporting renewable generation or energy efficiency technologies. In a similar vein, there are about 214,500 LEED-certified professionals across the State. These individuals are reworking the way buildings and communities are planned, constructed, maintained, and operated.[31]

As technologies such as solar and wind move towards market maturity, efforts to introduce new commercial technologies or improve synergies between existing technologies will ensure that the State remains competitive in the clean energy industry. As such, public support is especially important for this growing sector of the clean energy value chain. The supplemental survey honed in on hiring difficulties and funding needs, because understanding talent shortages and investment gaps can help to highlight areas where these firms might require more support.

Improved workforce development and labor market connectivity helps to ensure firms are better able to staff their teams with qualified individuals; these firms can then dedicate resources to expanding research efforts and technology commercialization. Unfortunately, both scientific research and development and architecture and engineering firms reported hiring difficulty over the last 12 months—about 78% and 85% of firms respectively. Information technology employers actually reported the greatest hiring difficulty; more than nine in 10 firms note difficultly finding qualified applicants over the last 12 months.

For a growing industry to maintain an active innovation community, investment dollars are equally as important as talent and workforce supply. Ease of access to funding streams allows researchers to dedicate more labor hours to product development as opposed to writing grant proposals. Funding needs within the overall professional service sector does vary by activity, though not surprisingly, research and development firms were most likely—more than two-thirds of firms—to apply for equity, or grant funding over the last 12 months.

Figure 10. Professional Services Firms by Activity



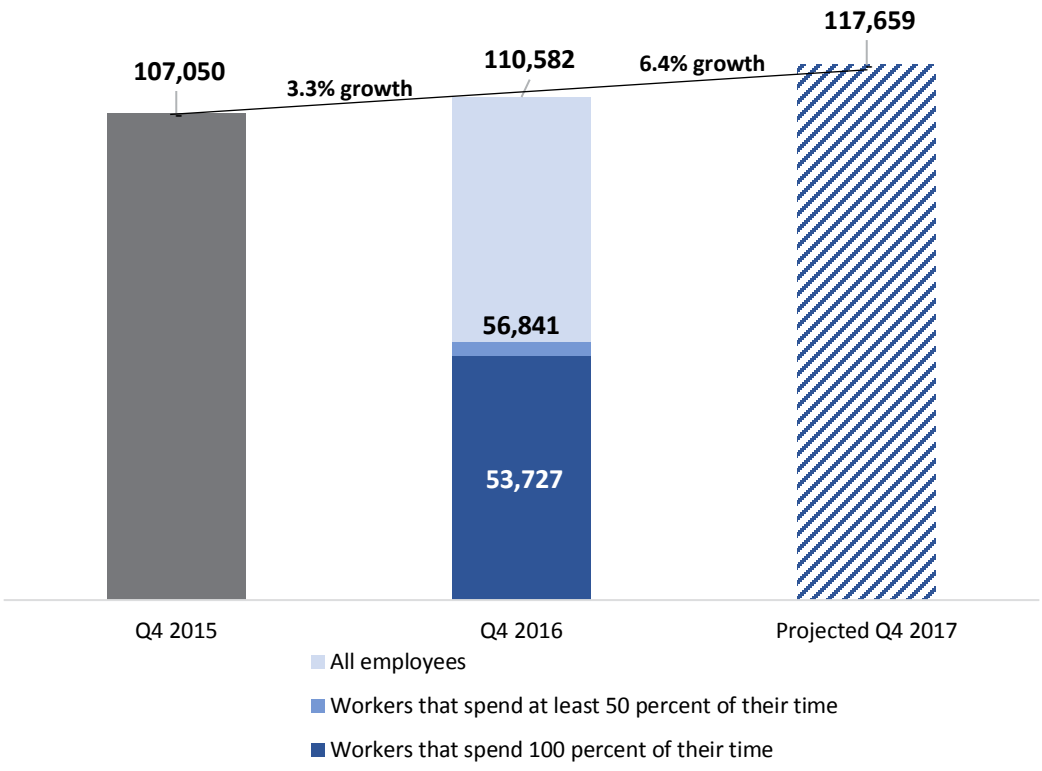
[31] *Leadership in Energy and Environmental Design (LEED), U.S. Green Building Council (USGBC) (http://www.usgbc.org/people)*

CLEAN ENERGY TECHNOLOGIES

ENERGY EFFICIENCY

With 110,000 workers across the State, energy efficiency firms are the largest clean energy employers, and businesses expect to grow their workforce by another 6% by the end of 2017 (Figure 11). The American Council for an Energy-Efficient Economy (ACEEE) has consistently ranked New York among the top 10 states between 2007 and 2017, and among the top five leading states in six out of 10 years, demonstrating New York's sustained commitment to driving progress in energy efficiency.[32] In the 2016 State Energy Efficiency Scorecard, the ACEEE ranked New York as fifth among all 50 states for leading the way on energy efficiency. The ACEEE scorecard examines State policies and programs that promote and improve energy efficiency standards. Policy areas include utility and public benefits programs, building energy codes and compliance, as well as appliance and equipment standards.

Figure 11. Energy Efficiency Employment Growth, Q4 2015 – Q4 2017 Projected

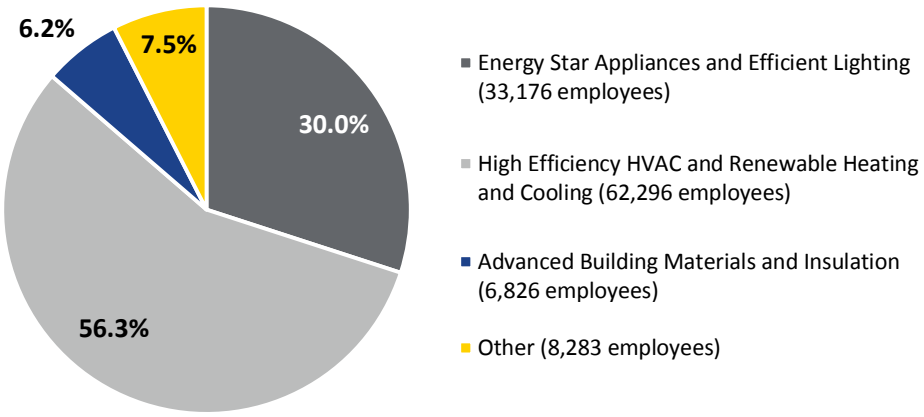


[32] *2016 State Energy Efficiency Scorecard, American Council for an Energy-Efficient Economy (ACEEE).*

Energy efficiency employment is found in every county across the State, with Wyoming and Putnam County coming in as the highest concentration of energy efficiency workers relative to the overall labor force (Figure 13). The majority of workers, about six out of 10, spend most of their time with ENERGY STAR® appliances, efficient lighting, high-efficiency HVAC, and renewable heating and cooling technologies. The remainder of employment is spread across traditional HVAC, advanced building materials, and other energy efficiency technologies (Figure 12).

Regarding workforce, energy efficiency firms experienced the highest level of hiring difficulty amongst all clean energy technologies. Almost nine out of 10 reported some hiring difficulty, and three out of 10 note hiring was very difficult. More than a quarter of respondents indicated that the reasons for reported difficulty included, lack of experience and general qualifications, as well as a small applicant pool with few qualified applicants. Employers reported difficulty finding qualified engineers, sales representatives, installers or technicians, and managers.

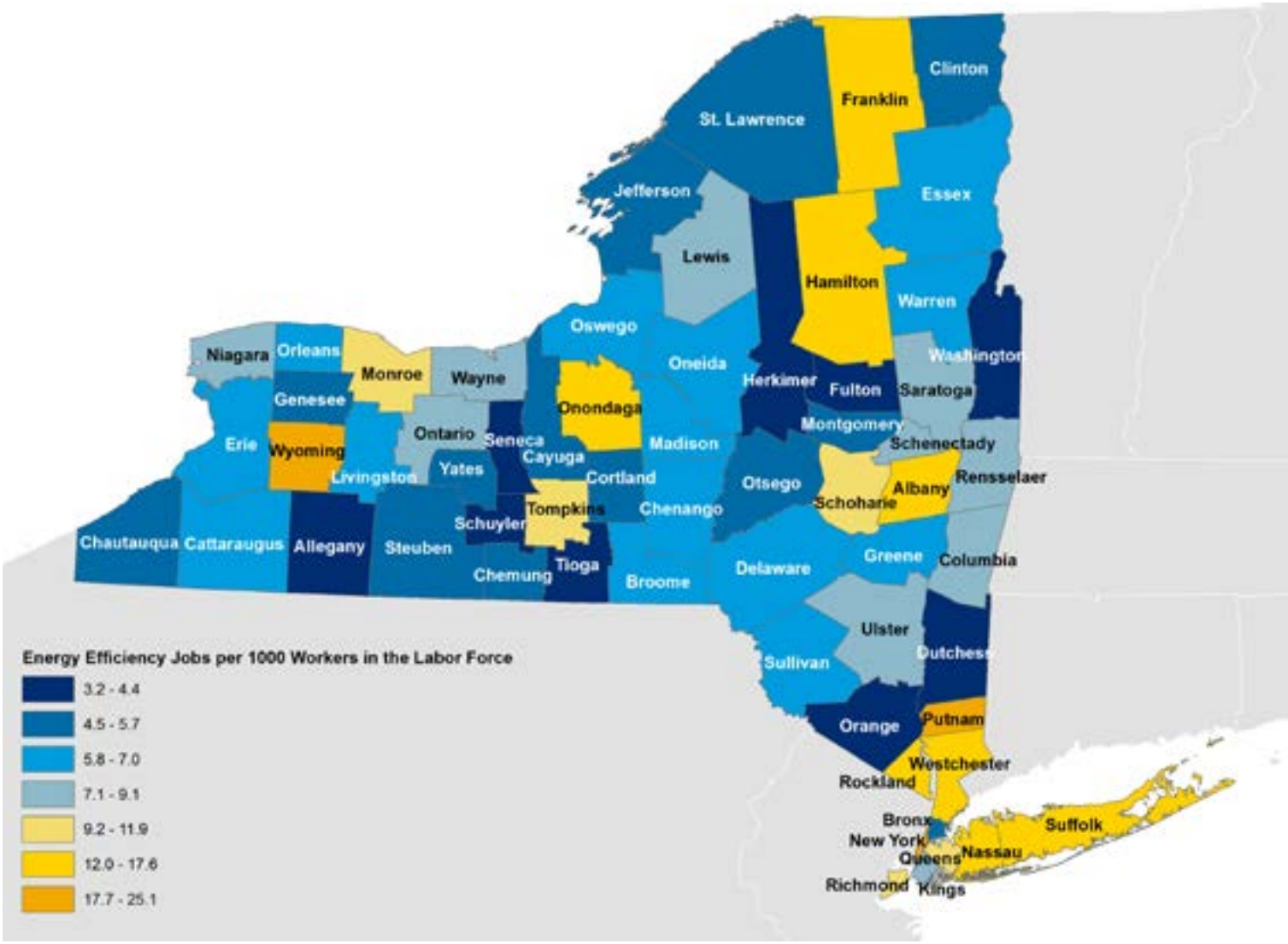
Figure 12. Energy Efficiency Employment by Sub-technology, Q4 2016[33]



[33] *High Efficiency HVAC and Renewable Heating and Cooling includes 29,155 employees that spend a majority of their time working on traditional HVAC goods and services, and 33,141 workers spending a smaller portion of their time working with these high efficiency products. "Other" energy efficiency employees work with recycled building materials, reduced water consumption products and appliances, and/or other energy efficiency products and services.*

A majority of energy efficiency workers, about six out of ten, spend most of their time with Energy Star® appliances, efficient lighting, high-efficiency HVAC, and renewable heating and cooling technologies.

Figure 13. Energy Efficiency Employment per 1,000 Workers in Labor Force by County

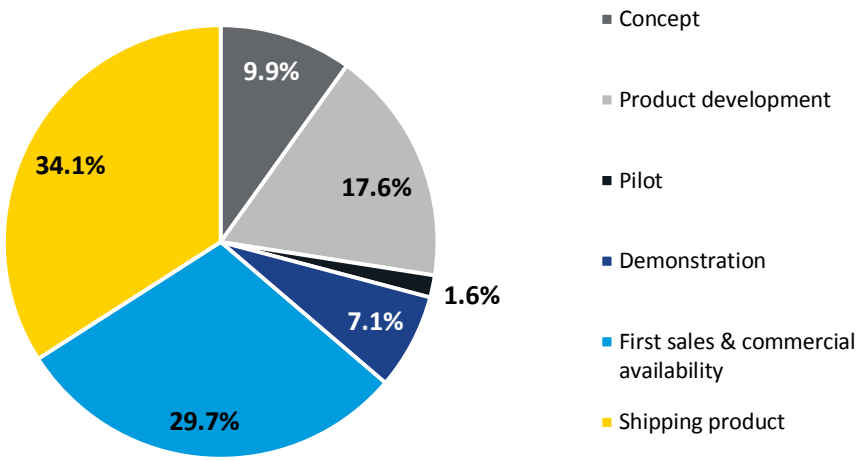


Energy Efficiency Markets and Innovation

New York's energy efficiency sector is largely driven by in-State deployment activity. The sector has a smaller innovation sphere with little early-stage capital flow. This coupled with above-average domestic consumption of goods and services, as well as marked hiring difficulty for installers, indicates that energy efficiency upgrades and retrofits are the main contributors to employment growth in the sector.

Much of the energy efficiency policy is focused on building retrofits and upgrades that reduce energy consumption. As such, activity in the sector is mostly concentrated on the installation of existing commercially-available technologies. The sector is quite mature, as the majority—about two-thirds of firms—work with products that are already widely commercially available (Figure 14).

Figure 14. Primary Product Stage: Energy Efficiency



Few energy efficiency businesses in the State applied for innovation funding in the last 12 months. Less than 38% of energy efficiency firms applied for equity, or grant funding between the last quarters of 2015 and 2016. The majority of firms that did not seek funding explained they had no need for capital.

Recent declines in innovation funding demonstrate the challenging funding environment, particularly for early-stage deals (Figure 15). While deployment activity is supported through a variety of other investments and expenditures, the current environment supports the need for NYSERDA to continue to invest in early-stage deals to maintain and expand new technology innovation in energy efficiency. Analysis of geographic distribution of deals shows that most innovation funding activity is concentrated around New York City, but NYSERDA grant activity is scattered across the State (Figure 21).

COMPANY PROFILE: **CDH ENERGY**

Adam Walburger came to CDH Energy in 1996 with a passion for pushing the development of energy consulting in New York State. He is now currently the General Manager and oversees a staff of 12 full-time employees and one part-time employee. CDH Energy deals in measured and monitored performance data for emerging clean energy technology like distributed generation. They also offer energy efficiency consulting that covers a range of services, including feasibility studies, product demonstration, and research and development.

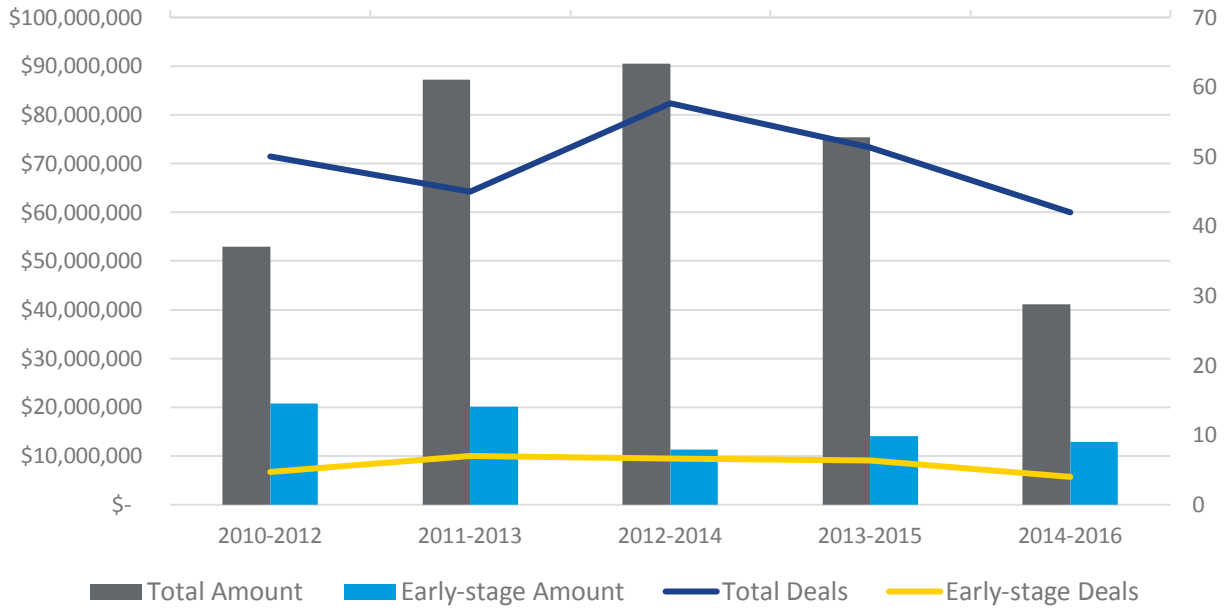
Mr. Walburger adds an interesting perspective to the clean energy discussion noting that "the technology is not a novel concept," but the prevalence of new technologies is what has changed. Renewable generation technology has been around for years, but data now indicates that support and growth are on the rise for New York's clean energy economy.

CDH Energy mainly sources talent from local academic institutions such as the State University of New York's College of Environmental Science and Forestry (SUNY ESF). New York-based schools like SUNY ESF offer strong programs in "green energy" and energy consulting and has prompted Mr. Walburger and his company to hire several recent graduates. For middle and upper positions at CDH, Mr. Walburger stated that most employees are hired through networking with a heavy emphasis on "a seen and be seen attitude" for vetting. Mr. Walburger said that his ideal employee for CDH would be a managing engineer with an overlapping background in engineering, data management, and analysis capabilities.

CDH Energy recently made a strategic business partnership with the Gas Technology Institute (GTI). CDH and GTI have complementary skills in energy efficiency, energy system analysis, and technology analysis, opening many new cross-business opportunities for both parties. GTI's emerging technology program accelerates the market introduction and acceptance of new emerging technologies to feed utility-sponsored energy efficiency programs. Another GTI subsidiary, Fisher-Nickel, Inc., is a California-based professional services firm with deep expertise in commercial kitchen energy efficiency and appliance performance testing. Partnerships with these firms will add incredible value to CDH Energy's growth and allow the company to offer its products through other partner's divisions in multiple markets.

Mr. Walburger thinks that CDH and the energy efficiency industry overall is benefitting from the fact that the market is not dominated by a monolithic firm, but instead diversified among many niche firms. His overall recommendation for focus areas hinged on more effectively shedding light on clean energy projects that the State has created through outreach and demonstration. In his experience, "the energy efficiency market is not successful when turned over to the economic 'invisible hand' philosophy due to the first cost issues of clean energy technologies." He projects the future of the energy efficiency market and his own company will be based on the re-emergence of renewable heating and cooling powered by air- and ground-sourced heat pumps. Mr. Walburger believes this will play an important role in increased electrification of the grid due to a refreshed sense of implementation, marketing, and public acceptance. He also stated that batteries and energy storage are going to be increasingly important to CDH Energy and the energy efficiency economy of New York State moving forward.

Figure 15. Energy Efficiency Overall and Early-stage Innovation Funding in New York, 2010–2016 Three-Year Rolling Averages[34]



The energy efficiency market is highly localized, with eight in 10 energy efficiency employers serving in-State customers. Only 3% also serve international clients (Figure 17).

[34] *Clean energy innovation funding data was extracted on February 23, 2017 from the i3 Cleantech Group's clean energy innovation database. Public grant data from the i3 database was supplemented with the NYSERDA awards database.*

Figure 16. Energy Efficiency Innovation Funding by Size and Type, 2010-2016[35]

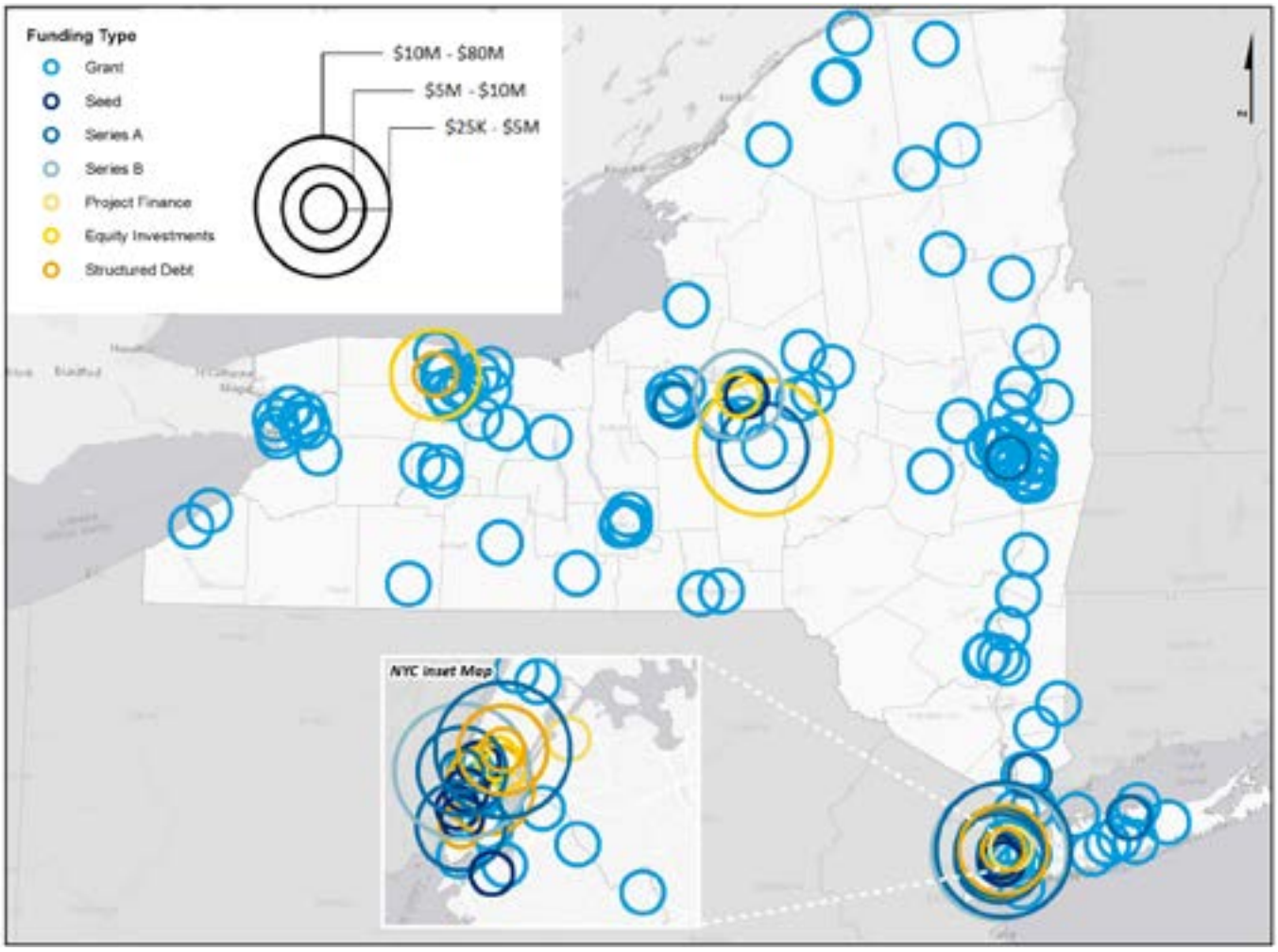
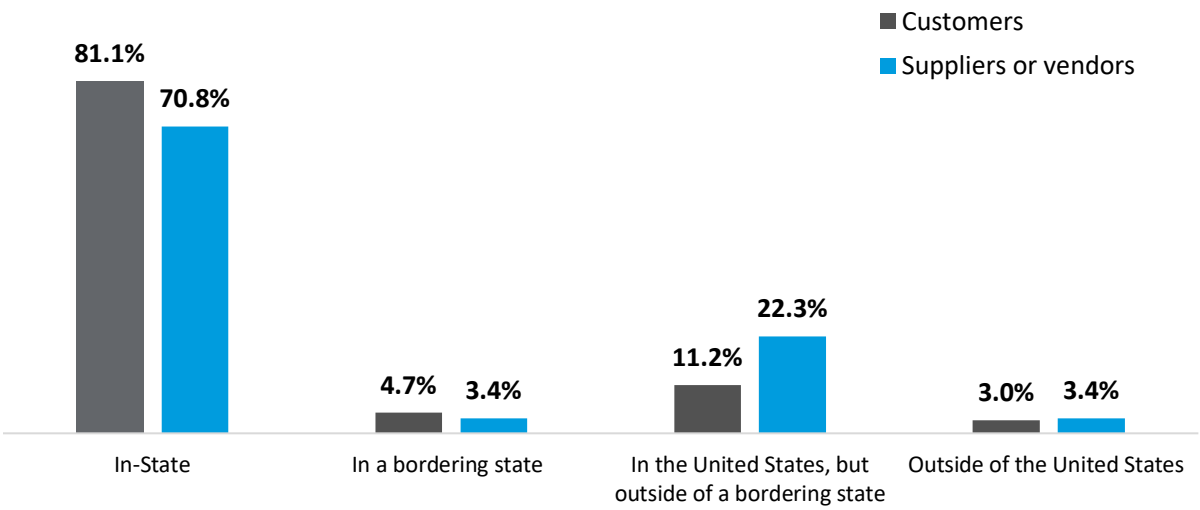


Figure 17. Energy Efficiency Customer and Vendor Location



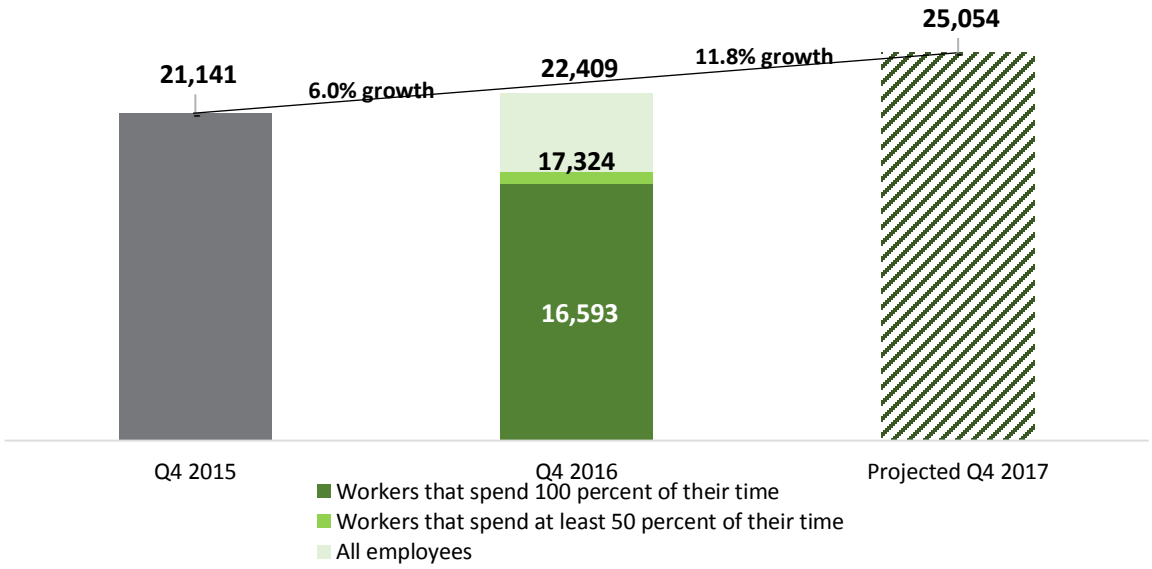
[35] *Id.*

RENEWABLE ELECTRIC POWER GENERATION

Renewable electric power generation experienced the highest growth among all clean energy technologies in New York State. Between Q4 2015 and Q4 2016, the sector grew by 6%, adding another 1,300 jobs to the State's economy. Employers also expect to see their staff counts expand by almost 12% by the end of 2017 (Figure 18). Warren County has the highest concentration of renewable energy workers, with between 7.6 and 11.8 renewable energy workers for every 1,000 individuals in the overall labor force (Figure 19). This is partially due to the relatively high reported employment for solar PV establishments in the county.

Despite high past and projected growth, the majority of renewable electric power generation firms hiring between Q4 2015 and Q4 2016 indicated difficulty finding qualified applicants, mostly due to lack of experience and general qualifications. The most difficult positions to fill included engineers, installers or technicians, and sales representatives.

Figure 18. Renewable Electric Power Generation Employment Growth, Q4 2015 – Q4 2017 Projected



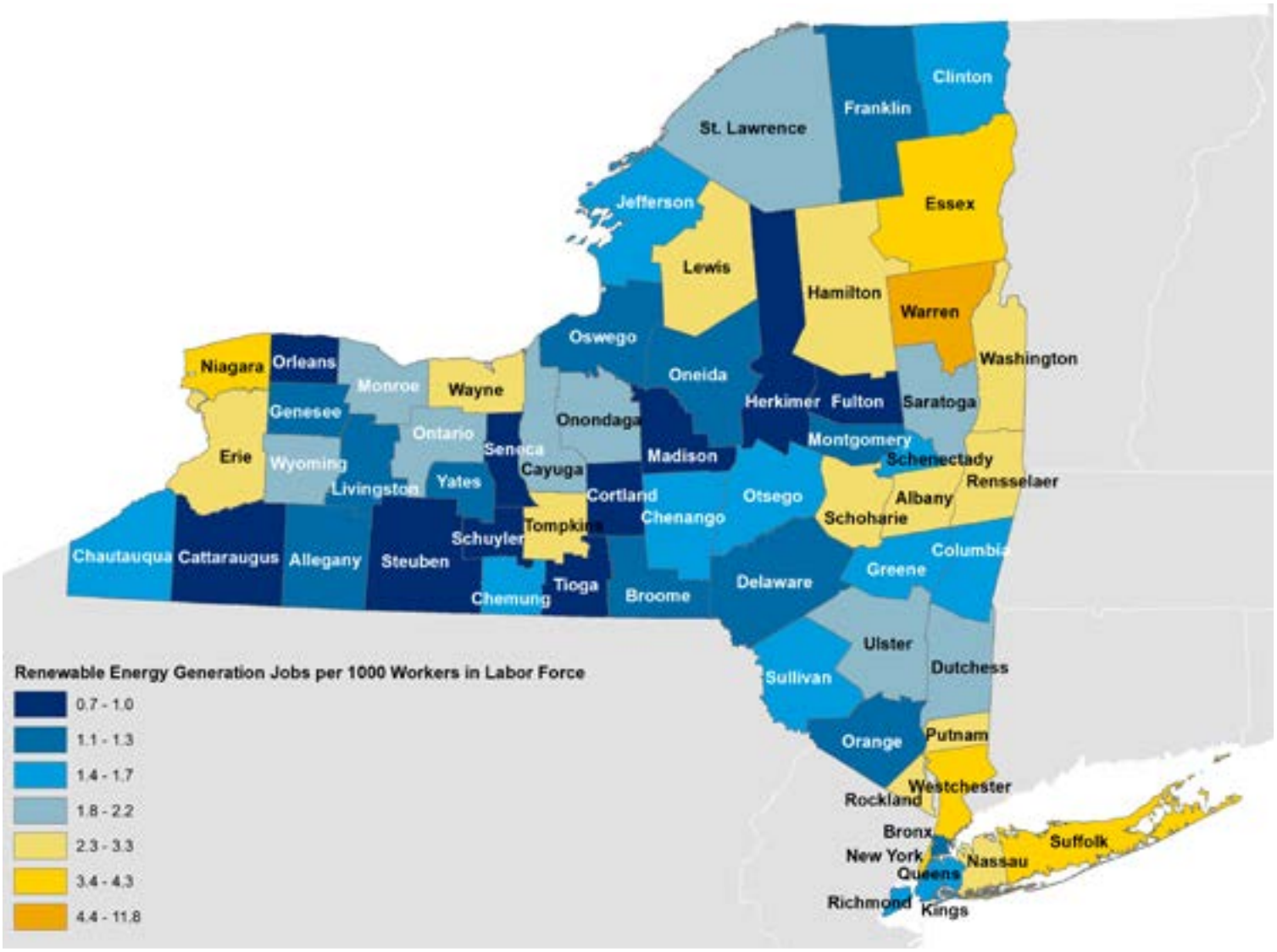
Strong growth in renewable generation employment is likely attributable to past State and federal policy developments, helping to launch New York to the top of renewable energy resource procurement indices. Optimism for near-term growth in the renewable energy technology sector depends in part upon continued growth in the solar industry. While the September 2017 *Suniva* ruling by the International Trade Commission (ITC) has caused some uncertainty in the solar industry, there remains significant opportunity for growth in this sector from all technologies, driven by New York's strong commitment to the Clean Energy Standard goal of having 50% of New York's electricity come from renewable sources by 2030. With the initiation of the Clean Energy Standard, New York is poised to continue this significant growth trend as the **CES is expected to attract $3 in private capital for every dollar invested by the State in new renewables**.[36]

[36] *New York State Government (https://static1.squarespace.com/static/576aad8437c5810820465107/t/57ffb900b3db2b5fba128147/1476376832464/CES-ov-fs-1-v4.pdf)*

Additionally, the State is leading the charge to make renewable energy available to the growing climate consciousness of corporations seeking to "green up" their operations. The 2017 Corporate Clean Energy Procurement Index ranked New York seventh in the nation based on the ease with which companies can obtain renewable energy for their operations located within the state. The index consists of 15 indicators, broken into three categories: utility purchasing options, third-party purchasing options, and onsite/direct deployment options.[37]

Moreover, further accessibility in renewable energy procurement has been promoted through the various financial incentives put in place by the State and federal government. These include rebates, corporate tax deductions or credits, personal tax credits, and grant or loan programs. To date in 2017, New York boasts 120 policy programs that promote the State's clean energy industries.[38] These policies seek to break down the barriers of entry New York's renewable energy firms are facing and help grow the clean energy economy.

Figure 19. Renewable Energy Employment per 1,000 Workers in Labor Force by County



[37] *2017 U.S. Clean Energy Procurement Index, Clean Edge.*
[38] *DSIRE Programs (http://programs.dsireusa.org/system/program?fromSir=0&state=NY)*

The State has also recently taken significant steps towards becoming a national leader in offshore wind generation. **In 2017, Governor Cuomo vowed to develop up to 2,400 megawatts of offshore wind by 2030—enough electricity to power 1.2 million homes**. To facilitate responsible development of New York's offshore wind resource, NYSERDA is producing a New York State Offshore Wind Master Plan. The Master Plan[39] will be the comprehensive strategy for developing offshore wind resources in New York State:

- Site identification and leasing strategies
- Site assessment and site characterization pre-development activities
- Cost, benefit, and interconnection studies
- Analysis and recommended mechanisms for the purchase/sale of the renewable energy to be produced
- Stakeholder and community engagement, as well as educational efforts
- Visual (viewshed), fishing, and other mitigation efforts

The potential for job creation from the development of offshore wind is significant.[40] As a result, the Master Plan is engaging in The Offshore Wind Economic Impact and Jobs Analysis. This report will study the projected economic impact of installing 2,400 MW of offshore wind by 2030 and to take inventory of the assets within New York State available to support the resulting offshore wind industry. Assets will include the manufacturing industry, workforce, and port infrastructure. The study will analyze assets currently in place as well as the gaps or weaknesses that must be addressed by either in-State or external resources. The analysis will also consider regional development of offshore wind, and will quantify the impact the broader industry will have on the State's economy and workforce. Specific recommendations for potential workforce development measures will be prepared for further consideration.

The potential for job creation from the development of offshore wind is significant.

At the time of publishing this 2017 NYSERDA Clean Energy Industry Report, many large corporations are bidding for developing offshore wind projects, including one company that already launched the first successful wind farm on the East Coast, Deepwater Wind.[41] Additionally, in 2016, the Bureau of Ocean Energy Management (BOEM) held a lease auction for New York's first Wind Energy Area comprising 80,000 acres located about 12 nautical miles off the coast of Long Beach, New York and stretching approximately 26 nautical miles to the southeast. The winner of the lease auction was Statoil Wind U.S. LLC. Statoil will now have the opportunity to explore the potential development of an offshore wind farm to provide New York City and Long Island with a significant, long-term source of renewable electricity. Subsequent to the BOEM award, the LIPA Board approved a contract submitted by Deepwater Wind for the South Fork Wind Farm after a year-long process engaging the private sector for the best available clean energy generation ideas and detailed cost modeling. This award is significant because it further signaled the future of the market by indicating that offshore wind is a competitive generation option for Long Island.[42]

[39] *New York State Government (https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind)*

[40] *See generally: National Offshore Wind Strategy: Facilitating the Development of the Offshore Wind Industry in the United States, September 2016. Available at: https://www.boem.gov/National-Offshore-Wind-Strategy/ See also: WDI New York State and the Jobs of Offshore Wind Energy, 2016. Available at: https://wdiny.org/Portals/0/New%20York%20State%20and%20The%20Jobs%20Of%20Offshore%20Wind%20Energy_%20WDI2017.pdf?ver=2017-05-03-150746-023*

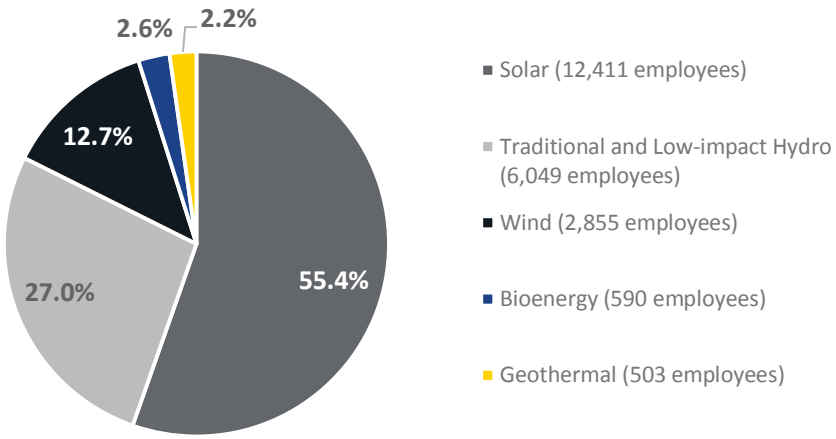
[41] *The firm proposed two projects: South Fork and Deepwater ONE. The South Fork project would produce enough clean, cost-effective energy to power more than 50,000 homes on Long Island's South Fork, and Deepwater ONE has the potential for more than 1,000 MW of offshore wind power. Deepwater Wind (http://dwwind.com/)*

[42] *Bureau of Ocean Energy Management and the U.S. Department of the Interior (DOI) (https://www.doi.gov/pressreleases/interior-department-auctions-over-79000-acres-offshore-new-york-wind-energy)*

In October 2017, New York State submitted an identified Area for Consideration to the federal government's Bureau of Ocean Energy Management (BOEM). This comes after rigorous fieldwork, analysis, and stakeholder outreach regarding appropriate locations for wind installations off New York State's Atlantic Coast. The State submitted extensive information supporting the Area for Consideration, which the State views as best suited for future offshore wind development. New York State requests that within this Area of Consideration, BOEM identify and lease at least four new Wind Energy Areas, each capable of supporting at least 800 megawatts. BOEM's identification and leasing of these Wind Energy Areas will encourage competition among offshore wind developers, help reduce costs, and support New York in meeting its commitment of 2,400 megawatts of offshore wind energy by 2030, enough to power 1.2 million New York State households. Taken together with the Master Plan study and development and recent lease and procurement activity, this action is a clear signal that New York is open for business, and recognizes the significant benefits to the broader New York clean energy economy that can come from developing this important clean energy resource in the State.

Solar technologies are the largest renewable generation employer, but New York also has robust onshore wind energy presence. As a result, wind technologies account for almost 13% of the renewable electric power generation workforce (Figure 20). As predicted by the Deepwater Wind project benefits and other related analyses, this workforce will undoubtedly grow from the anticipated addition of offshore wind in the coming years.[43]

Figure 20. Renewable Electric Power Generation Employment by Sub-technology, Q4 2016



[43] *Workforce Development Institute (https://wdiny.org/Services/Workforce-Development/Targeted-Sectors)*

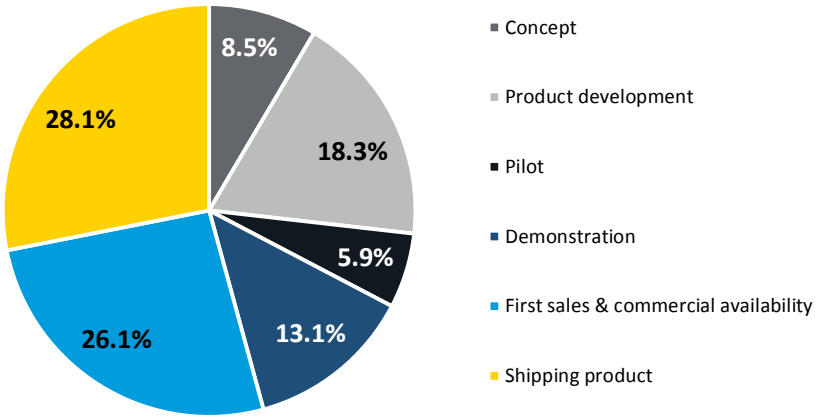
Renewable Electric Power Generation Markets and Innovation

As with energy efficiency, renewable electric power generation firms work largely with commercialized technologies. There is less relative innovative activity or early-stage funding in the sector, indicating that current job growth is also heavily dependent on deployment activity. However, many firms reported seeking funding in the last 12 months may signal new research and technology development on the horizon.

Approximately half of the firms primarily work with products that are already widely commercially available, and only about two in 10 firms report they primarily work only with products that are still under development. In fact, most firms report their primary product stage is either the first sales and commercial availability or shipping stage (Figure 21).

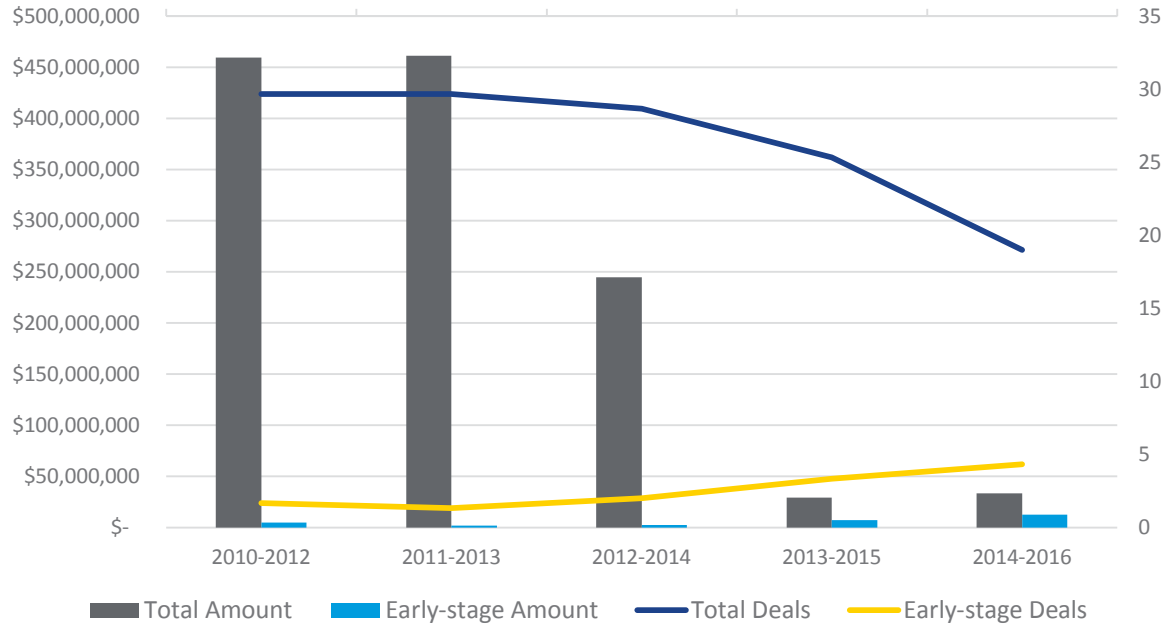
Significant investments have been made in the State to support expansion of the deployment market notably through NY-Sun, the State's Renewable Portfolio Standard program, and more recently, NY Green Bank. At the same time, the sector received less than $15 million in early-stage funding each year since 2010, and much of the funding activity has taken place around New York City (Figure 22 and Figure 23). In general, funding dollars declined from an average of $459 million in 2010 to $33 million in 2016 (Figure 23). Nevertheless, approximately half of renewable electric power generation firms reported seeking equity, or grant funding from Q4 2015 to Q4 2016. The majority of firms that did not seek funding cited no need for capital, while 15% mentioned that banks and other lenders were not willing to offer them financing.

Figure 21. Primary Product Stage: Renewable Electric Power Generation



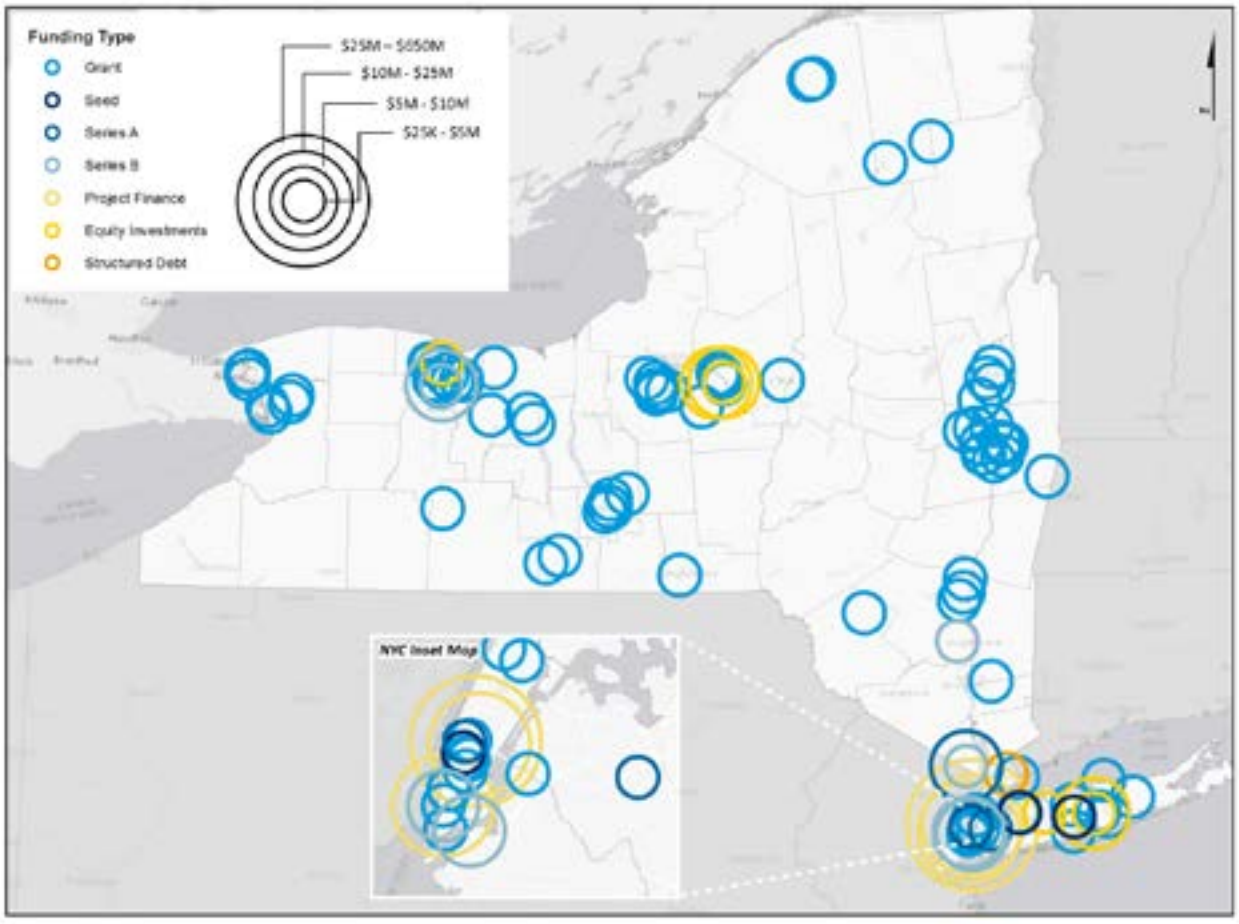
Significant investments have been made in the State to support expansion of the deployment market notably through NY-Sun, the State's Renewable Portfolio Standard program, and more recently, NY Green Bank.

Figure 22. Renewable Electric Power Generation Overall and Early-stage Innovation Funding in New York, 2010-2016 Three-Year Rolling Averages[44]



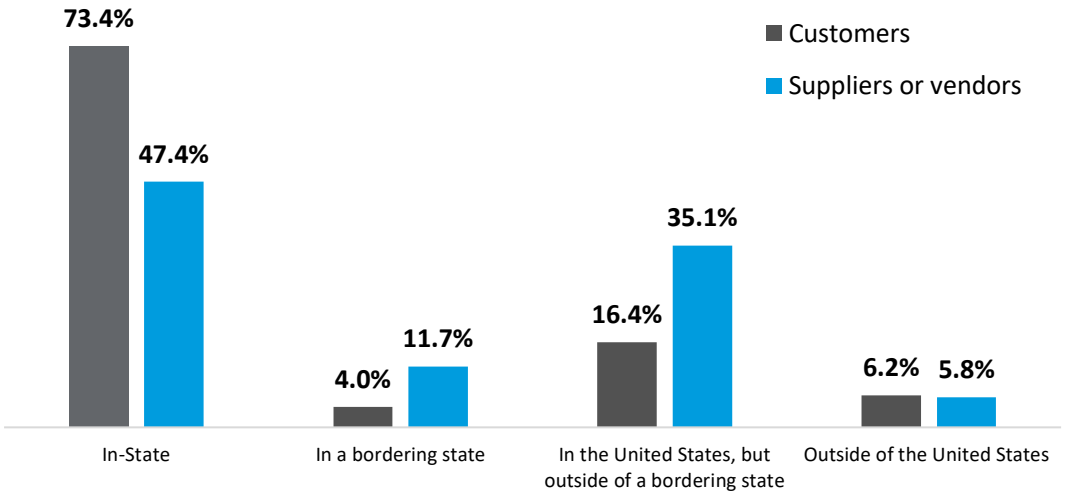
[44] *Clean energy innovation funding data was extracted on February 23, 2017 from the i3 Cleantech Group's clean energy innovation database. Public grant data from the i3 database was supplemented with the NYSERDA awards database.*

Figure 23. Renewable Electric Power Generation Innovation Funding by Size and Type, 2010–2016[45]



The distribution of renewable electric power generation customers is very similar to that of the energy efficiency and overall clean energy market. Nearly three-fourths of responding firms identified that their primary customers and vendors are located in New York, while 6% primarily serve international clients (Figure 24).

Figure 24. Renewable Electric Power Generation Customer and Vendor Location



[45] *Id.*

SOLAR DEEP DIVE

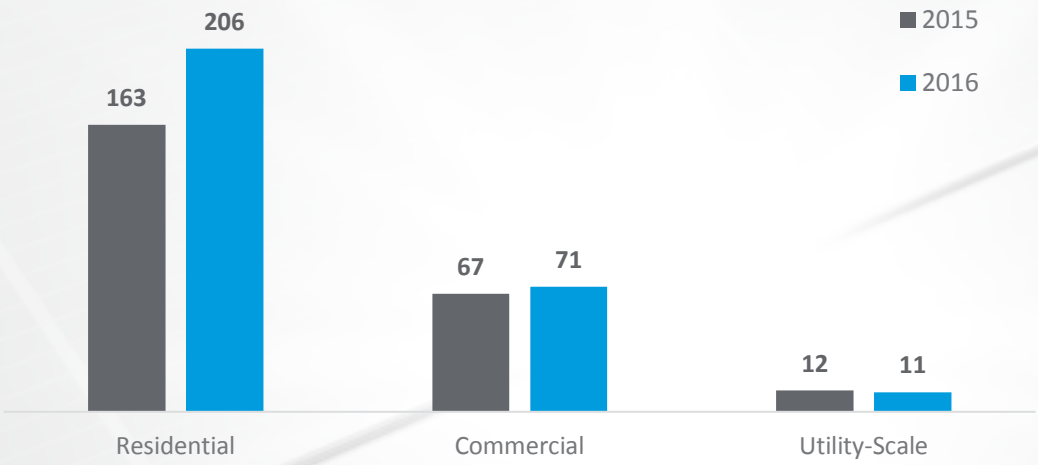
As of the end of 2016, New York had 927 megawatts (MW) of installed solar capacity, ranking it 10th among states in cumulative capacity.

Installation

As of the end of 2016, New York had 927 megawatts (MW) of installed solar capacity, ranking it 10th among states in cumulative capacity and 21st in cumulative capacity per capita. Compared to 2015, 2016 annual installed capacity grew by 288 MW, of which 206 MW were residential. New York's residential segment grew by 26% and was the only segment to exceed national growth (19%) in installed capacity. The commercial segment grew to 71 MW more than 2015 deployment. Utility-scale grew by only 11 MW, which was slightly less than experienced in 2015. New York State's utility-scale and commercial segment growth was considerably below the national level; U.S. utility-scale installed capacity ballooned by 148% while commercial grew by 49%.[46]

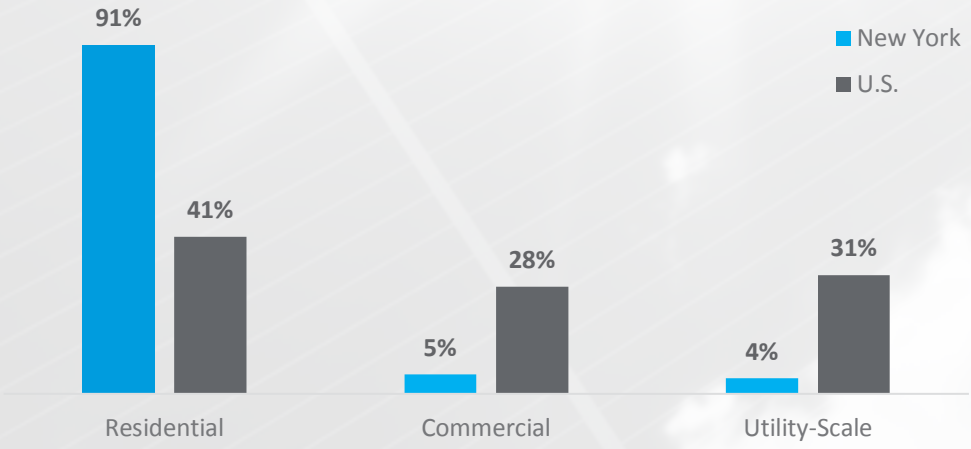
New York solar resource is comparable to many northern U.S. states. Albany, NY averages 4.27 kwh/m2/day which is 98% of that of Chicago (4.37) and 96% of that of Boston (4.47). The difference is greater when compared to southern states. Albany has about 66% of the solar radiation as Phoenix and 81% of Miami.[47]

Figure 25. New York Installed Solar PV Capacity 2015-2016 (Megawatts)[48]



These capacity trends are reflected in the survey responses to address the way solar workers spend their time. Roughly 90% of solar workers spend their time on residential projects in New York State compared to about 40% nationally. Since the residential segment requires a greater number of employees per MW installed than the other, more labor-efficient segments, residential tends to have relatively more employment.

Figure 26. Sectors Served by Solar Workers[49]



[46] *U.S. Solar Market Insight® Solar Market Insight Report Series, 2015 and 2016, GTM Research, A Wood Mackenzie Business/SEIA*
[47] *Based NREL PV Watts calculator for a standard 6 kw residential solar array. http://pvwatts.nrel.gov/*
[48] *Source: Solar Market Insight® Solar Market Insight Report Series, 2015 & 2016, GTM Research, A Wood Mackenzie Business/SEIA*
[49] *National Solar Jobs Census 2016, The Solar Foundation*

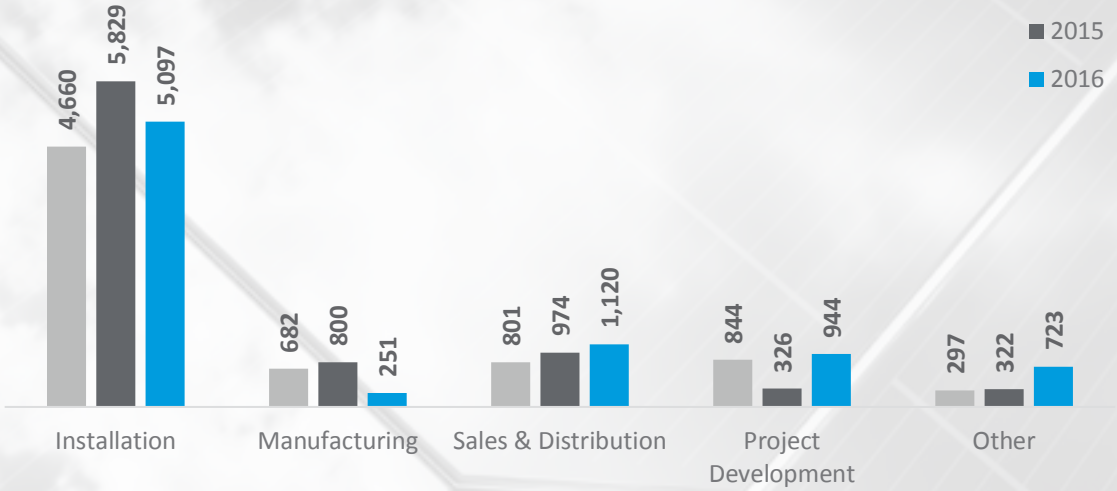
Solar Jobs

There were 8,135 solar jobs in New York in 2016, ranking the State sixth nationally in solar jobs and 29th in solar jobs per capita. This count is based on The Solar Foundation's definition of a solar job, which requires a person to spend at least 50% of their time on solar-related work to be counted as a solar job. Using a lower threshold definition, which counts any participation in solar as a solar job, New York had 12,411 solar jobs in 2016.

With the more stringent 50% requirement for jobs, most (63%) New York solar jobs were in the installation sector in 2016. This is followed by the sales and distribution sector (14%), project development (12%), other (39%), and manufacturing (3%). Project development is comprised of utility-scale development, including installation. All other installation is part of its eponymous sector. When the locations are surveyed, the respondents are asked to identify their primary sector. Therefore, each sector will include a variety of occupations. For example, an installation firm location might include installers, supervisors, permitting staff, designers, and accountants.

New York solar jobs decreased slightly, by 1%, between 2015 and 2016, contrasting dramatically with a 25% national growth rate in solar jobs. As mentioned, much of the national growth was propelled by high growth in the commercial and utility-scale installed capacity. All sectors experienced growth nationally, but for New York, only three—sales and distribution, project development, and other experienced growth. There were declines in installation and manufacturing. Nevertheless, for 2017, survey respondents project an 11% growth in solar jobs for New York, slightly more than the 10% projected nationally. Specifically, Solar manufacturing employment is expected to get a boost, however, the recent ITC decision has injected some uncertainty into the industry. The new SolarCity (Tesla) Gigafactory 2 in Buffalo is expected to create 1,460 jobs (500 in manufacturing), and attract another 1,440 from suppliers and service providers. It will begin production in 2017 and expect to hit full production in 2019.

Figure 27. New York Solar Employment Trends by Job Function



Battery storage is also important to the solar market. As the price of storage drops and the State implements favorable storage policies, the storage market will grow. Solar will receive an additional boost as costs of storage decline, leading to a greater frequency of pairing these complimentary technologies. Of the 73% of renewable electric power respondents that said that they were directly engaged with PV solar, 29% also reported that they were engaged with battery storage. This overlap mirrors national trends where 34% of solar PV respondents were also engaged with battery storage.

Industry Comparison

Solar energy provides more jobs in New York State than any other energy production sector. Using the lower threshold definition[50] of an energy job, the solar industry employed 21% of the energy industry total for electric power generation and fuels related jobs.[51] Solar employment was more than twice that of natural gas, traditional hydropower, oil and petroleum, or wind. Only the "other" category had more energy employment than solar.[52] Nationally, solar is second to oil/petroleum in total electric power generation and fuels related jobs.

Table 1. Employment Comparison of Top New York Energy Sectors[53]

Power Generation	Employment				
	Electric Power Generation	Fuels	Total	Percent of Total	U.S. Percent of Total
Other	17,871	6,157	24,028	40.6%	19.3%
Solar	12,411		12,411	21.0%	13.8%
Natural Gas	4,066	2,335	6,401	10.8%	17.7%
Traditional Hydropower	5,859		5,859	9.9%	2.8%
Oil/Petroleum	711	3,261	3,972	6.7%	25.2%
Wind	2,855		2,855	4.8%	5.0%
Woody Biomass		1,843	1,843	3.1%	1.5%
Ethanol		1,482	1,482	2.5%	2.5%
Coal	253	27	280	0.5%	7.8%
Total	**44,026**	**15,105**	**59,131**	**100.0%**	**100.0%**

Solar industry customers and vendors are primarily in-State. Two-thirds of respondents reported their primary customers were in-State and 42% reported their primary vendors were in-State. These figures exceeded those reported by respondents in all states. Nationally, 63% reported that their customers and 37% reported that their vendors were primarily in-state. New York respondents reported only 2% of their primary customers and 6% of their primary vendors were outside the United States.

[50] *See Clean Energy Labor Intensity explanation on page 16.*
[51] *The lower threshold definition of a solar job was used for the industry comparison because it is the same threshold used for all industries in the comparison.*
[52] *The "other" electric power generation category includes nuclear, low-impact hydroelectric generation, combined heat and power, bioenergy/biomass generation, geothermal generation. The "other" fuel category includes nuclear fuels, non-woody biomass including biodiesel, and other biofuels.*
[53] *2017 U.S. Energy and Employment Report, Department of Energy.*

Figure 28. Solar Customer Location, 2016[54]

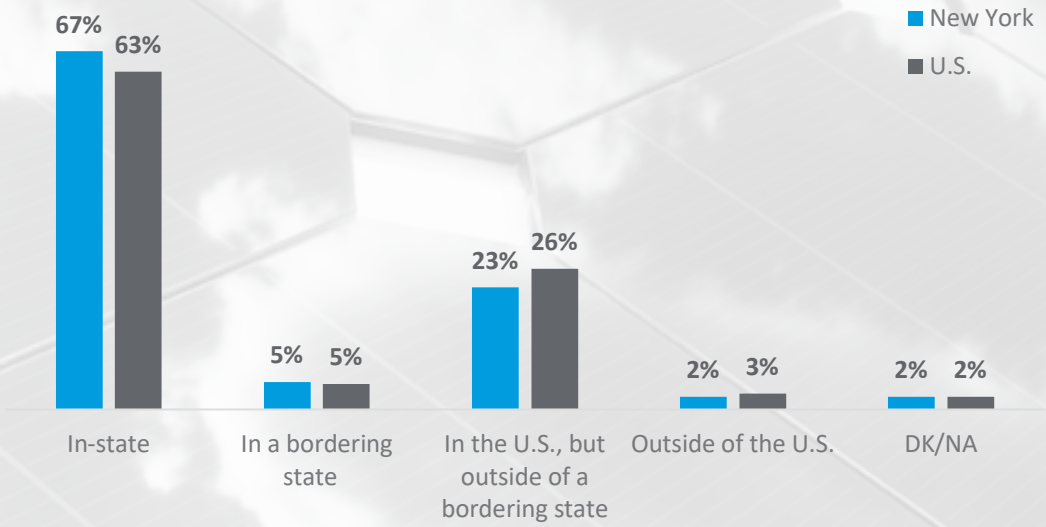
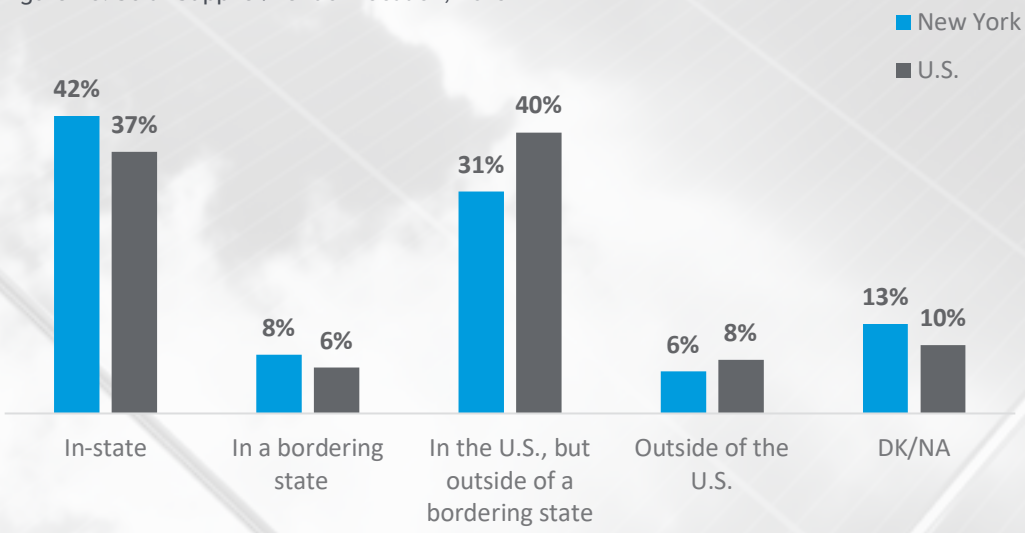


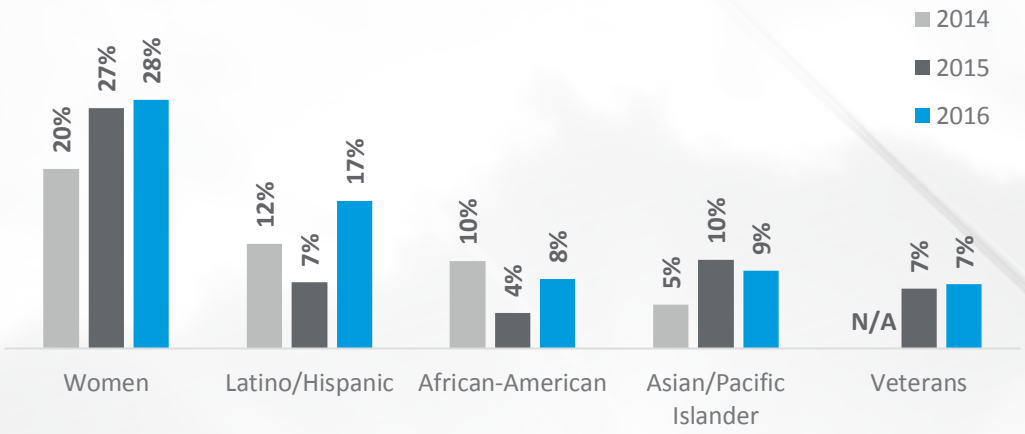
Figure 29. Solar Supplier/Vendor Location, 2016[55]



The demographic of solar workers is diverse. New York's solar labor is as increasingly diverse as the national labor market. Approximately 28% of the workforce are female, 17% are of Latin or Hispanic origin, 7% are African-American, and 8.7% are Asian or Pacific Islander. Most of these proportions increased throughout the last several years. Female workers increased from 20% to 28% from 2014 to 2016 while those of Latin or Hispanic origin increased from 12% to 17% over the same period. Only African-Americans declined, dropping from 10% to 8%.

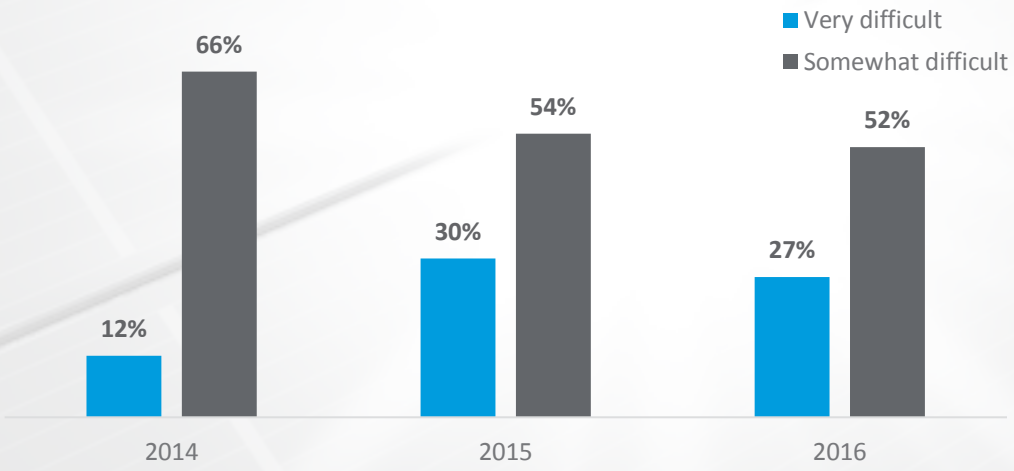
[54] *NYSERDA Supplemental Survey and National Solar Jobs Census 2016, The Solar Foundation.*
[55] *Ibid.*

Figure 30. Demographic Breakdown of Solar Workers[56]



Hiring difficulty increased dramatically from 2014 to 2015, but receded somewhat in 2016. In 2014, 12% of solar respondents reported difficulty finding qualified applicants. By 2015, this increased to 30% likely in response to a corresponding growth in installed capacity. With installed capacity tapering off in 2016, the resulting reports of difficulty in hiring dropped back slightly to 27%.

Figure 31. Hiring Difficulty[57]



[56] *National Solar Jobs Census 2016, The Solar Foundation.*
[57] *NYSERDA Supplemental Survey and National Solar Jobs Census 2016, The Solar Foundation.*

State Policy in New York

The small dip in 2016 solar jobs can partially be explained by interconnection challenges that delayed development in the commercial and community solar markets. The solar industry is optimistic about continued opportunities and anticipated hiring demands for 2017. These expectations are based on the continuation of federal and State policies that have advanced the industry in recent years. It is expected the International Trade Commission (ITC) will make recommendations at the Suniva proceeding regarding certain trade measures in response to the petition filed by Suniva and SolarWorld, and that the President will issue his determination by January 18, 2018. Given the pendency of that proceeding, and the potential results for the cost of solar cells and modules, there is uncertainty in the solar industry.

Several longer-term drivers for the solar industry including the CES and REV will continue to support growth across State. In 2016, New York established an aggressive Clean Energy Standard requiring that 50% of the State's electricity come from renewables by 2030. This includes solar, wind, and hydropower. Since it will require that New York double its current percent of renewable energy on the grid, the CES should stimulate a considerable amount of renewable growth including solar.

New York continues to refine its REV strategy, driving higher levels of distributed energy resources and seeking to "establish markets so customers and third parties can be active participants, to achieve dynamic load management on a systemwide scale."

The Public Service Commission's proceeding on the "value of distributed energy" (VDER) rate structure for solar energy, (implemented September 2017) will apply to all demand and community solar customers. Credits based on energy value, environmental benefits, capacity value, and distribution value will be generated for electricity exported to the grid. Community solar projects will also receive a market transition credit.[58] Residential onsite will continue to receive credit at the retail rate. VDER will provide more investor certainty for existing pipeline of projects on hold.

Additionally under REV, New York is working on ways to provide better information, including price signals, to guide the design and location of distributed energy resources so projects are better aligned with utility needs. As part of Phase Two of VDER, it will address a more granular approach to the value stack components, rate design and the inclusion of low income participants to benefit from distributed energy resources.

Other near-term drivers include two recent solicitations that yielded 200 proposals from large-scale, clean energy project developers that will add historic amounts of renewable energy to New York's power supply. The State expects to invest up to $1.5 billion in new clean energy projects through the two RFPs issued by NYSERDA and NYPA. Both solicitations yielded creative proposals to use large-scale solar, wind, hydroelectric, or biomass renewable energy generation technologies to support the Governor's Clean Energy Standard.

Utility-scale solar development has been limited in the State due, in part, to low wholesale electricity prices. Competition from wind also reduces some of the solar potential in the State, as seen through RPS, which awarded funds for many more megawatts of wind than for solar.[59] In addition, it seems waivers from PURPA interconnection requirements granted by the Federal Energy Regulatory Commission to states with competitive electricity markets allow New York utilities to avoid interconnecting utility-scale solar projects[60] under standard offer power purchase agreements, as has been popular in other states like North Carolina. Nevertheless, utility-scale activity appears to be picking up. As of April 2017, the New York ISO has seen new interconnection requests for more than 700 megawatts of projects averaging 40 megawatts in capacity.[61]

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[58] *"NY Sets Rates for Community, Commercial and Industrial Solar," NRDC, September 2017 (https://www.nyserda.ny.gov/-/media/NYSun/files/VDER-Implementation-Order.pdf)*

[59] *Governor Cuomo Announced $360 Million for 11 New Large-Scale Renewable Energy Projects in State of the State, Jan. 12, 2017, NYSERDA (https://www.nyserda.ny.gov/About/Newsroom/2017-Announcements/2017-01-12-Governor-Cuomo-Announced-360-Million-for-Large-Scale-Renewable-Projects)*

[60] *PURPA and Solar, Project Finance Newswire, April 2017 (https://www.chadbourne.com/purpa-and-solar-project-finance-april-2017)*

[61] *NYISO Interconnection Queue, April 30, 2017*

COMPANY PROFILE: VENTURE SOLAR

Alex Yackery co-founded Venture Solar after three years of working at OnForce Solar located in Bronx, New York. With Venture Solar exhibiting so much success, it is surprising to note that he had little knowledge of the solar industry before starting four years ago. He credits his time at Onforce Solar with honing his knowledge and providing his “bachelor’s, master’s, and PhD in solar in just three years.”

In an 18-month period, Venture Solar grew from two to 80 employees and is projected to employ more than 100 workers by the end of 2017. His company performs many different services ranging from customer acquisition, to permitting and installation. Venture Solar now installs, on average, 75 residential solar systems a month. Yackery credits a large portion of his company’s growth to supporting New York State entities like Sustainable CUNY and NYSERDA and their dedication to facilitating dialogue about the clean energy market. On the policy front, he hopes the State will continue to support electric vehicle adoption and lithium ion battery innovation in the State.

Mr. Yackery predicted energy storage innovation as the next prevailing focus in the clean energy market of New York State. He believes current codes for energy storage are outdated and equivalent to the code of past solar projects. He has seen first-hand that New York residents are unable to procure energy storage due to insufficient supply. With the volatile weather in the Northeast and the recent impact of Superstorm Sandy, it is evident that backup power will be a top priority for thw State moving forward. Mr. Yackery also pointed to community solar as being a large part of New York State’s solar future. Possible avenues with community solar could involve low-cost roof space leasing given the lack of space in New York City. He predicts that net metering might no longer exist for mass market customers in the next three to five years and that the price for solar power generation will be at least 25% lower.

Mr. Yackery sees Venture Solar expanding from New York City to Long Island and Connecticut. With this expansion, he hopes to make Venture Solar one of the few $100 million solar companies in the Northeast with the same bootstrap attitude he started the company with. He is extremely proud to be involved in distributed power generation for the “best city in the world.”

GRID MODERNIZATION AND STORAGE

Grid modernization and storage is a small, but growing sector in the State's clean energy economy; these firms employ just over 1,400 workers.[62] Between the last quarters of 2015 and 2016, the sector saw employment grow by 3%, and employers also expect to add workers at a rate of 5% by the end of 2017 (Figure 32). Expected growth is possibly linked to the growing collaboration between battery storage and solar PV technologies within the State. Energy storage accounts for the largest segment of labor activity—about eight in 10 workers—followed by smart grid technologies (Figure 33).

Nearly three-quarters of grid modernization and storage firms note hiring difficulty over the 12 months between Q4 2015 and Q4 2016; 18% report that hiring was very difficult and 55% report that hiring was somewhat difficult.

Figure 32. Grid Modernization and Storage Employment Growth, Q4 2015 – Q4 2017 Projected

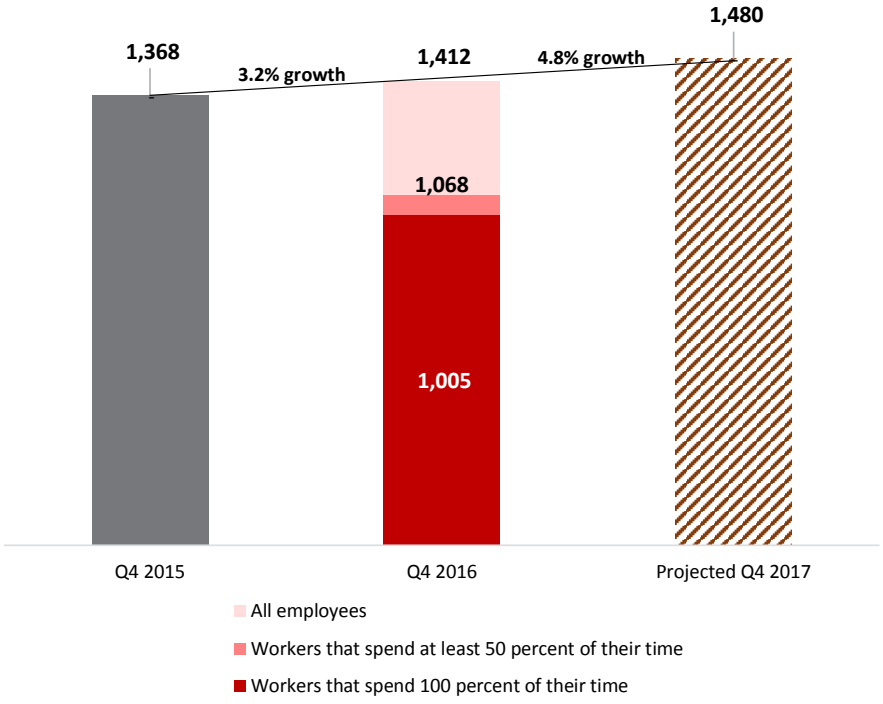
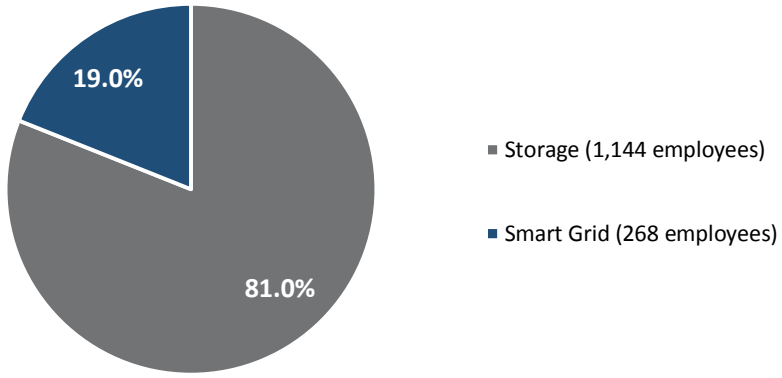


Figure 33. Grid Modernization and Storage Employment by Sub-technology, 2016



[62] *This employment number is slightly lower compared to the storage employment data produced in 2016 in the Energy Storage Industry in New York State report by Industrial Economics (IEc) due primarily to the IEc's inclusion of "traditional" markets such as forklifts, medical devices, lead-acid batteries, or military applications. The IEc report includes 650 grid storage jobs for emerging electricity storage markets in addition to 724 battery transportation jobs. Together, these two subsectors account for 1,374 workers, which is close to this report's estimated 1,412 workers in grid modernization and storage. The remaining 2,560 workers from the IEc report are in traditional markets, which are not included in this NYSERDA report.*

Grid Modernization and Storage Markets and Innovation

The grid modernization and storage sector is an area of significant innovative activity for New York State's clean energy economy. With the highest percentage of firms that primarily work with non-commercial products—about 35%—grid modernization and storage firms secured the most innovation funding dollars from 2012 through 2016 compared to any other technology sector.

Unlike energy efficiency and renewable energy, both sectors with highly mature technologies, market activity for grid modernization firms occurs largely outside of New York State. This means that because the workforce spends more time devoted to research and development as opposed to installation, the sector's customer base is less likely to be local. In fact, more than half of smart grid and storage employers report their primary customers are outside of New York State (Figure 37).

62% of grid modernization and storage firms sought equity, or grant funding between Q4 2015 and Q4 2016

Between 2010 and 2016, grid modernization and storage technologies received a total of $251 million in innovation funding. Most firms are primarily working with products that are in the concept, product development, or pilot stage (Figure 34). Because many firms are working with pre-commercial products, it is not surprising that approximately 62% of grid modernization and storage firms sought equity, or grant funding between Q4 2015 and Q4 2016.

While overall funding dollars have increased during the last six years, early-stage innovation funding declined, which indicates that technologies may be moving towards the demonstration and commercialization phases of development (Figure 35). The majority of innovation funding activity between 2010 and 2016 occurred around New York City (Figure 36).

Figure 34. Primary Product Stage: Grid Modernization and Storage

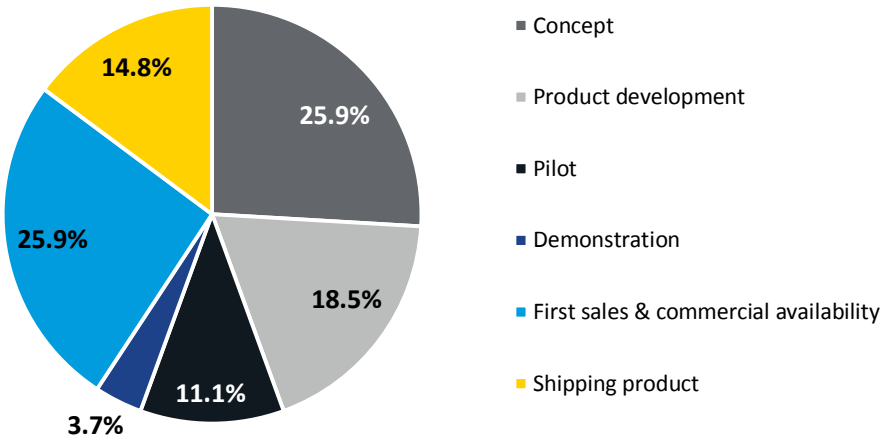
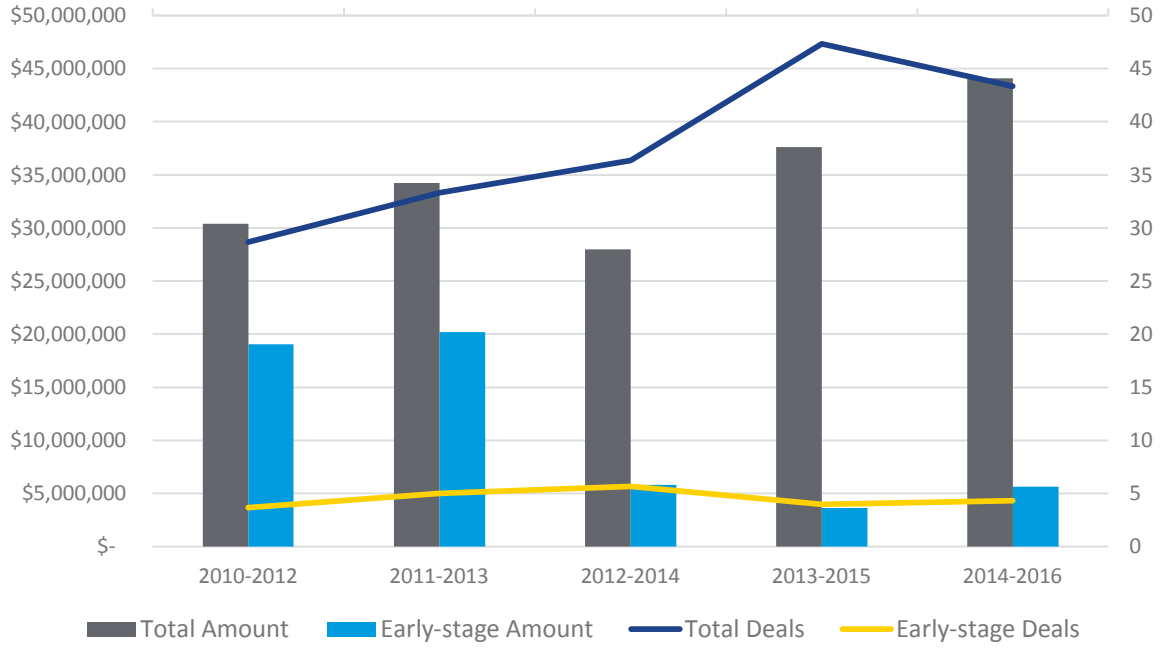


Figure 35. Grid Modernization and Storage Overall and Early-stage Innovation Funding in New York, 2010-2016 Three-Year Rolling Averages[63]



[63] *Clean energy innovation funding data was extracted on February 23, 2017 from the i3 Cleantech Group's clean energy innovation database. Public grant data from the i3 database was supplemented with the NYSERDA awards database.*

The grid modernization and storage sector is an area of significant innovative activity for New York State's clean energy economy.

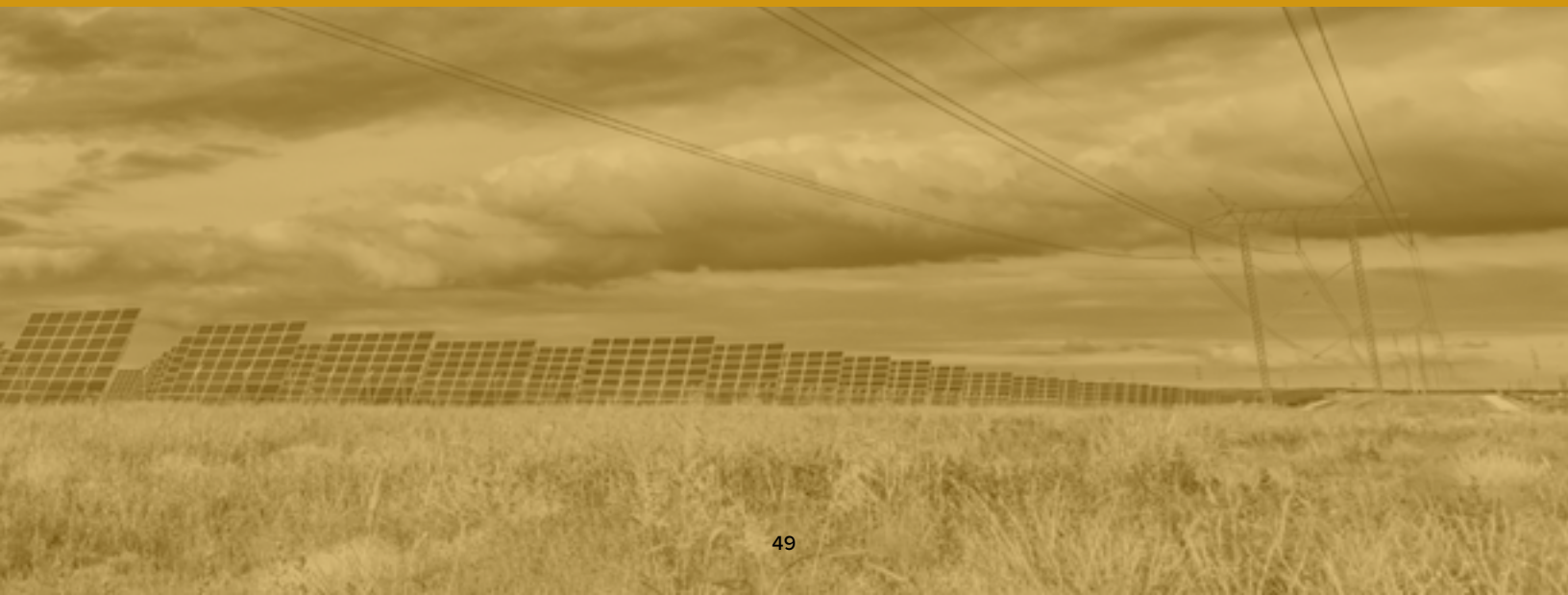


Figure 36. Grid Modernization and Storage Funding by Size and Type, 2010-2016[64]

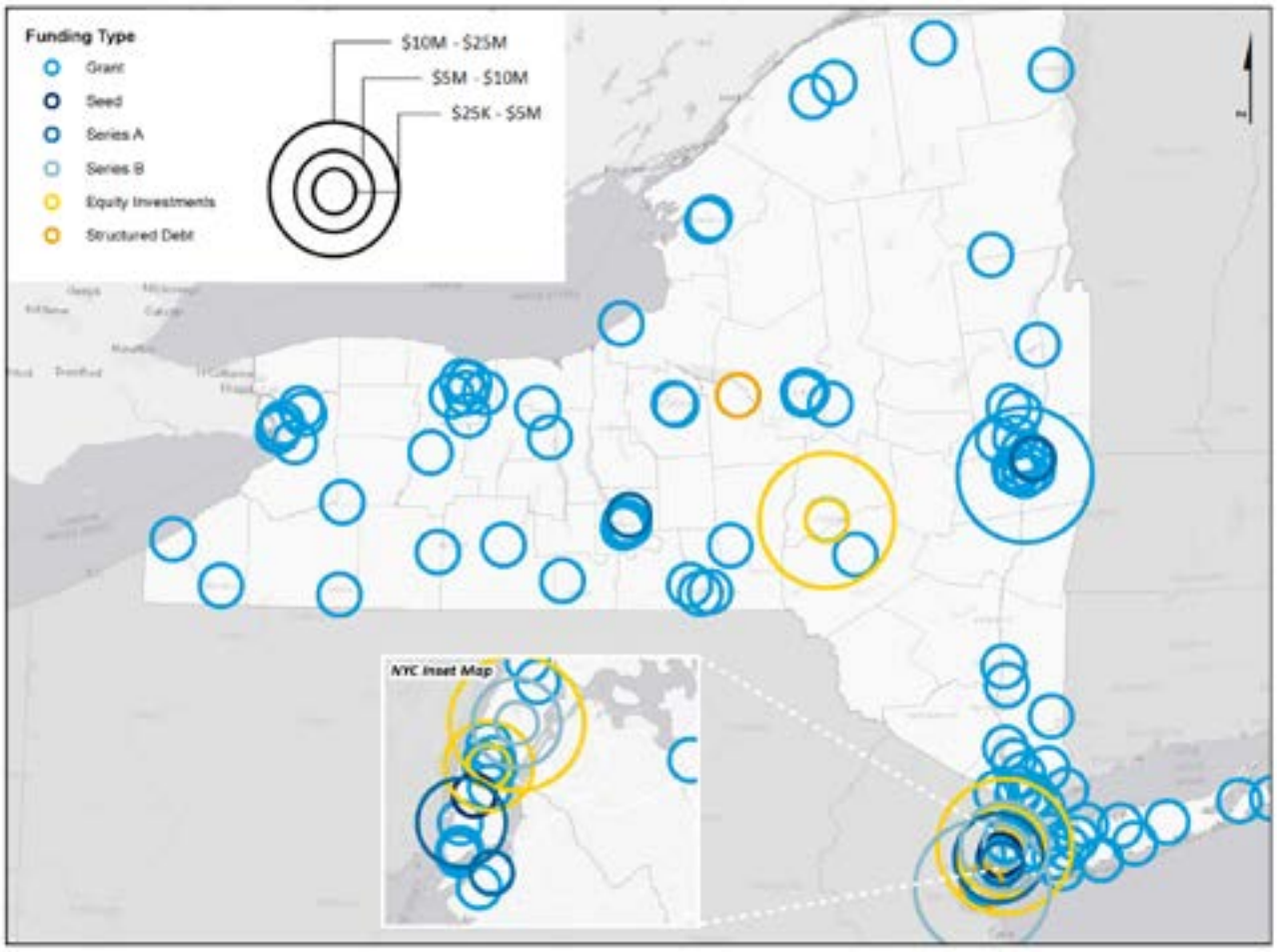
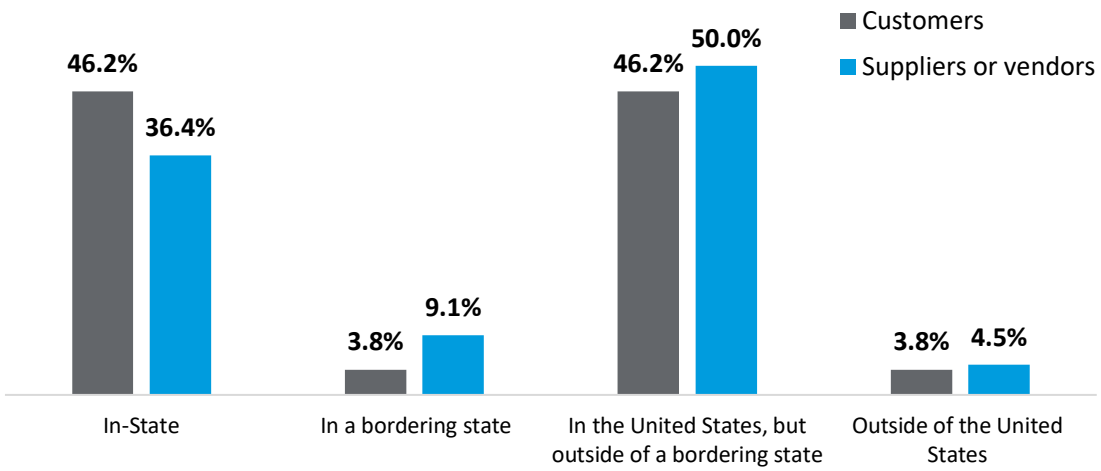


Figure 37. Grid Modernization and Storage Customer and Vendor Location



[64] *Id.*

NEW YORK'S COMMITMENT TO GRID MODERNIZATION AND STORAGE TECHNOLOGIES

Governor Andrew M. Cuomo set New York State on a path to deliver a comprehensive energy strategy and build a clean, more resilient, and affordable energy system. Under REV, New York is modernizing its electric grid and integrating clean, distributed energy resources as essential elements of the State's energy system.

Policy and regulatory interventions are encouraging the major electric distribution utilities in New York State to evolve into distributed system platforms—the foundational network platforms of the electric grid envisioned under REV. This will enable market-friendly connections between multiple aspects of a modernized grid, including distributed energy resources, large-scale power generators, customers, and other parts of the energy system. Both the DSIPs and NWAs are providing opportunities for investment in energy storage and grid modernization solutions.

In addition to regulatory interventions under REV, New York continues to support growth of a smart grid and energy storage innovation sector. New York State launched the NY Battery and Energy Storage Technology (NY-BEST) Consortium which aims to build a vibrant, world-class, advanced battery, and energy storage sector in New York State. The Consortium holds three main objectives that include accelerating the commercial introduction of energy storage technology, building human capital and expertise to sustain a vibrant commercial energy storage industry, and leveraging seed resources of approximately $25 million to create a sustainable organization that provides value to its members. The Consortium builds upon and works with the already established cluster of energy storage and smart grid entities that include Department of Energy Frontier Research Centers, nearly twenty colleges and universities, Brookhaven National Laboratory, supercomputers at RPI and Stony Brook/Brookhaven National Lab, and a robust amount of energy storage companies.

New York State launched the NY Battery and Energy Storage Technology (NY-BEST) Consortium which aims to build a vibrant, world-class, advanced battery, and energy storage sector in New York State.

New York is also supporting high-impact research, development, partnership, and commercialization for energy storage and grid modernization through the Clean Energy Fund. As the State's main organization supporting clean energy research and development, including grid modernization and storage technologies, NYSERDA makes strategic investments in research, market analysis, product development, and technology field validation to help advance REV. One of the primary vehicles for this investment is the Clean Energy Fund (CEF), which is a $5-billion funding commitment from 2016 to 2025 that supports a variety of clean energy market-enabling initiatives. While these CEF activities are far reaching, there is a focus on developing market interventions that will complement utility programs. Grid modernization and storage technologies benefit from CEF investments used to conduct early-stage market analysis associated with new technologies, advance clean energy innovation towards market-readiness, and stimulate an innovation economy in the State. The Grid Modernization program at NYSERDA works collaboratively with utilities and solution providers and makes investments in research in the areas of enhanced grid visualization (e.g., advanced sensing, communications, diagnostics, and controls), planning processes, and advanced materials that accelerate the adoption of an advanced, digitally enhanced and dynamically managed "high-performing" electric grid.

COMPANY PROFILE: NOHMS TECHNOLOGIES

Rich Delmerico was already a veteran of the energy industry when he came to NOHMs Technologies after having successfully brought innovation to market at Kodak for decades. He saw an opportunity to leverage his experience in the exciting and growing cleantech industry with an innovative energy storage start-up carrying out research at Cornell University. He served as acting CEO for the first half of his five years with NOHMS where he drove technology development, oversaw operations, and enabled significant strategic partnering in Silicon Valley. He currently acts as the Business and Technical Advisor to NOHMs in addition to supporting NYSERDA as an Innovation Advisor, Launch NY as an Entrepreneur in Residence, and RIT in the Entrepreneurial School as an Adjunct Professor. NOHMs currently has 14 employees, most located at the Research and Development facility in Rochester, NY at the Eastman Business Park Industrial Complex.

The company focuses on Novel Electrolytes (NanoLyte™) related to improved safety and high-performance energy storage for the lithium battery industry. The go-to-market drive for NOHMs is geared toward Electric Vehicles (EVs), Plug-in Hybrid Electric Vehicles (PHEVs), and some niche military applications. NOHMs currently has joint development agreements with both private and public entities that range from chemical companies to the United States Military. He credits his company's early technological development to non-dilutive federal and State grants with NYSERDA, DOE, NSF, NASA, DARPA and the Air Force. Mr. Delmerico stated that NYSERDA was instrumental in assisting NOHMs with not only critical early stage funding, but also leveraging the resources available in New York State's clean energy ecosystem.

Mr. Delmerico wholeheartedly believes that the success of a company hinges on its ability to hire quality employees, and this is especially true for small companies like his own. NOHMs leverages industry hiring portals and has been very selective in targeted hiring. "With a small, growing team, we must do excellent diligence as everyone has such an important role to play as we drive to the market," he says. Mr. Delmerico describes the current team at NOHMs as highly technical with excellent operational, business, and financial acumen.

With reference to further helping small business in New York State, he thinks that the State and NYSERDA are complementary in mapping New York's clean energy ecosystem and properly investing funds across the State. He further stated that NYSERDA has been instrumental in supporting innovative clean energy solutions that drive the REV Goals for the State. Mr. Delmerico listed possible areas of improvement to benefit company growth and the energy storage industry as a whole as being "a more robust leveraging of all the excellent assets available in the State and an elevated focus on the business development that is required to create sustainable business."

Mr. Delmerico believes the future is bright for his company with its technology being fully integrated into the supply chain and licensed for applications in the large EV and PHEV markets, along with some niche applications, including military. In the future, he hopes to continue to help NOHMs drive the market and mentor other startups in the State.

RENEWABLE FUELS

The renewable fuels sector is the only sector that experienced a decrease in total employment between the last quarters of 2015 and 2016. At only 2% of the State's clean energy economy, the renewable fuels sector employs almost 3,000 workers to date. Employment dropped by 6%, partially due to the employment reduction for logging and support activities in forestry over the same time period, but employees expect to see their workforce rebound by 4% by the end of the year (Figure 38). Just under two-thirds of the workforce is concentrated in woody biomass fuels, with the remainder supporting other ethanol and non-woody biomass (Figure 39).

Fewer renewable fuels firms indicated hiring activity over the period between the last quarters of 2015 and 2016, most likely due to the overall decrease in employment. Of those that were actively hiring, however, 44% indicated difficulty finding qualified applicants.

Figure 38. Renewable Fuels Employment Growth, Q4 2015 – Q4 2017 Projected

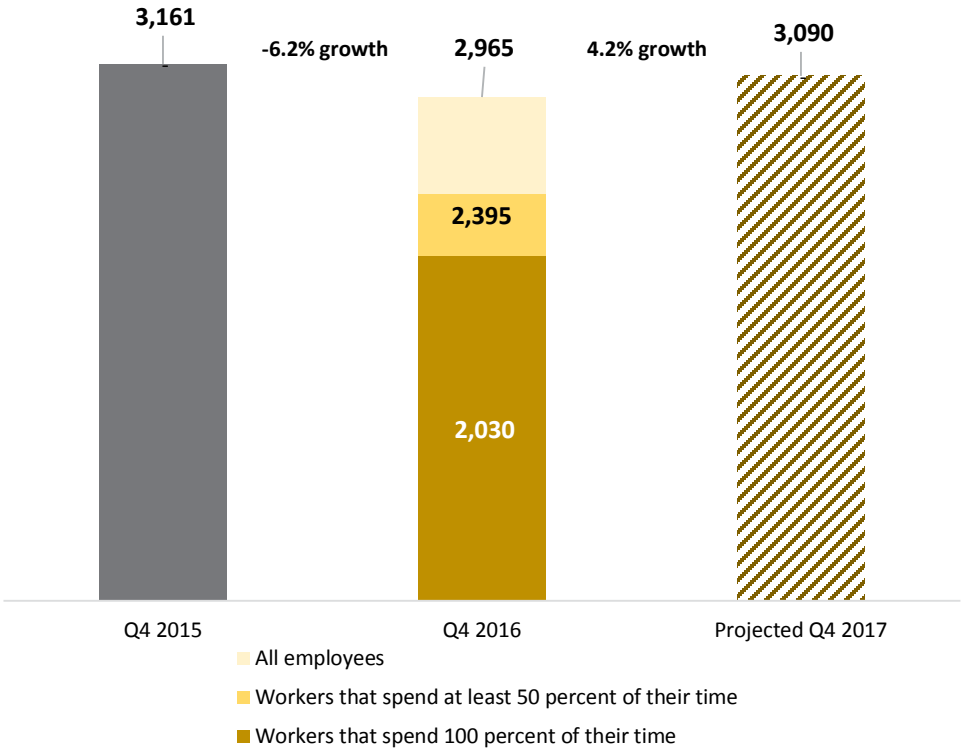
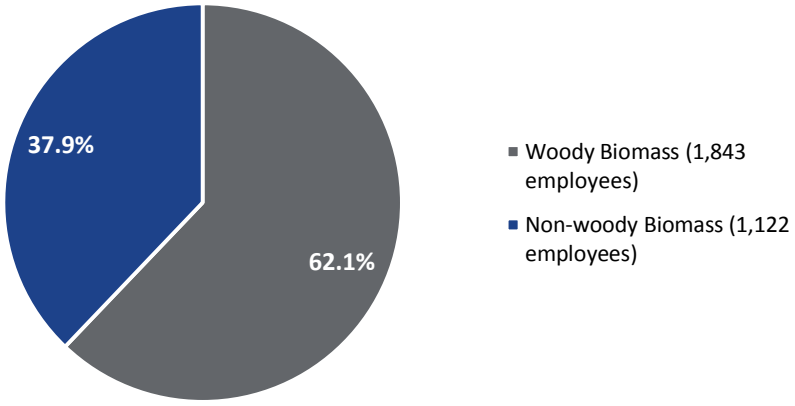


Figure 39. Renewable Fuels Employment by Sub-technology, Q4 2016[65]



[65] *Non-woody biomass includes biodiesel fuels made from other materials such as straw, manure, vegetable oil, animal fats, etc.*

Renewable Fuels Markets and Innovation

Business activity in the renewable fuels sector is mostly dependent on already commercially-available fuel technologies. As a result, the renewable fuels customer market is largely based in-State with relatively little innovation or early-stage innovation funding activity.

Almost half the firms report they work primarily with already widely commercially available products; about 24% work with products that are under development and 29% work with both. In fact, 42% of firms indicate that their primary product is in the shipping stage (Figure 41). This is not surprising given the significantly low early-stage innovation funding activity in the sector within the last three years. In fact, between 2010 and 2016, renewable fuel technologies received a total of just $27 million in early-stage investment dollars, even though just over a quarter of renewable fuels firms reported seeking equity or grant funding between Q4 2015 and Q4 2016 (Figure 42). The majority of these firms report their primary customers are located in New York, and there is no international activity in this sector (Figure 40).

Figure 40. Renewable Fuels Customer and Vendor Location

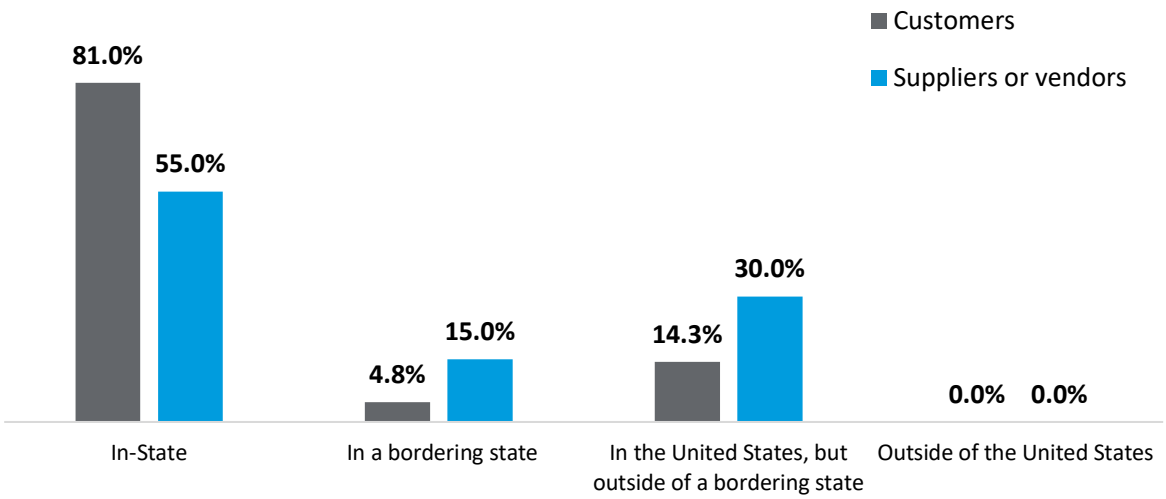


Figure 41. Primary Product Stage: Renewable Fuels

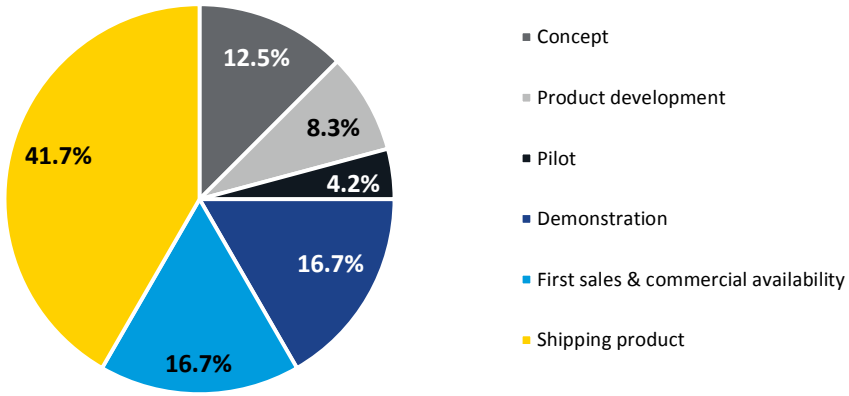
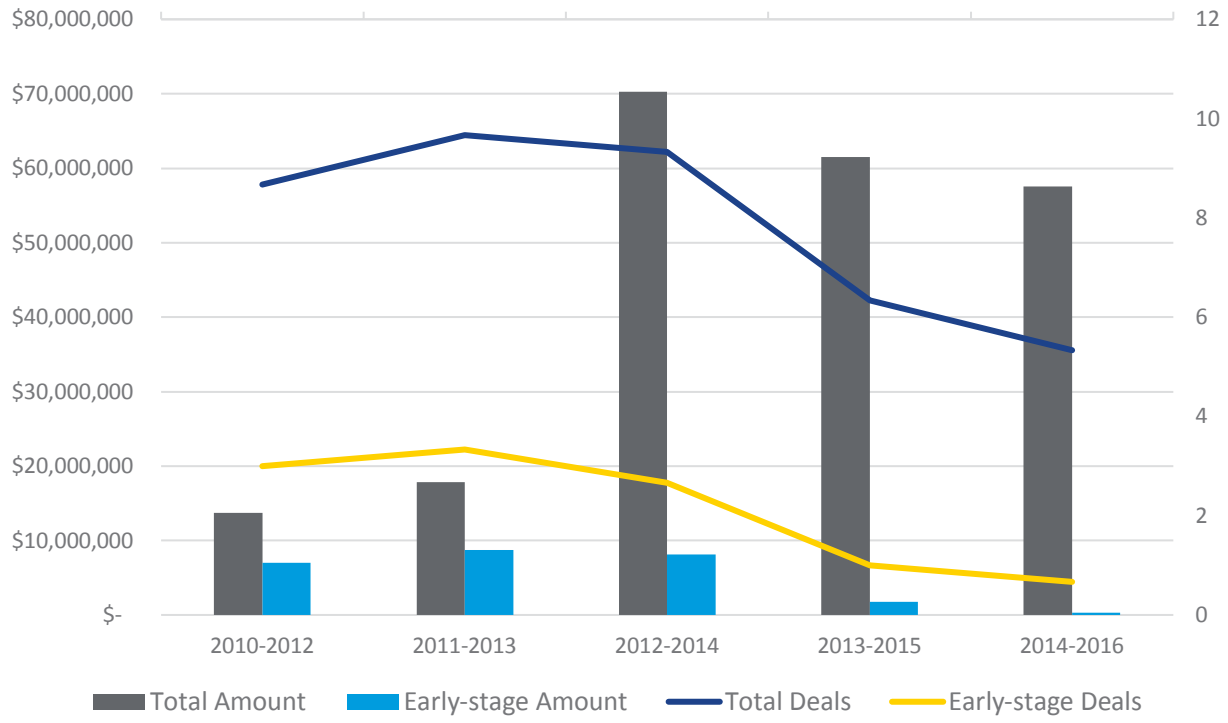


Figure 42. Renewable Fuels Overall and Early-stage Innovation Funding in New York, 2010-2016 Three-Year Rolling Averages[66]



[66] *Clean energy innovation funding data was extracted on February 23, 2017 from the i3 Cleantech Group's clean energy innovation database. Public grant data from the i3 database was supplemented with the NYSERDA awards database.*

42% of firms indicate that their primary product is in the shipping stage.

COMPANY PROFILE: **CURRAN RENEWABLE ENERGY**

Kelli Curran has worked at Curran Renewable Energy since 2009, after branching the company from its now sister company, Seaway Timber Harvesting. The split occurred when Seaway Timber Harvesting saw a need to expand into additional wood-based markets beyond paper and board, due in part to paper mills moving away from the area. Thus, Curran Renewable Energy was born to create an energy market in New York State based on low-grade timber.

Curran Renewable Energy serves a local New York State market with wood pellets for residential energy generation while employing 95 workers. After eight years of providing renewable energy services, Curran Renewable Energy now boasts impressive expansion and internal growth. The company is vertically integrated with a direct feedstock source from their sister company. Curran deals with a number of customers and suppliers both in- and out-of-state. In-State suppliers include Caterpillar, Western Star, and Kenworth, while out-of-state suppliers consist of Andritz and Trinity Packaging. Curran provides its renewable energy services mainly in the Northeast with some customers in Ontario and Quebec.

Ms. Curran notes there is a need for improved policy for low-grade timber companies and other alternative fuel companies in the State. She provided an example of a possible route to this end by growing the wood pellet industry from the bottom up, stating “there could be a strategic Wood Pellet Reserve just like the oil reserve. When there are slower seasons, producers can contribute to the reserve to help manage the ebbs and flows of weather and oil prices.”

Ms. Curran realizes how important it is to project the near future of growing companies to ensure that they are prepared for change. Curran Renewable Energy signed a solar option project with NextEra Energy to build solar installments on company-owned land in Massena, Brasher, and part of Norfolk, New York. The plan foreshadows a 100-megawatt solar farm, which could bring “stability to both companies and ensure solidification of the current base of employees.” Market and seasonal shifts have impacted the wood pellet market recently, but Curran is optimistic about the future of demand for Curran’s alternative fuel products.

ALTERNATIVE TRANSPORTATION

Alternative transportation technologies are a growing source of employment in New York's clean energy industry.[67] The sector grew by about 2% in 2015, now supporting a little more than 8,400 workers. Employers project to see their workforce grow by 6% by the end of 2017 (Figure 43). More than one-third of the workforce supports hybrid electric vehicles, followed by natural gas vehicles at approximately a quarter of employees. Electric, plug-in hybrid, and hydrogen or fuel cell vehicles comprise the remainder of the workforce (Figure 44).

Figure 43. Alternative Transportation Employment Growth, Q4 2015 – Q4 2017 Projected

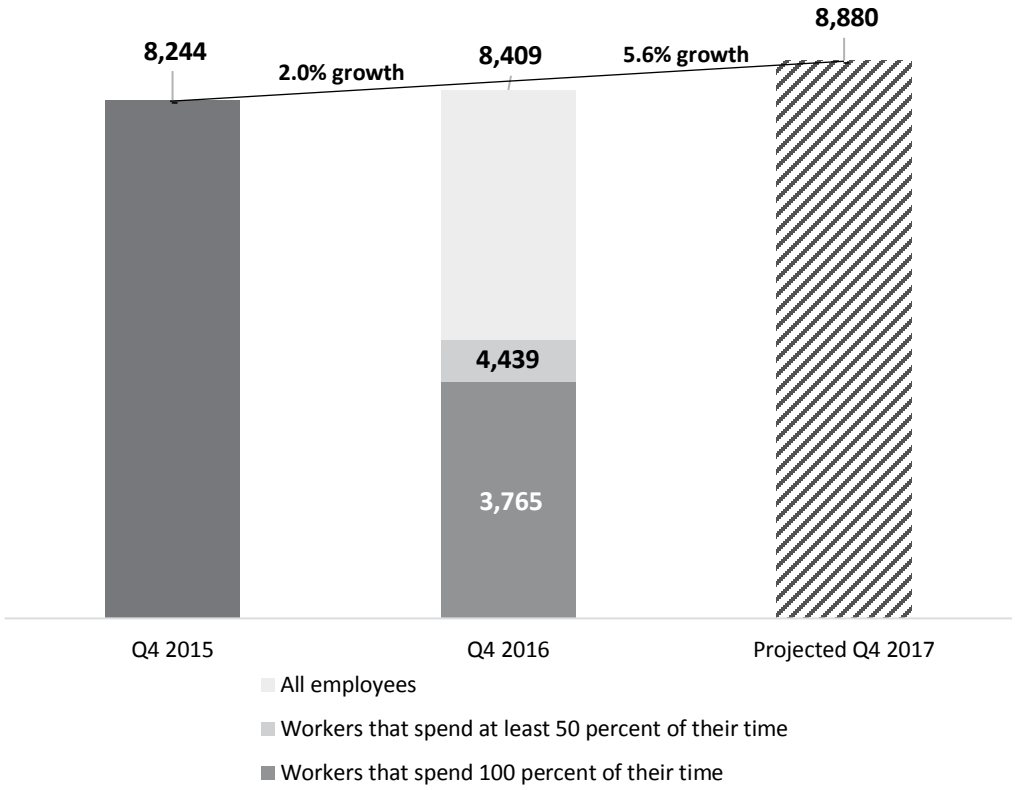
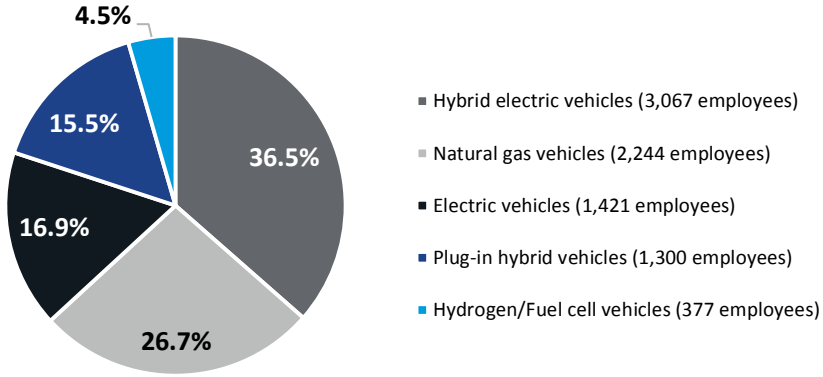


Figure 44. Alternative Transportation Employment by Sub-technology, 2016



[67] *Alternative transportation workers are concentrated in automotive repair and maintenance, motor vehicle body and trailer manufacturing, parts manufacturing, parts and supplies merchant wholesalers, with employment across professional services, such as legal, consulting, engineering, and research and development.*

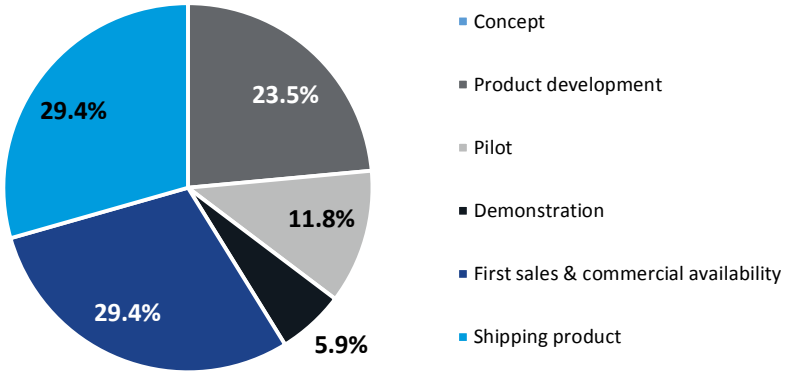
Alternative Transportation Markets and Innovation

New York State's alternative transportation sector has a small innovation sphere, with most activity focused on market development. Nearly half of the alternative transportation firms reported seeking funding. The sector's customer base is largely outside of the State, but given little activity in research and development, employment may more likely be driven by trade and distribution of component parts.

Only 24% of firms work primarily with products under development, 53% work with products both commercially available and in development, and 24% work mostly with products already commercially available. In fact, 59% of firms report their primary product is either in the first sales and commercial availability or shipping product stage (Figure 45).

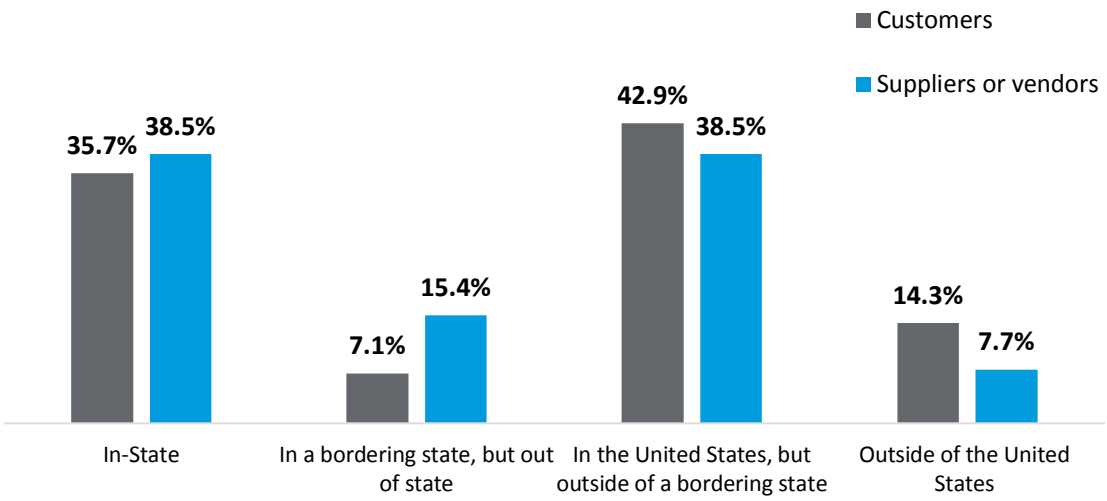
Alternative Transportation requires significant infrastructure upgrades to expand markets—if renewable fuel or electric charging stations are unavailable, the market for alternative vehicles suffers. As a result, funding has largely been focused on capital infrastructure, with the sector attracting $33.8 million in total innovation funding; but the only reported early-stage deal was granted in 2013 for $30,000. Approximately half of alternative transportation firms surveyed sought equity or grant funding between Q4 2015 and Q4 2016. Though it does not seem high priority for the sector, as 57% of firms that did not seek funding mentioned there was no need for capital in those 12 months.

Figure 45. Primary Product Stage: Alternative Transportation



The majority of alternative transportation firms in New York are export focused. About 64% of firms report their customer base and products source are primarily from outside the State (Figure 46).

Figure 46. Alternative Transportation Customer and Vendor Location



59% of firms report their primary product is either in the first sales and commercial availability or shipping product stage.

COMPANY PROFILE: **AMERICAN FUEL CELL**

General Motors left New York, he seized the opportunity to start a fuel cell component company that would take advantage of the thin film coating capabilities at the Kodak facilities. American Fuel Cell and Kodak were able to create a mutually beneficial relationship for New York State's clean energy economy in the assembly of membrane electrodes for fuel cells, and continue to nurture that relationship.

Mr. O'Connell and his company are actively involved in sourcing talent from the academic institutions in the State that include several accredited research universities. He identified Rochester Institute of Technology, University of Rochester, Cornell, and Alfred University as providing a quality, in-state talent pool. American Fuel Cell actually just hired a recent graduate from Alfred University, displaying the company's sincere belief in providing jobs to students attending New York's academic institutions. The State's academic institutions also act as important sites for testing technologies that come out of small clean energy companies like American Fuel Cell and its innovative fuel cell components.

American Fuel Cell receives most of its component material from outside of the State merely due to supply issues, while maintaining the in-state purchasing of tooling, processing, and dye materials. Once these materials are purchased and utilized in the manufacturing of American Fuel Cell's technology, it is interesting to see where the customer base lies. Mr. O'Connell notes that his customer base has shifted to locations outside of the United States. Currently, the largest purchasing customers of American Fuel Cell's fuel cell components are located in Europe and China.

Mr. O'Connell outlined a path to alter this trend and bring jobs back to both the State and U.S. He stated that in his opinion, "funds are focused too much on research and development at universities when there needs to be an academic paradigm shift that places more value on applied research. This applied research can then produce a product that can be made and sold in the United States." Mr. O'Connell thinks that it is imperative for manufacturing to come back to New York to ensure further economic development of the clean energy sector for the State.

Looking forward, Mr. O'Connell believes that the fuel cell powered fork lift market will continue to be a blossoming opportunity for American Fuel Cell. With New York's massive import and export market, fork lifts powered by energy-efficient fuel cells are going to be an ever-growing opportunity. American Fuel Cell stands behind its energy storage product and believe that fuel cells are simply better than traditional batteries for multiple applications.

Mr. O'Connell's recommendations included an increased focus on hydrogen innovation and more efficiently utilizing the breadth of energy resources in the State of New York, specifically Niagara Falls. He believes that with this innovation and the continued efforts of companies like American Fuel Cell, New York can be a worldwide leader in fuel cell technology. Mr. O'Connell vows that he will strive to develop his company and the entire fuel cell industry, and in his committed words, "I am here for the duration!"

NEW YORK STATE'S CLEAN ENERGY INNOVATION ECONOMY

The innovation economy is another way of measuring creativity—how firms are either creating or capturing new value as the industry matures. Innovation frequently involves early-stage companies or product development that attracts capital investment, resulting in further job growth and typically measured over a long-term perspective, from concept to development and ultimately commercial maturity. It is especially important to understand innovation within a diverse and growing industry. As long-time commercial technologies reach market saturation, the ability to supply the new technologies will determine the degree to which New York State remains competitive in the clean energy economy.

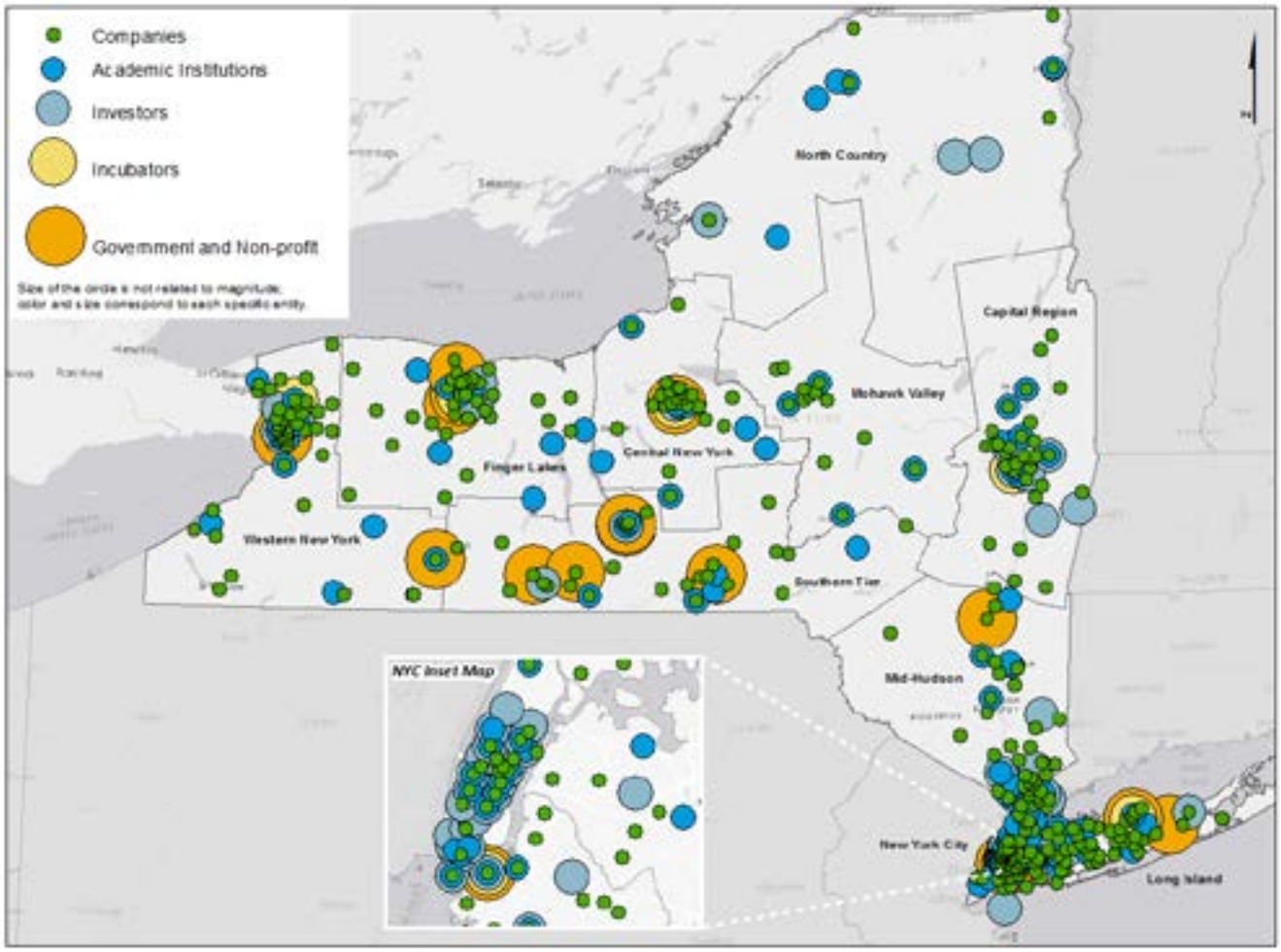
Longitudinal innovation funding data is used as a proxy to understand an industry's innovation sector. This data used in tandem with more qualitative survey data can highlight gaps—where public or private capital is not meeting an innovation firm's needs—and how public entities can better support regional research and development initiatives.

A state will commonly develop regional clusters of innovation activity where capital and knowledge resources become concentrated, creating centers of output for patent activity and academic literature.

It is important to note that a state will commonly develop regional clusters of innovation activity where capital and knowledge resources become concentrated, creating centers of output for patent activity and academic literature. In New York, these innovation clusters are mostly located around academic institutions in Buffalo, Rochester, Ithaca, Syracuse, Albany, and New York City, but also appear in areas like the Southern Tier where certain specialized capabilities such as energy storage component manufacturing, solar, and R&D and prototype development for energy efficiency organizations have become relevant in the clean energy sector.[68] Companies engaged in clean energy innovation are scattered across the State and benefit from many other statewide assets such as investors, incubators, government organizations, and nonprofits (Figure 47).

[68] *https://www.nyserda.ny.gov/-/media/Files/Publications/Energy-Analysis/Inventory-Supply-Side-Organizations-Clean-Energy-Economy.pdf.*

Figure 47. New York Clean Energy Asset Map[69]



Innovation funding over the last decade is beginning to stabilize to pre-ARRA levels.[70] Following particularly large innovation investments between 2010 and 2013, the New York clean energy industry saw overall innovation funding decline from 2013 through 2016 (Figure 48).

[69] *Investor data is from the i3 Cleantech Group's clean energy innovation database. Incubator data is taken from the New York State government (https://www.nyserda.ny.gov/incubators). Academic institutions were compiled from university lists provided by NYSERDA; these exclude universities that are definitely not engaged in clean energy-related research (i.e., schools for pharmacy, music, nursing, etc.). Companies, government, and nonprofit institutions were taken from NYSERDA's Supply-side Inventory.*

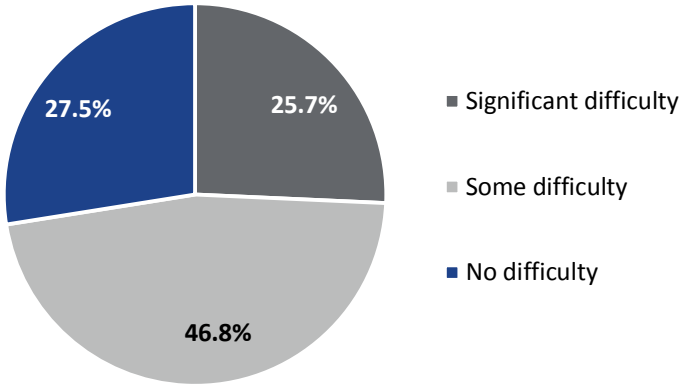
[70] *Yearly innovation funding data and trends are discussed in each individual technology chapter of the report. All innovation funding data charts will depict three-year rolling averages due to the year-over-year volatility clean energy funding; this analysis better highlights longitudinal investment trends by type and source.*

Figure 48. Total Innovation Funding in New York, 2006-2016 Three-Year Rolling Averages[71]

Year	Amount	Deals
2006-2008	$126,178,255	18
2007-2009	$240,173,719	24
2008-2010	$212,120,953	27
2010-2012	$573,791,660	50
2011-2013	$623,933,192	65
2012-2014	$455,898,519	68
2013-2015	$226,326,290	49
2014-2016	$185,681,802	33

Given the decline in total clean energy innovation funding through recent years, it is unsurprising that almost three-quarters of firms reported difficulty obtaining capital in the last 12 months, and 26% note that securing capital was very difficult (Figure 49). In particular, early-stage firms note that they have had difficulty attracting capital over the last year; employers report these difficulties could be eased by lowering the cost of business and better connecting firms to investors.

Figure 49. Firms Reporting Difficulty Obtaining Funding



The growth trend between 2010 and 2013, followed by subsequent national declines through 2016 is evidenced across both early-stage and private dollars[72] (Figures 50 through 52). Public innovation funding has remained fairly steady since 2006, averaging about $40 million through the last six years. In 2016, however, clean energy grant funding declined to the lowest level since 2006 (Figure 15). Across the nation, clean energy innovation funding has declined, a trend that is seen at the national, state, and regional levels. National cleantech innovation funding is also highly concentrated, with more than half allocated to companies from only four metro areas in the U.S. (three are in California).[73]

[71] Clean energy innovation funding data was extracted on February 23, 2017 from the i3 Cleantech Group's clean energy innovation database. Public grant data from the i3 database was supplemented with the NYSERDA awards database.
[72] See generally: i3 Cleantech Group and PricewaterhouseCoopers (PwC) clean energy investment data trends.
[73] https://www.brookings.edu/research/cleantech-venture-capital-continued-declines-and-narrow-geography-limit-prospects/

These national data illustrate that investments in clean energy technologies have shifted to late-stage deals in a narrow set of technologies. New York has expanded its leadership in clean energy innovation funding despite national and global challenges and in an increasingly difficult environment. Because these types of investments are critical to fostering innovation and creating good-paying jobs, it is crucial that New York continues to fill the market gap of support for early-stage deals in novel and less-typically funded technologies.[74]

Executive interviews with early-stage clean energy firms indicate general satisfaction with the State's business climate. Employers report they initially located their businesses in New York State due to the availability of clean energy facilities and other complementary advantages, including intellectual, academic, and technical resources. The biggest reported hurdles to growth were similar to those from other industries and other states (taxes, regulations), and notably absent were concerns about policy inconsistency or lack of markets, often seen in other industries.[75]

Figure 50. Total Early-stage Clean Energy Innovation Funding in New York, 2006-2016 Three-Year Rolling Averages[76]

Year	Amount	Deals
2006-2008	$15,895,824	6
2007-2009	$28,608,333	8
2008-2010	$26,610,000	8
2010-2012	$51,608,045	14
2011-2013	$50,813,299	18
2012-2014	$28,072,275	18
2013-2015	$26,578,059	15
2014-2016	$31,517,991	13

Figure 51. Total Private Clean Energy Innovation Funding in New York, 2006-2016 Three-Year Rolling Averages[77]

Year	Amount	Deals
2006-2008	$90,769,148	10
2007-2009	$195,159,667	13
2008-2010	$159,608,000	14
2010-2012	$529,668,879	23
2011-2013	$580,576,714	30
2012-2014	$409,954,857	32
2013-2015	$182,293,973	29
2014-2016	$155,789,241	26

Figure 52. Total Public Clean Energy Innovation Funding in New York, 2006–2016 Three-Year Rolling Averages[78]

Year	Amount	Deals
2006-2008	$35,409,108	8
2007-2009	$45,014,052	12
2008-2010	$52,512,953	13
2010-2012	$44,122,781	27
2011-2013	$43,356,478	52
2012-2014	$45,943,662	37
2013-2015	$44,032,317	19
2014-2016	$29,892,561	3

[74] *See generally: Id.*
[75] *BW Research Energy Employment Index Data; 2015-2016.*
[76] *Clean energy innovation funding data was extracted on February 23, 2017 from the i3 Cleantech Group's clean energy innovation database. Public grant data from the i3 database was supplemented with the NYSERDA awards database.*
[77] *Id.*
[78] *Id.*

CONCLUSIONS

New York's clean energy economy is strong, with nearly 146,000 workers across the State, more than half of which are considered "full-time" clean energy employees. Sustained policy support and market demand have left employers feeling optimistic, as they project their clean energy workforce to **grow by another 7% by the end of 2017**.

Sectors with the strongest commercial activity include Renewable Electric Generation and Energy Efficiency, but the future of the State's clean energy industry lies in fostering research, innovation, and new technology product development. Both the alternative transportation and grid modernization and storage sectors present significant opportunity for the State to leverage its academic research institutions, investors, and early-stage companies to remain competitive in global markets.

While clean energy goods and services promise a future of both employment growth and overall economic well-being, the State faces barriers to growth on the horizon. Insufficient access to capital, especially for innovation-focused sectors, as well as the limited supply of qualified labor present challenges for firms seeking to enter the clean energy market or expand the clean energy portion of their business. Employers who spend more time and resources engaged in securing funding or finding qualified applicants have less time to dedicate to developing and growing their business through commercial installation or product development. Future studies will continue to track growth across each component of the clean energy economy, but in the meantime, encouraging both public and private investment dollars as well as continued policy support will ensure the State's clean energy economy continues on this growth trajectory.

METHODOLOGY

This report chronicles the core elements of the New York clean energy industry and its key levers through the analysis of public data, such as federal and State labor market data and Census Bureau data; proprietary data sources such as business listings from Dun & Bradstreet and InfoUSA; and, investment information from Cleantech Group's i3 platform. It also uses cutting-edge, rigorously developed and tested primary data collection techniques that provide novel insights into New York's clean energy cluster.

The lack of a commonly accepted definition for clean energy and the consequent lack of reliable data sources poses a significant challenge in assessing and reporting on the status of this growing industry. Clean Energy, while defined by NYSERDA, does not have a consistent definition across states and nations or a comprehensive set of NAICS codes. As a result, existing data frameworks, which rely on standard industry and occupational codes, do not provide meaningful insight into clean energy trends on their own. Primary data, collected directly from employers, serves as a necessary substitute to ensure the accurate development of clean energy-specific metrics, including employment and establishment totals.

The research methodology employed for this report, including the survey instrument and sampling plan, has been rigorously reviewed and accepted by the Department of Energy and Bureau of Labor Statistics. It has been used by the U.S. Government in its annual Energy and Employment Report as a tool for measuring clean energy industry jobs and businesses across multiple states, including California, Massachusetts, Florida, Illinois, Iowa, Missouri, Ohio, Pennsylvania, Rhode Island, Tennessee, and Vermont.

DATA SOURCES

Jobs and Businesses Data

Jobs and business data is collected from federal and State data sources and employer surveys; survey data references the 12 months between Q4 2015 and Q4 2016. The federal sources used include the Bureau of Labor Statistics' Quarterly Census of Employment and Wages, Current Employment Statistics, and Occupational Employment Statistics, all available publicly at http://bls.gov.

Solar employment in this report will not match numbers reported in The Solar Foundation's Solar Census (http://www.thesolarfoundation.org/national/) unless directly referencing the Census. Solar employment totals in this report should not be equated to full-time equivalents, but instead taken as a total quantification of the State's solar energy employment. To better understand labor intensity, survey data provides both a 50% and 100% employment threshold for workers that spend at least half of their time and those that spend all of their time supporting solar energy portion of business. Where The Solar Foundation uses the 50% threshold for their employment totals, NYSERDA includes reported total solar employment; as a result, NYSERDA solar employment totals will be higher.

Innovation Funding Data

This report uses Cleantech Group's i3 Platform for all investment data. The public grant data from the i3 database was supplemented with the NYSERDA awards database. The Cleantech Group's i3 data platform was selected for the analysis because every investment included in the database is independently cited and can be verified, unlike many reports that do not disaggregate the data. The Platform is a comprehensive catalogue of innovative clean energy companies worldwide; datasets can be filtered by technology, investment type, geography, and time frame. The time frame for the latest investment data is January through December 2016.

Cleantech Group's Investment Capital data include only "new energy" investments, which is in stark contrast to other widely circulated studies on clean energy investment trends. Most of those reports, including the Bloomberg New Energy Finance Reports, are heavily influenced by asset finance deals. Unfortunately, asset finance is not further delineated between new project financing and existing entity debt restructuring or other business lines of credit not focused on new energy.

There is sound justification for separating project finance from a broader category of asset finance. The first is in the nature of the investment. Whereas asset financing is commonly a debt-only transaction involving one or more banks, project finance typically involves both debt and equity, with project sponsors pledging 10-40% equity and banks or other lenders covering the remainder.[79] The former is more typically driven by rates and often represents refinancing of debt, while the latter more typically involves capital used for expansion. In clean energy markets, project finance typically is used for new energy production rather than for restructuring previous energy projects.

The i3 data include a wide range of investment types as well as technologies that are outside of the scope of this report. As a result, Cleantech Group's publicly reported data will differ from the results included in this report. For the purposes of this study, the following filters were applied:

> **Investment Type:** Early-stage (Seed, Series A, Series B), Structured Debt, Growth Equity, Project Finance, Grants, Loans, and Guarantees.
>
> **Technologies:** Energy Efficiency; Renewable Electricity Power Generation (e.g., Geothermal, Hydro and Marine Power, Solar, Wind, Biomass Generation); Grid Modernization and Storage (Energy Storage and Smart Grid); Renewable Fuels (Biofuels and Biochemicals); Alternative Transportation (e.g., Fuel Cells and Hydrogen, CNG, Hybrid Electric, Plug-in Hybrid, and Electric Vehicles).

The i3 data are supplemented in this report by transaction data provided by NYSERDA. The deals included in that dataset include organizations focused on clean energy innovation, as defined by NYSERDA.

DEPARTMENT OF ENERGY USEER SURVEY METHODOLOGY

The 2017 New York Clean Energy Jobs Report uses publicly available data on New York energy employment produced by the U.S. Department of Energy, available at: https://energy.gov/downloads/2017-us-energy-and-employment-report. These public data are refined and customized for New York based on a supplemental survey conducted on behalf of NYSERDA by BW Research Partnership, Inc.

SUPPLEMENTAL EMPLOYER SURVEY METHODOLOGY

Supplemental surveys were administered online and by telephone to a list of known employers as well as to a representative, clustered sample of professional services (information technology, legal services, accounting, tax preparation, bookkeeping, payroll services, architectural, engineering, design services, management, scientific, and technical consulting services, scientific research and development, advertising, public relations, etc.) companies from the NAICS system identified by the Bureau of Labor Statistics and BW Research Partnership as being potentially related to the Renewable Energy, Energy Efficiency and Alternative Transportation technologies.

The supplemental survey used a stratified sampling plan that is representative by industry code (NAICS or ANAICS), establishment size, and geography to determine the proportion of professional services establishments that work with specific clean energy-related technologies, as well as the proportion of workers in such establishments that work with the same.

The supplemental survey was administered by telephone and electronically—15,939 outbound calls to approximately 24,300 unique companies and 15,204 emails sent across New York State. The phone survey was conducted by Braun Research Inc. The web instrument was programmed internally by BW Research employees and each respondent was assigned a unique ID to prevent duplication.

In total, approximately 1,680 business establishments participated in the supplemental survey effort, with more than 660 providing full responses to the survey. The margin of error is +/- 2.36% at a 95% level of confidence. The survey was administered between February 14, 2017 and March 9, 2017 and averaged 12 minutes in length.

GLOSSARY OF TERMS

Activity: For the purposes of this report, an establishment's activity refers to the primary value-chain industry to which it most associates its work. Activities include installation, professional services, other support services, public or private utility, manufacturing, sales and distribution, and other.

Alternative Transportation: Alternative Transportation includes natural gas and non-fossil fuel related vehicles, electric vehicles. This includes;

- *Hybrid Electric Vehicles*—use two or more distinct types of power, such as internal combustion engine + electric motor.
- *Plug-In Hybrid Vehicles*—a hybrid electric vehicle that uses two or more distinct types of power, such as internal combustion engine and an electric motor that is powered by rechargeable batteries, or another energy storage device, that can be recharged by plugging it in to an external source of electric power.
- *Electric Vehicles*—a vehicle which uses one or more electric motors for propulsion with no onboard generator or non-electric motor.
- *Natural Gas Vehicles*—an alternative fuel vehicle that uses compressed natural gas (CNG) or liquefied natural gas (LNG) as a cleaner alternative to other fossil fuels.
- *Hydrogen Vehicles*—uses hydrogen as its onboard fuel for motive power.
- *Fuel Cell Vehicles*—a type of hybrid vehicle which uses a fuel cell, instead of an engine, in combination with a storage device, such as a battery, to power its on-board electric motor.

Clean Energy Industry: The aggregate of establishments that are directly involved with researching, developing, producing, manufacturing, distributing or implementing components, goods or services related to Renewable Electric Power Generation, Energy Efficiency, Grid Modernization and Storage, Renewable Fuels, and Alternative Transportation.

Clean Energy Establishment: For the purposes of this report, an establishment is any establishment that is involved with an activity related to the clean energy industry.

Clean Energy Worker: Full-time and part-time permanent employees who support the clean energy portion of the business, including administrative staff, excluding interns and other temporary workers.

Deal: Refers to the single number of investments closed.

Early-stage Investment: Investments including Seed, Series A, and Series B investments.

Energy Efficiency: Goods and services that reduce electricity demand. Energy Efficiency includes the following technologies:

- ***ENERGY STAR® Appliances***—appliances that meet the international Energy Star standard for energy efficient consumer products originated in the United States.
- ***LED, CFL and Other Efficient Lighting***—energy-efficient lighting sources.
- ***Traditional HVAC Goods, Control Systems, and Services***—heating, ventilation, and air conditioning systems (HVAC), including building retro-commissioning and retrofits connected to heating and cooling.
- ***ENERGY STAR/High AFUE HVAC***—HVAC that meets the international Energy Star standard for energy efficient consumer products originated in the United States or has high Average Fuel Utilization Efficiency (AFUE) rating of 90 or greater or 15 SEER or greater.
- ***Renewable Heating and Cooling (including Solar Thermal)***—refers to establishments that are involved with heating, ventilation and air conditioning (HVAC) from Renewable Energy sources or work that increases the Energy Efficiency of HVAC systems (solar thermal—uses the sun's energy to generate thermal energy).
- ***Advanced Building Materials/Insulation***—all materials that represent advances in efficiency over the traditional materials.
- ***Recycled Building Materials***
- ***Reduced Water Consumption Products and Appliances***—high-efficiency (HE) washing machines, faucet aerators, low flow shower heads, etc.

Grid Modernization and Storage: Modernization of electricity transmission and distribution system to maintain a reliable and secure electricity infrastructure that can meet future demand growth and the storage of electricity.

- ***Smart Grid***—an electricity supply network that uses digital communications technology to detect and react to local changes in usage.
- ***Storage***—using a cell or connected group of cells to convert chemical energy into electrical energy by reversible chemical reactions and that may be recharged by passing a current through it in the direction opposite to that of its discharge.

Pre-commercial: Work that has yet to reach market or products that are in the development phase.

Renewable Electric Power Generation: Any establishments that are involved in the manufacturing, sale, installation, or research and development of renewable electric power generation technologies.

- *Solar Photovoltaic Electric Generation*—generating electrical power by converting solar radiation into direct current electricity using semiconductors that exhibit the photovoltaic effect.
- *Wind Generation*—converting the wind's kinetic energy into electrical power.
- *Geothermal Generation*—using steam produced from reservoirs of hot water found a few miles or more below the Earth's surface to produce electricity.
- *Bioenergy Generation*—generating electricity from materials derived from biological sources or any organic material which has stored sunlight in the form of chemical energy.
- *Low-Impact Hydroelectric Generation*—similar to traditional, but certification criteria are aimed at ensuring that the certified dam adequately protects or mitigates its impacts in eight key resource areas: river flows, water quality, fish passage and protection, watersheds, threatened and endangered species, cultural resources, and public access and recreation opportunities. The eighth criterion requires that the dam not have been recommended for removal (LIHI – Low Impact Hydropower Institute).
- *Traditional Hydroelectric Generation*—electricity generated by hydropower; the production of electrical power through the use of the gravitational force of falling or flowing water.

Renewable Fuels: fuels produced from renewable resources.

- *Woody Biomass*—fuel developed from the by-product of management, restoration, and hazardous fuel reduction treatments, as well as the product of natural disasters, including trees and woody plants (limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment).
- *Non-Woody Biomass*—fuel made from other materials such as straw, manure, vegetable oil, animal fats, etc.

Retrocommissioning: Refers to the process of improving a building or structures operating process by increasing occupant comfort and saving energy usually through Energy Efficiency measures (weatherization, lighting, etc.).

Renewable Portfolio Standard (RPS): A regulation requiring the increased production of energy from renewable energy sources. Typically, states set an RPS quota in which utilities must obtain some percentage of their production capacity from renewable sources by a certain time.

Sub-technology: For the purposes of this report, sub-technology refers to the specific technologies with which an establishment works, within each technology area.

Technology: For the purposes of this report, technology refers to the primary application or end use of a establishment's produced goods or services. Technologies include Renewable Electric Power Generation, Energy Efficiency, Grid Modernization and Storage, Renewable Fuels, and Alternative Transportation.

CLEAN ENERGY INDUSTRY REPORT COMPARISONS

2011 Sizing the Clean Economy, Brookings Institute

Generally, the sizing of the Clean Economy report by the Brookings Institute is not comparable to the New York Clean Energy Industry Report. The definition used for clean jobs by Brookings is significantly broader than clean energy, including public transit, waste management, water and wastewater employment, and other environmentally important but not energy related employment. Overall employment in this report (185,038) of clean jobs is not comparable because so many additional non-energy sector jobs are included.

2016 Solar Census, The Solar Foundation (TSF)

Solar employment in this report will not match the numbers reported in The Solar Foundation's (TSF) Solar Census unless directly referencing the Census. Solar employment totals in this report should not be equated to full-time equivalents, but instead taken as a total quantification of the State's solar energy jobs. Where TSF uses the 50% threshold for their employment totals, NYSERDA includes total solar employment. As a result, NYSERDA solar employment totals will be higher compared to TSF reports.

2016 Clean Energy Industry Report, Massachusetts Clean Energy Center (MassCEC)

The 2017 NYSERDA report includes the new and improved methodology that captures more energy efficiency manufacturing. Upon release, the 2017 MassCEC report will be comparable to the 2017 NYSERDA report.

2016 New York Storage, Industrial Economics (IEc)

The employment number in the NYSERDA 2017 report is slightly lower compared to the overall storage employment data produced in 2016 in the Energy Storage Industry in New York report by Industrial Economics (IEc). This is due primarily to the IEc's inclusion of "traditional" markets such as forklifts, medical devices, lead-acid batteries, or military applications. The IEc report includes 650 grid storage jobs for emerging electricity storage markets, in addition to 724 battery transportation jobs. Together, these two subsectors account for 1,374 workers, which is close to this report's estimated 1,412 workers in grid modernization and storage. The remaining 2,560 workers from the IEc report are in traditional markets, which are not included in this NYSERDA report.

2017 U.S. Energy and Employment Report (USEER), Department of Energy

All employment data in the 2017 NYSERDA report is based on DOE USEER data; employment totals for NYSERDA were redistributed based on NYSERDA's clean energy technology definition. The 2017 NYSERDA report includes a supplemental survey that provided a deeper dive and more comprehensive employment estimate, particularly for professional services (architecture and engineering, research and development, information technology, etc.).

2016 National Energy Efficiency Report, Environmental Entrepreneurs (E2)

The 2017 NYSERDA report includes the new and improved methodology that captures more energy efficiency manufacturing. Furthermore, E2's report only counted employment at the 50% threshold—energy efficiency workers that spend most or all of their time on these technologies—while NYSERDA includes all energy efficiency workers that spend any amount of their time supporting the energy efficiency portion of business.

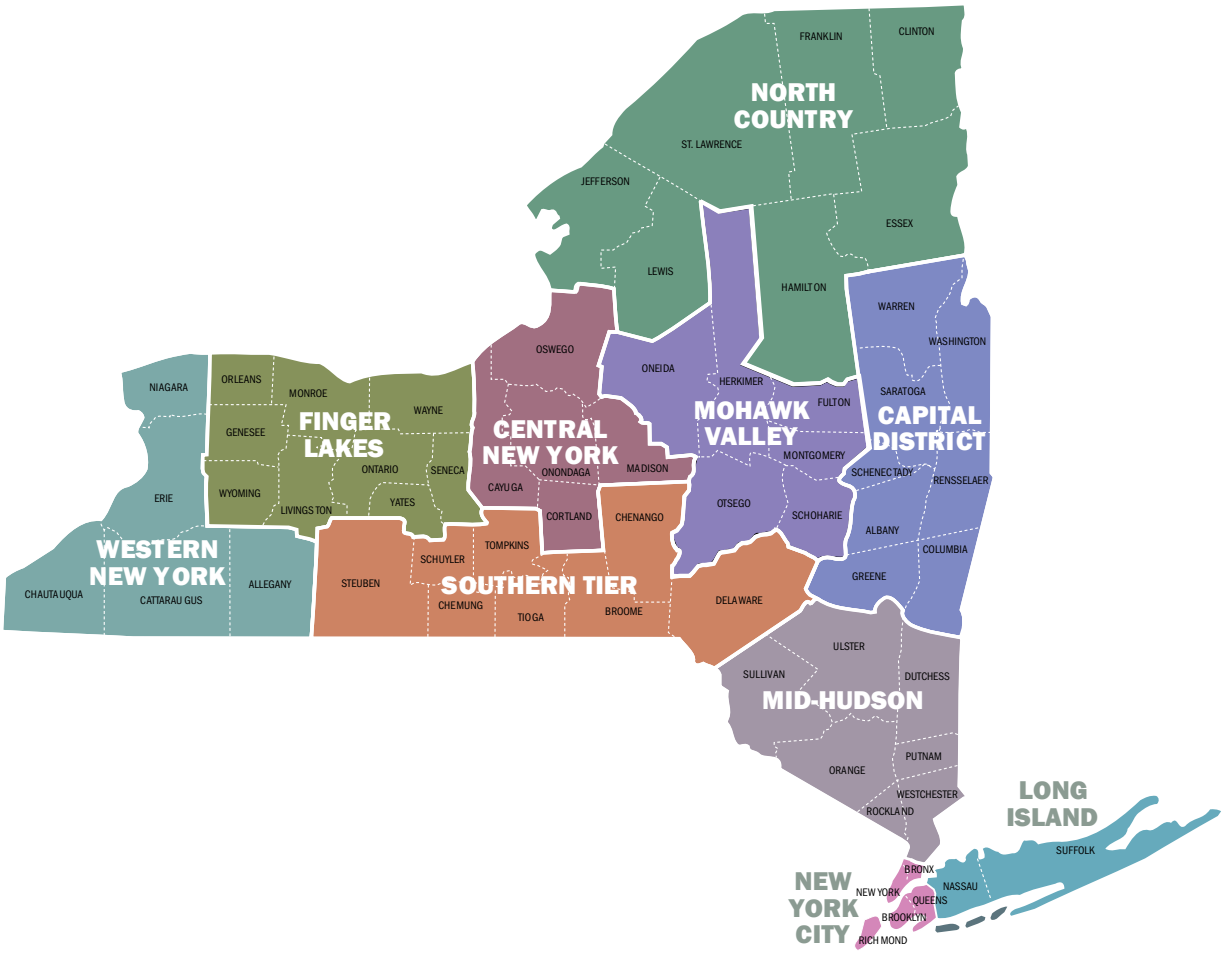
2016 California, Texas, and Florida Advanced Energy Industry Report, Advanced Energy Economy (AEE)

The 2017 NYSERDA report includes the new and improved methodology that captures more energy efficiency manufacturing. Furthermore, AEE has a different definition for clean energy technologies; advanced energy includes nuclear and advanced natural gas.

2016 New York Clean Energy Industry Report, E2

E2's 2016 New York Clean Energy Industry report was a survey-based report that found approximately 85,000 workers who spent at least some time working on clean energy technologies. The 2017 NYSERDA report is more comprehensive and current, with an expanded scope to include vehicle efficiency, software and other IT focused on energy, a deeper analysis of financial firms, and a broader scope of ENERGY STAR manufacturing, renewable energy, and alternative transportation.

APPENDIX
REGIONAL ECONOMIC DEVELOPMENT COUNCILS



Western New York: Allegany, Cattaraugus, Chautauqua, Erie, Niagara

Finger Lakes: Genesee, Livingston, Monroe, Ontario, Orleans, Seneca, Wayne, Wyoming, Yates

Southern Tier: Broome, Chemung, Chenango, Delaware, Schuyler, Steuben, Tioga, Tompkins

Central New York: Cayuga, Cortland, Madison, Onondaga, Oswego

Mohawk Valley: Fulton, Herkimer, Montgomery, Oneida, Otsego, Schoharie

North Country: Clinton, Essex, Franklin, Hamilton, Jefferson, Lewis, St. Lawrence

Capital Region: Albany, Columbia, Greene, Rensselaer, Saratoga, Schenectady, Warren, Washington

Mid-Hudson: Dutchess, Orange, Putnam, Rockland, Sullivan, Ulster, Westchester

New York City: Bronx, Kings, New York, Queens, Richmond

Long Island: Nassau, Suffolk

The future of the State's clean energy industry lies in fostering research, innovation, and new technology product development.

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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