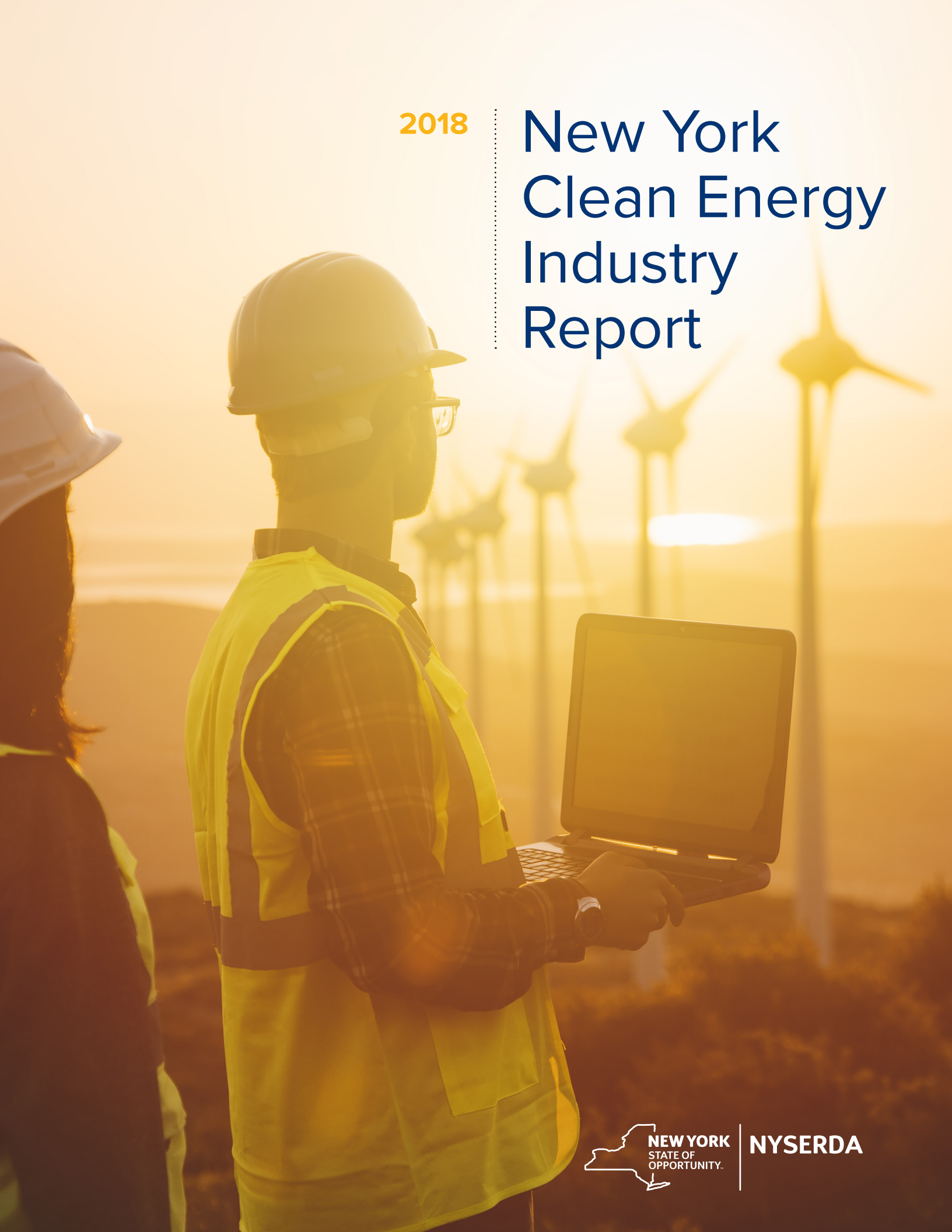
2018

New York Clean Energy Industry Report



NEW YORK STATE OF OPPORTUNITY.

NYSERDA

Letter from NYSERDA President and CEO

I am proud to unveil the results of the second annual New York Clean Energy Industry Report—a comprehensive assessment of patterns and trends in New York's fast-growing clean energy industry. New York has rapidly established itself as a national leader in advancing clean energy and taking on the fight against climate change—and the results are already paying off for New York workers. **New York now ranks third nationally both for energy efficiency employment and solar jobs**, and other sectors such as grid modernization and energy storage are growing at an incredible pace.

This year's report provides solid proof that New York's ambitious clean energy agenda—driven by Governor Andrew M. Cuomo's signature **Reforming the Energy Vision (REV)** strategy—is already bringing economic growth to our State. A core component of Governor Cuomo's REV strategy is the **Clean Energy Standard**, which mandates that 50% of New York State's consumed electricity will come from renewables such as solar, wind, and hydro by 2030. To support this significant effort, New York's 10-year, $5 billion **Clean Energy Fund** will deliver on the State's commitments to build a clean, resilient, and more affordable energy system for all New Yorkers. Together, these commitments have fueled New York's progress toward our nation-leading energy and climate goals and served as a catalyst for economic growth and job creation in clean energy industries across the State.

Key findings from this year's report include:

- **Over 151,000 New Yorkers** are working in the clean energy industry across the State.
- **A nearly 4% rate of employment growth** in 2017—double the statewide average.
- **Clean Energy Employers Are Bullish on New York's Clean Energy Economy**. They expect to hire over 8,000 new workers in 2018 alone.
- **Energy efficiency is the largest clean energy technology category** in terms of jobs and investments—employing 117,300 workers in 2017 with firms receiving over $4.1 billion in investments since 2011.
- **Renewable energy jobs** are also poised to see robust growth in the years ahead as New York moves toward the 50% renewable energy target and new industries like offshore wind take hold in New York.
- **Clean energy provides opportunities in all regions of the State**. New Yorkers are rapidly embracing clean energy options, which is fueling job growth in communities across the State.

To maintain this outstanding growth, NYSERDA is focused on ensuring that the industry's trajectory is not hampered by a shortage of skilled clean energy workers in the future. This report therefore also digs into the current trends and challenges faced by employers when hiring, and the findings will help inform and support NYSERDA's workforce training and development efforts.

Simply put, New York State is making clean energy jobs happen. We are proving that advancing policies to fight climate change and deploy clean energy do not come at a trade-off for economic growth—they are the fuel that is cranking a fast-growing economic engine. The results will be cleaner air, a more sustainable environment, and better jobs for New Yorkers.

Alicia Barton — President and CEO, NYSERDA

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The 2018 New York Clean Energy Industry Report was commissioned by NYSERDA to understand the size and composition of the State's clean energy economy. This multi-year, longitudinal research study analyzes data on clean energy jobs, employer needs, and existing assets to inform policies that will help New York meet its climate goals and create jobs and economic opportunity within its borders.

over

151,000+

clean energy jobs across New York at end of 2017

since 2015,

clean energy employment has grown by

10,501

that's 7.4%

5,686

jobs created as a result of clean energy growth in 2017

energy efficiency firms

largest component of New York's clean energy economy and among the fastest growing with over

117,300 employed in 2017

Executive Summary

New York's clean energy sector is an engine for growth in the statewide economy.

In 2017, New York saw 5,686 new clean energy jobs, an increase of 3.9% that brought the total number to over 151,000. This employment growth rate outpaced the statewide average of 1.6% during the same time frame. Strong employment growth has been a hallmark of the clean energy economy; clean energy employment has grown by 10,501 (7.4%) since the New York Clean Energy Industry Report (NYCEIR) began tracking clean energy jobs in 2015. This year's report also finds that an additional 3,758 indirect and induced jobs were created as a result of the direct clean energy job growth in 2017. These additional jobs are found across construction, legal services, trade, real estate, architecture and engineering, and other industry sectors.

Employing over 117,300 workers in 2017, **energy efficiency firms are the largest component of New York's clean energy economy** and among the fastest growing. The number of energy efficiency jobs increased by 6,757 (6.1%) in 2017. Fifty-seven percent of energy efficiency workers spend most of their time supporting high-efficiency HVAC technologies,[1] and another 30% of energy efficiency workers concentrate on ENERGY STAR® appliances and energy efficient lighting. The smallest technology category of the clean energy economy—grid modernization and energy storage—while employing a little over 1,500 workers grew a significant 12.6% in 2017. Renewable electric power generation employment shed some jobs, particularly in solar where 553 jobs were lost (4.5%).[2] This is consistent with a nationwide decline in residential solar installations due to several factors, including the fact that in 2016, developers had raced to capture a federal tax credit that was scheduled to expire. Alternative transportation employment also saw a slight decline of about 6% in 2017, again consistent with a nationwide trend. Renewable fuels see continued pressure on jobs, though remains relatively even across woody biomass and ethanol or non-woody biomass sources; these declines are tied to overall market trends and competition from low fossil fuel prices.

Overall, the New York clean energy economy is likely to **continue its expansion** as the State pursues its greenhouse gas emissions reduction goals and continues to **lead the charge** as a cofounding member of the U.S. Climate Alliance in upholding the 2015 Paris Agreement.

Clean energy employers are bullish on the New York clean energy economy.

Employers predict that robust job growth will continue, estimating that they will hire more than 8,000 new workers in 2018 alone. The majority of those predicted hires is in the energy efficiency technology category, with employers in all five technology categories expected to hire more workers in 2018.

Firms that participate in the clean energy sector are focusing more of their employees' time and effort on clean energy products and services.

New York's clean energy economy is not only growing in size, but in intensity as well. The proportion of clean energy workers who reported they spend all their time on clean energy-related projects has increased by 3%; those reporting that they spend most of their time increased by 4%. This means that out of the more than 151,000 clean energy workers, over 84,000 (55%) work exclusively with clean energy-related goods and services. This increased focus on clean energy work holds for majority-time workers in four of five technology categories. The number of clean energy workers who work full time in the renewable electric power generation and energy efficiency technology categories increased 3.8% and 3.3% respectively. The number remained largely constant in other technology categories.

over 84,000 work exclusively with clean energy-related goods and services

Clean energy provides opportunity in all regions of the State.

New Yorkers are embracing clean energy options, and that is providing a thriving clean energy economy throughout local communities across the State. From renewable energy installations in the North Country and the Capital Region, to energy efficiency projects in New York City and Long Island, and vibrant multi-sector job opportunities from Western New York to the Mid-Hudson, all regions in New York are seeing demonstrating strong work opportunities for job growth. This includes advanced clean energy technology clusters, like those that have emerged in the Southern Tier with the support of the State's 76West Clean Energy Competition. New York truly offers a thriving ecosystem for technology development and market growth.

New York's clean energy firms are exporting more clean energy goods and services to other states.

New York firms reported that in 2017, they sourced less from out-of-State vendors and suppliers and more from in-State; and their sales to out-of-State customers grew relative to sales to in-State vendors and suppliers. In short, New York firms are continuing to support in-state demand for clean energy technologies and services and are supporting demand to out-of-State customers to an increasing degree

most difficult positions to fill were those for technicians, sales and customer service, engineers and scientists, and installers

Hiring difficulty throughout the clean energy economy decreased between 2016 and 2017.

Seven in 10 employers reported having at least some hiring difficulties, a drop of 13% from the previous year but still a large proportion of the total. The most difficult positions to fill were those for technicians, sales and customer service, engineers/scientists, and installers. Hiring difficulties for these occupations could have significant impacts on the clean energy economy, as installation and other support services account for nearly 80% of the clean energy value chain. The leading reason given by employers for the hiring challenges they faced was a lack of experience or technical skills.

Clean energy innovation and entrepreneurship is strong in New York, but firms need support in the commercialization and growth stage of innovation.

This report divides the process of innovation and commercialization into three phases. Phase I "research" funding increased by 17% from $62 million to $74 million since 2011. This growth is echoed in the annual number of clean energy academic journal publications by New York-based researchers (a proxy for innovation and research), which has more than doubled since 2010. However, Phase II "demonstration and acceleration" activity remained steady since 2011, though saw a decline of 8% in the 2014–2017 period. Phase III "commercialization and growth" has also seen a decline since 2011. From 2011 through 2017 (measured using three-year rolling averages), investments in this phase declined from a high of $573 million to roughly $237 million (60%). It should be noted that these declines are substantially the result of a small number of very large investments in earlier years and further demonstrate the high investment risk associated with early commercialization activity; if these investments are removed from the analysis, later stage innovation investments exhibit a small increase over time.

New York firms are also building the system of the future. Demand for grid modernization and energy storage technologies is growing fast and expected to continue to grow.

Although it is the technology category with the fewest jobs and is only the third largest in terms of investment, the outlook for grid modernization and energy storage is very promising. It has seen steady employment growth since 2011 and was the fastest growing technology category in terms of employment in 2017, when it grew by 12.6%. Total investment in grid modernization and energy storage has increased 129% between the three-year rolling averages of 2011–2013 and 2015–2017.[3] Furthermore, in phases two and three, funding has grown 121% and 181% respectively during the same time period. Strong growth in the later-development stages indicates that this technology is expected to be adopted on a large scale. Private sector funding reflects this: it accounts for more than 76% of all grid modernization and energy storage funding. This technology category also accounted for nearly one-fifth of all clean energy journal publications—a meaningful indicator for future growth and development.

grid modernization and energy storage saw a 12.6% job growth in 2017


Option
Application
Option
Application

Industry Overview

clean energy jobs grew 3.9% last year

10,500 new clean energy workers over three years

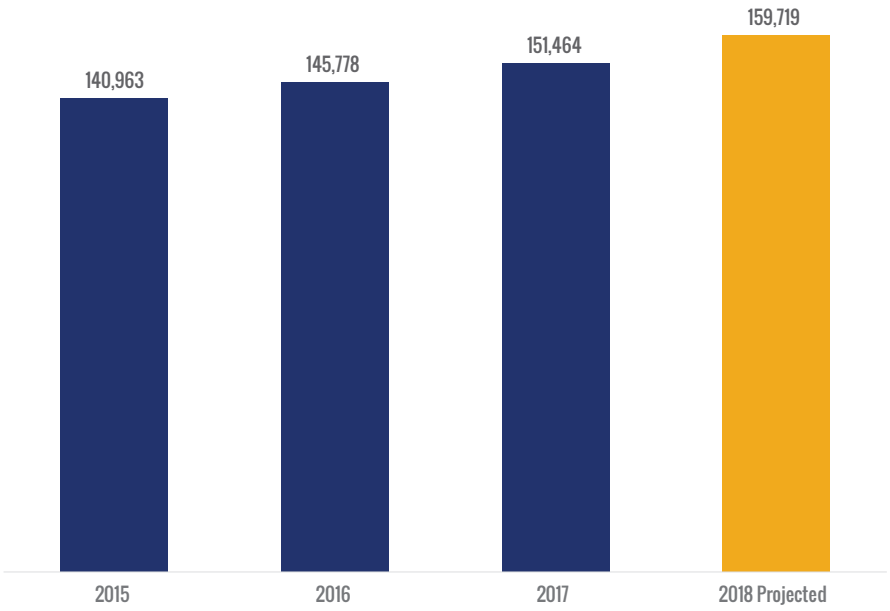
largest category of clean energy technology employers remains energy efficiency firms

Overall Employment

As of 2017, New York was home to over 151,000 clean energy workers—up from about 146,000 in 2016. This means the State saw 5,686 new clean energy jobs last year, a 3.9% rate of growth that was significantly higher than the overall statewide employment growth rate of 1.6%. In fact, clean energy employment overall has grown by 7.4% since the New York Clean Energy Industry Report (NYCEIR) began tracking clean energy jobs in 2015, which translates to 10,500 new clean energy workers over three years (Figure 1). As of mid-2017, the clean energy workforce accounts for almost 2% of total jobs in the State.[4]

The largest category of clean energy technology employers remains energy efficiency firms, with 117,339 jobs (78% of total clean energy jobs). The next largest is renewable electric power generation, with 22,000 jobs (roughly 15%). The remaining categories of clean energy technologies—alternative transportation, renewable fuels, and grid modernization and energy storage—account for 12,061 workers (8%) of New York's clean energy workforce (Figure 2).

Figure 1. Clean Energy Employment Growth, 2015-2017



Amid overall growth in 2017, some technology categories shed jobs: renewable fuels declined by roughly 375 workers (12.6%), followed by alternative transportation with a loss of 528 jobs (6%). These declines were consistent with nationwide trends. Growth and fluctuations in the renewable fuels technology categories are tied to the price of fossil fuels; as the price of oil declines, residents are less likely to invest in wood or pellet heating fuel sources and equipment.

Renewable electric power generation also lost jobs at a rate of just over 1%, mainly due to net losses at firms focused on solar power. These losses reduced but did not outweigh gains in overall job since 2015 in renewable electric power generation, energy efficiency, and grid modernization and energy storage (Table 1). For more information on each technology and related employment totals by sub-technology, please refer to the Jobs Across Clean Energy Technology Categories section.

Figure 2. Clean Energy Employment by Technology, 2015-2017

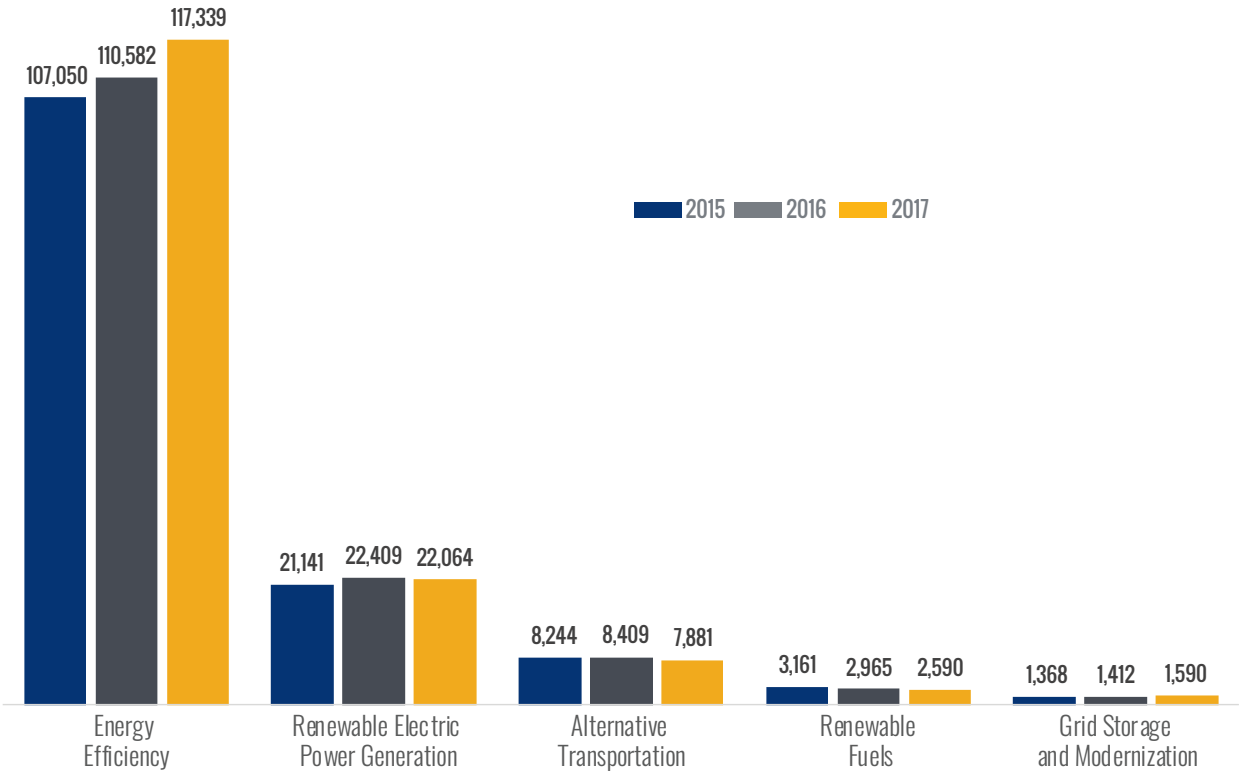


Table 1. Clean Energy Employment by Technology, 2015-2017

	Employment			Change, 2015-17		Change, 2016-17	
Technology	**2015**	**2016**	**2017**		%		%
Renewable Electric Power Generation	21,141	22,409	**22,064**	923	4.4%	-346	-1.5%
Energy Efficiency	107,050	110,582	**117,339**	10,289	9.6%	6,757	6.1%
Grid Modernization and Energy Storage	1,368	1,412	**1,590**	222	16.2%	178	12.6%
Renewable Fuels	3,161	2,965	**2,590**	-571	-18.1%	-375	-12.6%
Alternative Transportation	8,244	8,409	**7,881**	-363	-4.4%	-528	-6.3%
TOTAL	**140,963**	**145,778**	**151,464**	**10,501**	**7.4%**	**5,686**	**3.9%**

For context, note that overall non-farm employment in New York grew by 1.6% in 2017 and by 3.1% since 2015

A note about clean energy workers and survey methodology:

Employment data for this report capture all employees from qualifying clean energy firms that spend any portion of their time supporting the research, development, production, manufacturing, 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 (FTEs), but instead taken as a total quantification of work in the State's clean energy economy. Survey data capture the number of workers that spend at least half of their time supporting the clean energy portion of a given business, as well as those that spend all of their time doing so. For more information, please refer to Figures 3 and 4 of this report.

It is important to note that solar employment in this report will not match numbers reported in The Solar Foundation's (TSF) Solar Census. Where TSF excludes workers who spend less than half their time on solar, the NYCEIR reports total solar employment. As a result, NYCEIR solar employment totals exceed those of TSF.

It is also important to note that employment data excludes any retail employment—i.e., workers at motor vehicle dealerships, appliance and hardware stores, and other retail establishments are not included in the survey.

As demand for clean energy goods and services grows, New York's clean energy workers are spending more of their time on clean energy-related activities; the number who spent at least half of their time on clean energy increased by four percentage points between 2016 and 2017 (Figure 3), and the number who spent all their time increased by almost three points (Figure 4). This means that just over 84,000 full-time workers are spending all their labor hours on the installation, sale, manufacturing, research, or professional support of clean energy goods and services.

This overall trend was driven especially by renewable electric power generation and energy efficiency, which saw roughly four- to five-point increases in the number of workers who devote the majority or all of their

Figure 3. Clean Energy – Majority-Time Workers, 2016-2017[5]

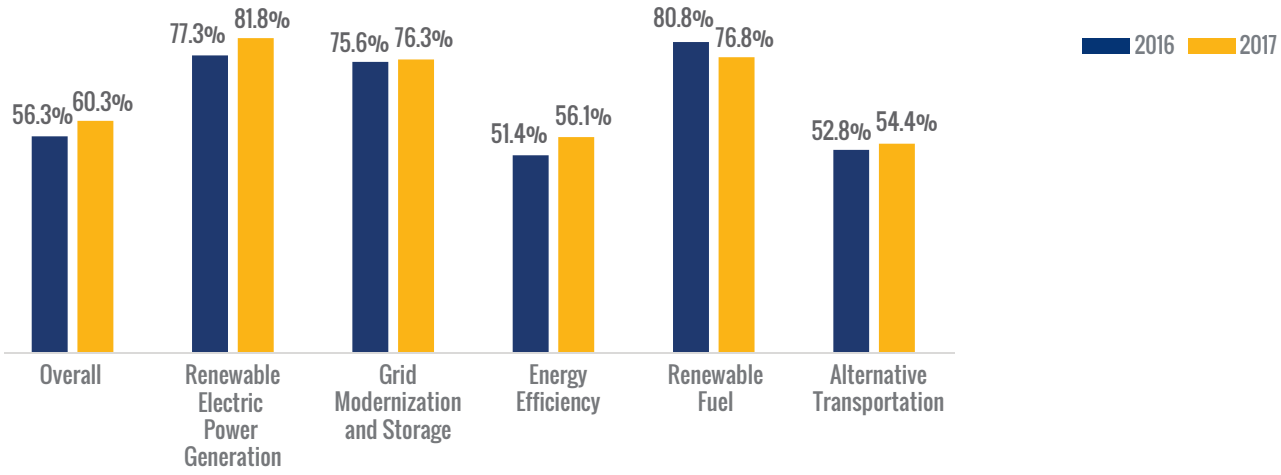
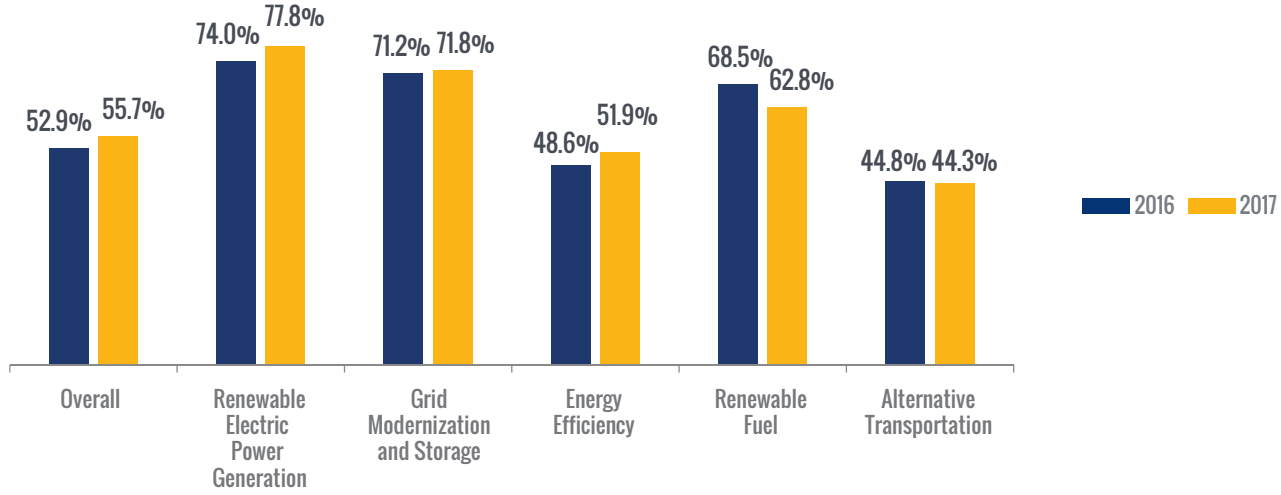


Figure 4. Clean Energy – Full-time Workers, 2016-2017[6]



time to clean energy activities.

The demographics of New York's clean energy workforce differ from a cross-section of the State's population in several respects (Table 2). Most obviously, clean energy workers are disproportionately male and white.

In addition to data on gender and race, other notable demographic points include the following:

among clean energy workers in New York, 11.5% are veterans, 15.0% are 55 or over

Table 2. Demographics

Category[7]	New York State's population[8]	Clean Energy Workers in New York		
		All	Renewable Electricity Generation[9]	Energy Efficiency[9]
Female	48.4%	29.7%	28.4%	23.3%
Male	51.4%	70.3%	71.6%	77.7%
White	55.3%	72.3%	73.5%	79.3%
Hispanic/latinx	19.2%	17.5%	16.1%	13.0%
Black	17.7%	7.8%	6.8%	6.8%
Asian	9.1%	8.8%	8.1%	4.0%
Native American	1.0%	1.3%	1.8%	1.9%
Pacific Islander	0.1%	1.1%	1.1%	0.8%

This report does not capture full information about wages in New York's clean energy industry, but the nationwide data shown in Table 3 provide some useful insights. For instance, several clean energy occupations not only have high median wages, but also high wage floors. In addition, the upward end of several occupations' wage ranges are far above their respective medians, reflecting that different regions and levels of demand can have significant effects on compensation.

Table 3. Nationwide Wage Ranges By Occupation

Standard Occupational Classification	Occupation Title	10th Percentile	Median	90th Percentile
11-9199.09	**Wind Energy Operations Managers**	$25.59	$52.70	$95.82
17-2199.10	**Wind Energy Engineers**	$25.48	$44.62	$71.13
49-9081	**Wind Turbine Service Technicians**	$17.15	$24.32	$37.07
49-9021	**Heating, Air Conditioning, and Refrigeration Mechanics and Installers**	$16.12	$26.62	$42.95
13-1199.01	**Energy Auditors**	$21.13	$36.39	$61.96
47-2231	**Solar Photovoltaic Installers**	$15.63	$18.90	$26.56

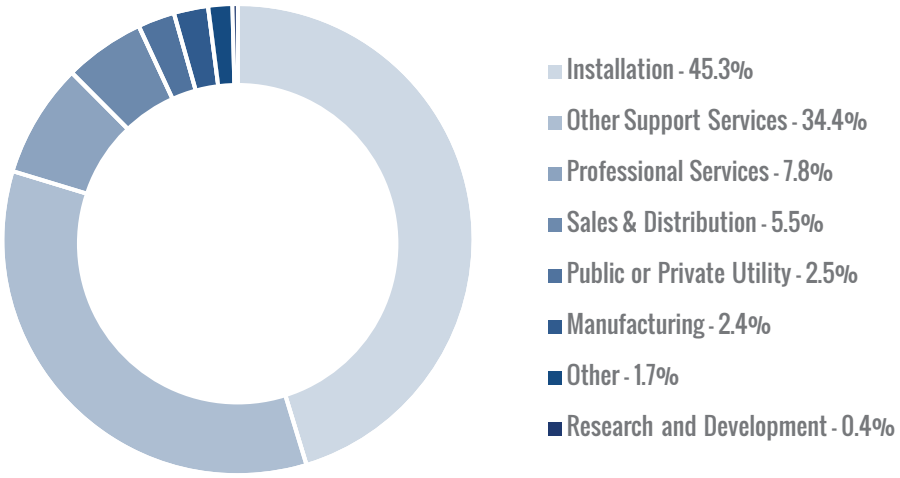
Clean Energy Market, Value Chain, and Labor Supply

The Clean Energy Value Chain

Installation remains the largest type of clean energy activity in New York, with 5,300 (45%) of New York firms engaged in the clean energy economy focused on installation. This is followed by other support services, including repair and maintenance, administrative support, and facilities management. Together, these two types of value chain activities—installation and support services—comprise the majority of New York's clean energy economy. Professional services such as consulting, engineering, finance, legal, and other professional support services account for 8% of activity, or just over 900 businesses. The remaining types of activity, such as trade, utilities, manufacturing, nonprofit or other work, and research and development comprise about 13% of he State's clean energy activity (Figure 5).

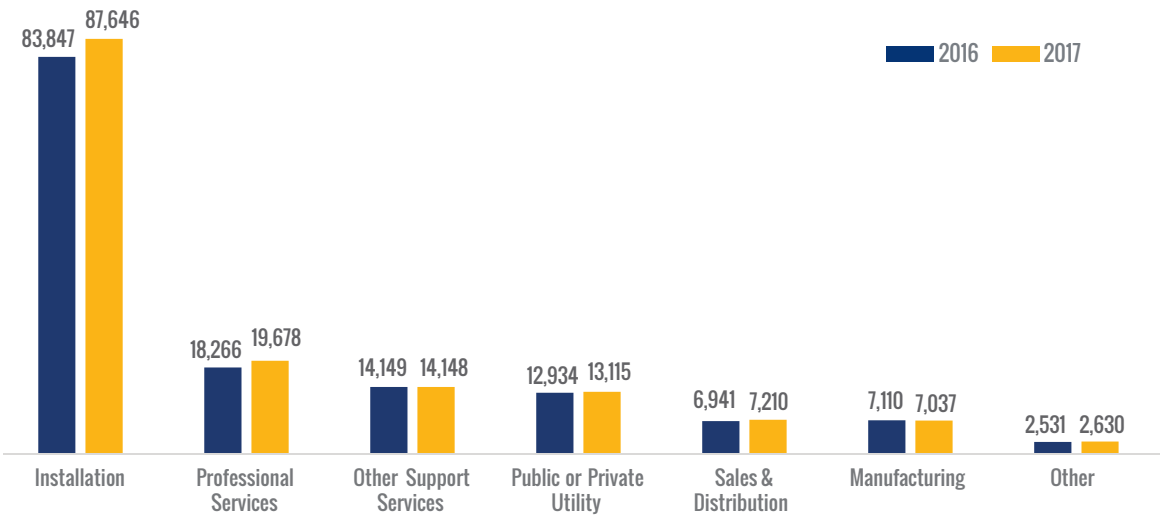
installation and support services comprise the majority of New York's clean energy economy

Figure 5. Clean Energy Establishments by Value Chain, Q4 2016[10]



Employment by value chain saw increases across nearly all activities, save for manufacturing, and to a lesser extent, other support services. The installation workforce grew by almost 3,800 jobs, from 83,850 to 87,650 in 2017—a growth rate of almost 5% in 12 months. Professional services saw the greatest proportional growth with an additional 1,400 lawyers, consultants, accountants, or engineers that provided support to the clean energy industry (7.7%). The sales and distribution workforce also grew by 270 jobs (4%), while manufacturing declined by 72 workers (1%). The increase in sales jobs is a positive indication as the firms around New York ramp up to meet in-State demand and exports beyond the State and the region (Figure 6).

Figure 6. Clean Energy Employment by Value Chain, 2016-2017[11]



Clean Energy Markets

New York clean energy employers are sourcing more of their clean energy goods and services from within the State. In 2017, almost eight in 10 employers indicated that their suppliers or vendors are primarily located within the State; this represents a jump of almost 18 points over 12 months (Table 2). At the same time, the State's clean energy economy has expanded its reach. Only 57% of employers reported that their customer base is primarily within the State, a decrease of 17 points since 2016. They saw a corresponding seven-point increase in primary customers in a bordering state and a 10-point increase in primary customers in the United States but not in a bordering state. There was a slight increase of 0.5% in employers reporting that they primarily serve international clients (Table 3).

Table 2. Supplier or Vendor Location, 2016-2017

Supplier or vendor location	2016	2017
In-State	61.7%	79.4%
In a bordering state, but out of State	6.4%	3.1%
In the United States, but outside of a bordering state	27.4%	16.7%
Outside of the United States	4.5%	0.7%

Table 3. Customer Location, 2016-2017

Customer location	2016	2017
In-State	73.8%	56.8%
In a bordering state, but out of State	4.4%	11.1%
In the United States, but outside of a bordering state	16.6%	26.4%
Outside of the United States	5.2%	5.7%

Clean Energy Labor Supply

Overall, hiring difficulty for clean energy employers persisted in 2017, but to a somewhat lesser degree than over the previous 12 months; almost one-third indicated that hiring was not difficult. Seven in 10 employers indicated that they had some hiring difficulty in 2017, compared to 83% in 2016. The proportion reporting that hiring was not at all difficult increased from 17% to 30% (Figure 7).[12]

The overall pattern was consistent for the two main technology segments, renewable electric power generation and energy efficiency; employers in these segments reported declines in total hiring difficulty of 5% and 13% respectively (Table 4).

Figure 7. Hiring Difficulty, 2016-2017

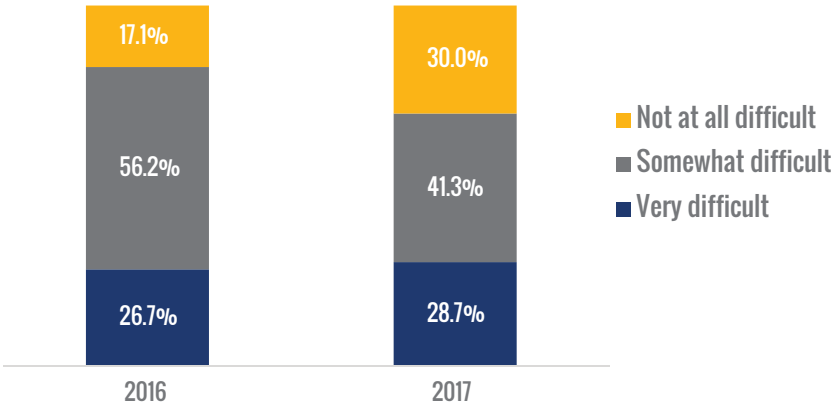


Table 4. Hiring Difficulty by Technology, 2016-2017[13]

	2016			2017		
	Very difficult	Somewhat difficult	Not at all difficult	Very difficult	Somewhat difficult	Not at all difficult
Renewable Electric Power Generation	20.2%	60.7%	19.0%	18.6%	57.6%	23.7%
Energy Efficiency	29.0%	56.1%	15.0%	25.0%	46.3%	28.8%

Employers indicated that the top reason for hiring difficulty over these 12 months was lack of experience, training, or technical skills in addition to insufficient non-technical skills, such as work ethic, dependability, or critical thinking. About a quarter of employers also noted that their applicants did not have the proper qualifications in terms of certification or educational attainment (Figure 8). Positions for which employers reported the most difficulty hiring include technicians or technical support; sales, marketing, or customer service occupations; and engineers or scientists (Figure 9).

Figure 8. Reasons for Hiring Difficulty, 2017

top reason for hiring difficulty was lack of experience, training, or technical skills

Figure 9. Occupations with Hiring Difficulty, 2017

positions with most difficulty hiring include technicians or technical support; sales, marketing, or customer service occupations; and engineers or scientists

Jobs Across Clean Energy Technology Categories

in two years, the energy efficiency segment created 10,200 jobs

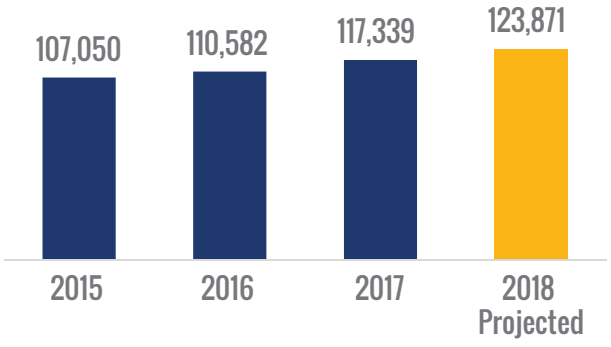
employers expect jobs to grow another 5.6% by the end of 2018

Energy Efficiency

Energy efficiency firms, which account for the largest segment of the clean energy economy, grew their workforce by 6.1% in 2017, and 9.6% growth since 2015. In two years, this technology has created more than 10,200 jobs, and employers expect jobs to grow by another 5.6% by the end of 2018 (Figure 36). The relatively large size of the energy efficiency technology category owes to the dispersed nature of energy efficiency firms and projects, and is consistent with the pattern seen in other states that, like New York, have aggressive clean energy policies.

The majority of energy efficiency workers in New York spend most of their time working with high-efficiency HVAC technologies (57% or 66,614 workers). The second largest segment (30%) of the energy efficiency technology works with ENERGY STAR appliances and efficient lighting, followed by other efficiency products and services and advanced building materials and insulation (Figure 37). Most energy efficiency workers are either engaged in installation and repair or work at utility companies (71%), while the remainder work in professional and other support services, manufacturing, or sales and distribution (Figure 38).

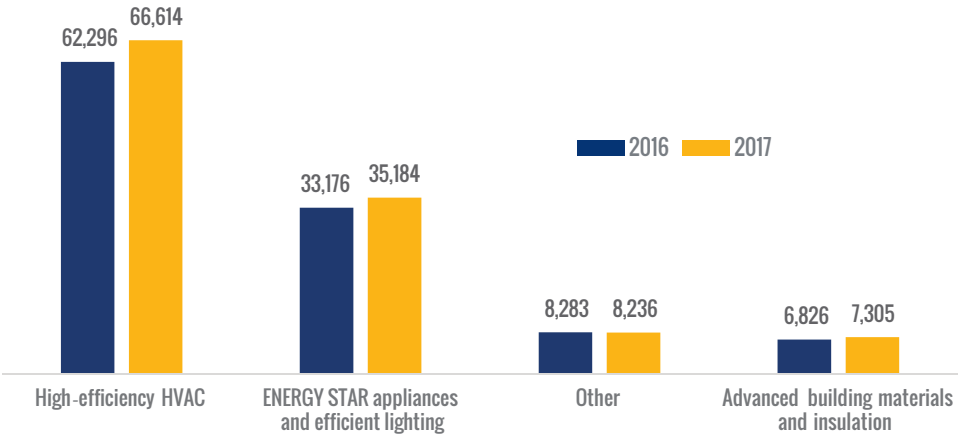
Figure 36. Energy Efficiency Employment Growth, 2015-2017



Continued growth is expected in energy efficiency given the State's recent commitment to achieving ambitious energy efficiency goals through policy mechanisms focused on the commercial, industrial, and residential sectors. In April 2018, the State announced a target of 185 trillion Btus (British thermal units) of end-use energy savings below the 2025 energy-use forecast. Efforts to catalyze the improvement of existing technologies through new appliance standards and building codes as well as advancements in electrification and heat pumps are under way. In addition, to support progress toward the 185 TBtu target, New York has also committed to energy efficiency innovation and workforce training. For instance, NYSERDA supported the development of a Multifamily Building Analyst curriculum at the Building Performance Institute to train New York City workers in building performance improvement measures ranging from air sealing and weatherization, to roof fan maintenance, to boiler operation and maintenance. In April 2018, NYSERDA committed $36.5 million to train over 19,500 New Yorkers for energy efficiency jobs.[18]

NYSERDA committed $36.5 million to train over 19,500 New Yorkers for energy efficiency jobs

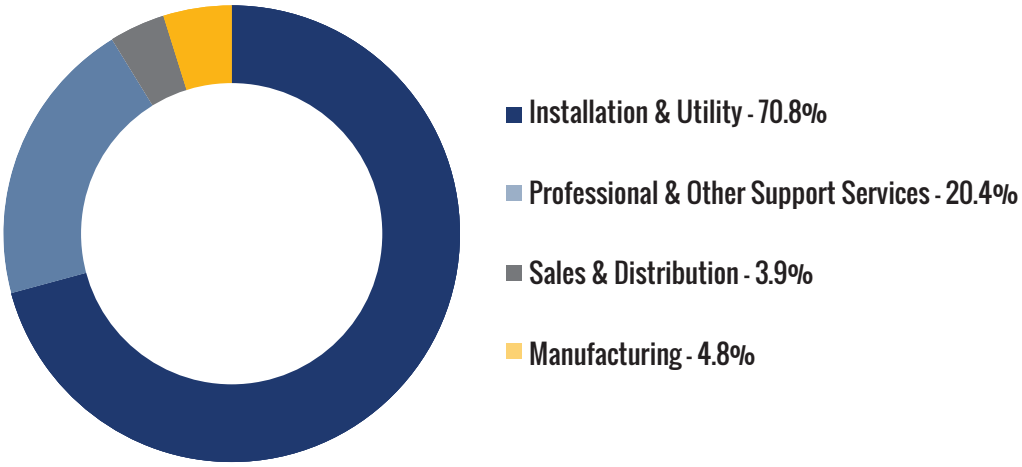
Figure 37. Energy Efficiency Employment by Sub-technology, 2016-2017



Other encompasses a variety of goods and services such as:

- Variable speed pumps
- Other design services not specific to a subtechnology
- Software not specific to a subtechnology
- Energy auditing, rating, monitoring, metering, and leak detection
- Energy efficiency policy not specific to a subtechnology
- LEED certification
- Consulting not specific to a subtechnology
- Phase-change materials

Figure 38. Energy Efficiency Employment by Value Chain, 2017



Company Name: **LED Specialists, Inc.**

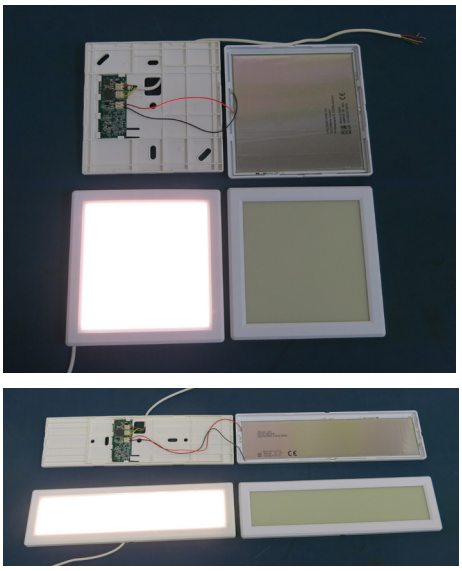
Contact: **Bill Reisenauer**

Primary Technology: **LED/OLED**

LED Specialists, Inc. was formed in 2004 after its founders foresaw a major shift in the lighting market from incandescent bulbs to light emitting diodes (LED lighting). The firm initially targeted large-scale engineering projects.

In 2005, with the help of funding from New York State, the firm began developing a new line of business: organic light emitting diodes (OLED lighting). New York has supported LED Specialist, Inc.'s innovative work by providing business contacts and facilitating networking with New York-based clients.

Presently, the firm works with a variety of large corporations, like Boeing, that regularly need engineering expertise to develop lighting solutions. LED Specialists, Inc. recently expanded its focus to also support ultra violet (UV) curing and sterilization systems, although the firm's main focus remains the commercialization of LED and OLED lighting.



Company Name: **Prescriptive Data LLC**

Contact: **Matt Stetson**

Primary Technology: **Software for integrated building systems**

Initially incubated within Rudin Management Co., Prescriptive Data LLC has commercialized their NANTUM system and now provides software and support services to buildings owned by Rudin and other real estate development and building management firms, chiefly in New York City.

The basic insight that Prescriptive Data has turned into a value proposition is that building systems generally use more energy than necessary and can reduce their energy use substantially by only operating when building occupants are physically present. By tracking movement within a building and shutting off lights and adjusting demand for heating or cooling when spaces are empty, NANTUM-connected buildings provide similar levels of service to occupants while using less energy, thereby reducing costs.

Special Section:

The Energy Efficiency Installation Sector

As part of the 2018 NYCEIR effort, additional research examined workforce development issues related to energy efficiency installation work. Two surveys were fielded, one for employers and one for employees, after which researchers conducted a facilitated discussion with employers and industry association leaders.

The purpose of this inquiry was to gain a deeper understanding of workforce issues within the largest technology category of New York's clean energy economy. The information gleaned from the process provides insight on the state of the talent pipeline. In particular, this research identified some key challenges in the energy efficiency talent pipeline that could potentially cause slowdowns in growth; these key findings are discussed below.

Career and technical education, internships, and apprenticeships outweigh a college degree.

Hiring remains challenging. The consensus is that the technology category has an ample supply of applicants, but that these applicants lack the proper qualifications. For energy efficiency businesses, a highly qualified candidate must have industry-specific training, experience, and technical skills. 89% of employers reported that the applicant supply was substantial but that applicants often did not have the technical training required, and 73% reported that applicants often lack the desired level of experience. Clear majorities of employers indicated that they had difficulty finding workers with relevant work experience (81%), technical skills (81%), or training specific to the position (65%). When asked about how much experience they would like to see from applicants, 81% of employers indicated that they would prefer an applicant to have spent at least 12 months in a comparable position, and a third indicated that they would prefer one to three years. Nearly 40% of employers indicated that Associate and Bachelor's degrees are less important than technical training, industry certification, and completing an internship. These findings are consistent with the background of the current workforce, as just over half of energy efficiency workers noted that they had some sort of formal education or training that prepared them specifically for a career in energy efficiency. Of those with formal education or training, seven in 10 reported having an industry certification, 11% having taken college courses but not received a degree, and even fewer having received an associate's, bachelor's, or master's degree. When asked what was most important for career success, employees listed skill development through work experience, on-the-job training, technical certifications, and previous work experience.

Special Section

Mentorship, informal support networks, and non-technical skills are also important for career success.

Workers also reported that self-guided learning and experimenting, informal mentorships, early education, support and guidance from family and friends, and online learning communities of industry professionals were important for navigating their careers. In a similar vein, employers highlighted the importance of non-technical skills such as timeliness, communication, customer service, and professional presentation and behavior.

There is limited awareness or understanding among jobseekers and the general public that the energy efficiency technology category offers good paying jobs and opportunities for career growth.

More than half of surveyed energy efficiency workers reported that they have successfully moved up the career ladder and continue to grow professionally. Training and experience are key to landing an entry-level job, but once workers enter the industry, they encounter significant opportunity for growth and advancement. Despite this, employers mentioned a stigma surrounding energy efficiency occupations, resulting from a general lack of knowledge or negative perspectives on energy efficiency occupations—creating a need to raise awareness of the technology's positive career potential. According to employers, jobseeker interest in energy efficiency careers is hurt by a lack of information, parents' general preference that their children pursue a college degree, perceived declines in the quantity and quality of career and technical high school (i.e., vocational) education, and failure of the industry to present energy efficiency jobs as innovative, science-based careers that have positive impacts on society and the environment.

Streamlining the talent pipeline will increase the efficiency of both employee training and recruitment.

Eight in 10 employers said they recruit energy efficiency installers from internet job boards, 58% reported using word of mouth, and 45% indicated they recruit directly from training programs. Related to their observation that technical and vocational education programs are more important than college for successful entry into an energy efficiency career, employers also remarked on the lack of an effective or comprehensive workforce development network in New York. Not only is there insufficient training and vocational education, but the training programs that do exist are poorly connected to the industry that might hire their graduates. In fact, 69% of energy efficiency employers indicated that their firm does not have a relationship with schools, training providers, or other third-party organizations that might supply energy efficiency workers to their firms.

In short, much could be gained from establishing more connections and partnerships—ideally using a systemic approach that starts with K-12 education and links stakeholders in education and workforce development, including employers, trade and professional associations, community colleges and technical schools, workforce development intermediaries, four-year colleges, and even parent-teacher organizations.

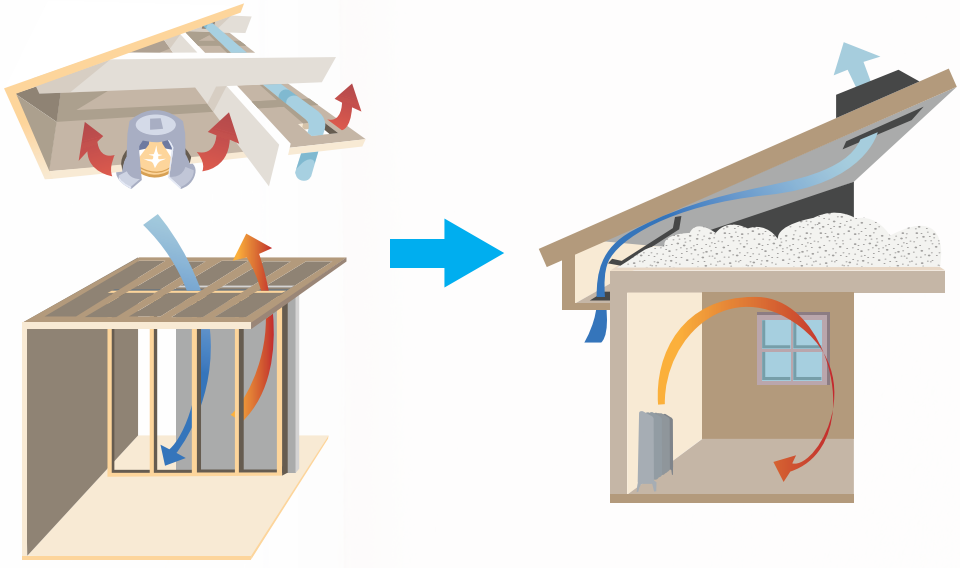
Company Name: **SEALED**

Contact: **Andy Frank**

Primary Technology: **Machine learning profiling and financing home efficiency upgrades**

SEALED is based in New York City and has 12 full-time employees. It uses machine learning to model home energy savings and finances energy efficiency upgrades to install insulation, weatherization, HVAC upgrades, and IoT devices by working with local contractors and utilities.

The firm identified several benefits to conducting their energy efficiency work in New York, including an abundance of older, single-family homes, high energy prices, the support of NY Green Bank, and several REV Demonstrations. New and innovative partnerships with New York utilities have been especially important to Sealed's business. Grant opportunities like those available through NYSERDA's ENERGY STAR® Program, which facilitates residential energy efficiency investments, have been especially important to SEALED's business.



Renewable Electric Power Generation

New York's electric power generation firms employ just over 22,000 clean energy workers across the State. This represents a decline of 1.5% compared to 2016. This technology category shed roughly 350 jobs over those 12 months, but there was still a net gain of 4.4% compared to 2015. Employers remain optimistic for the future, projecting a 6.3% employment growth rate for 2018, or 1,360 more jobs (Figure 39). Employment is most concentrated in installation and utilities: these value chain activities account for almost seven in 10 workers, followed by professional and other support services, sales and distribution, and manufacturing (Figure 41).

electric power generation firms employ just over 22,000 clean energy workers across the State

Despite a decline in 2017, the solar workforce still represents the majority of renewable energy employment (54%). In 2017, solar employment declined by almost 5% in New York. But a similar decline occurred nationwide,[19] driven by slower rates of residential installations.[20] In addition, it was accompanied by the increase shown in Figure 3 in the amount of time renewable electric power generation workers spent working on clean energy projects. Following solar, the next largest renewable energy employer is hydropower, with just over 5,800 workers—about a quarter of the workforce in this technology category. Wind firms account for almost 3,200 workers (15%). Bioenergy and geothermal technologies firms employ the remaining roughly 1,140 workers, 5% of the renewable energy workforce (Figure 40).

even with a decline, the solar workforce still represents the majority of renewable energy employment at 54%

Figure 39. Renewable Electric Power Generation Employment Growth, 2015-2017

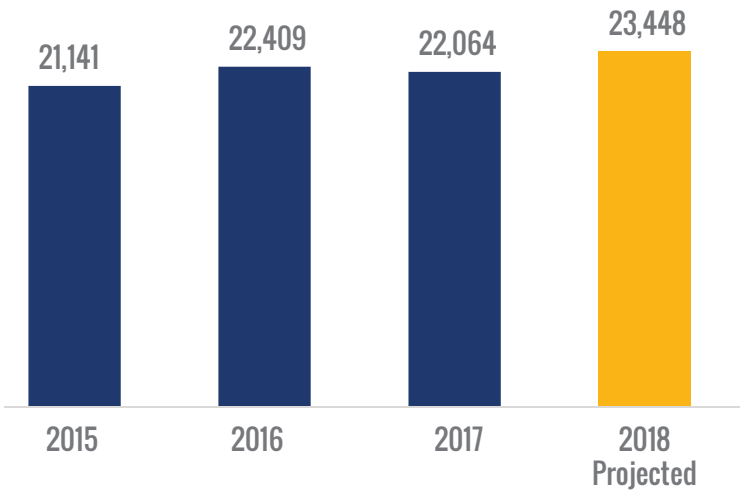


Figure 40. Renewable Electric Power Generation Employment by Sub-technology, 2016-2017

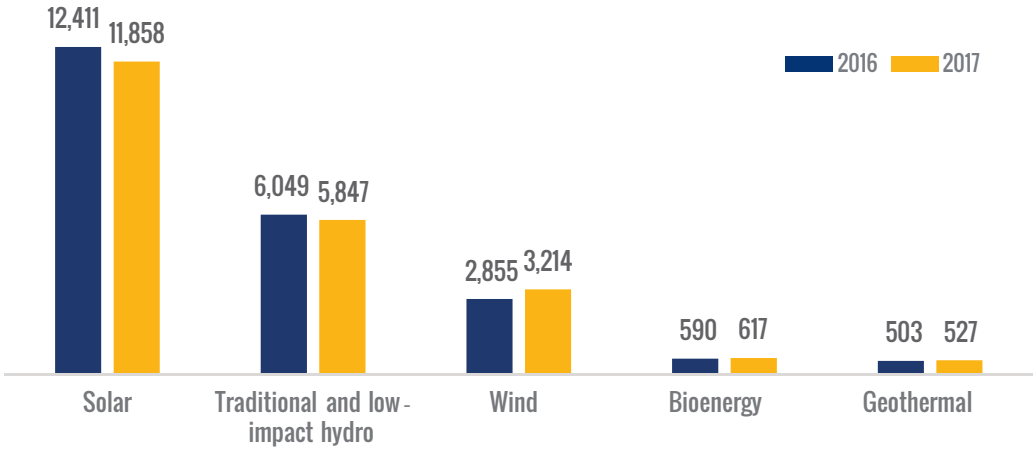


Figure 41. Renewable Electric Power Generation Employment by Value Chain, 2017

Company Name: **Poseidon Systems**

Contact: **Ryan Brewer**

Primary Technology: **Oil monitoring and diagnostic systems**

Poseidon Systems develops and markets oil debris monitoring and diagnostic systems for gearboxes to proactively provide early warnings for potential failures. Wind turbine operations can be modified to change what could have been a four week forced outage to a two day scheduled outage. One failure prevented can reward the customer with 10x savings on the monitoring system cost. The firm is based in Rochester, New York and employs fifteen people full-time. Wind turbines are the firm's primary market, though these products are marketed to other industries (mining, transportation, etc.).

Poseidon Systems also offers remote monitoring and data collection and analysis for its systems with real time alerts set with custom thresholds by each customer. Poseidon Systems has drawn on NYSERDA for support during its business development. It was selected as best presentation at AWEA's O&M and Safety Conference in February 2018. New York State in-State manufacturing incentives have also helped the company with demonstrations to develop its capacity and client base.

Special Section:

The Solar Installation Sector

As with the energy efficiency installation sector, additional research was carried out into workforce development issues related to the solar industry. The research involved surveys of employers and employees, as well as a facilitated discussion with employers. This section describes insights from that research, which are especially important given recent national declines in solar employment.

Few employers report serious hiring difficulty in recruiting solar installers, but seasonal and locational barriers do exist.

Only 17% of employers said it was "very difficult" to find qualified applicants. Employers generally noted that solar is a thoroughly attractive industry—solar firms offer good jobs and the industry is viewed positively by the general population. Furthermore, the educational system does a good job of introducing students to the industry. Fifty-one percent of employers did report that it was "somewhat difficult" to find qualified applicants, noting that their need for candidates with better qualifications than are available through the applicant pool often results in postings on job-boards expiring without having received qualified applications. Employers also explained that the seasonal nature of installation work can make hiring more difficult. In winter months, when installation rates ebb, workers tend to seek out more distant commercial projects to maintain steady employment. Employers stated that local staffing agencies play a crucial role in addressing some of these challenges. Finally, employers also said that some regions are more likely to have qualified workers than others.

Finding, or training, qualified electrical workers is a persistent challenge.

Employer focus groups were unanimous in saying that New York's solar industry needs both more and better qualified solar electricians. Reasons for hiring difficulties according to survey respondents include a lack of certified electricians, a lack of electricians with solar-specific knowledge, and generally high demand and competition for licensed electricians. These results echoed focus group sentiments: 78% of employers reported a preference for candidates with a national certification related to solar energy, but only 41% said they could feasibly require such a certification. Meanwhile, more than half (56%) of solar employers consider technical training for industry-specific skills to be an extremely important factor in their hiring process, and 69% said that the current pool of installers should receive more training.

Special Section

The industry would benefit from a continually updated, shared database or resource center to connect available solar installers and electricians.

Employers in the focus group stated that a database that connects available solar installers to potential employers would be valuable. This resource could contain a worker's qualifications, date and locational availability, and expected compensation. Employer survey data indicated a similar need. Even though internet job postings remain the leading recruitment method for solar installation employers, those employers note that job-boards, whether due to poor design or other issues, fall far short of what is needed.

Solar installers are satisfied with opportunities for upward mobility and report low barriers to entry.

New York's solar installers report an exceptionally high level of satisfaction with their ability to move up the career ladder. 80% report some level of success in moving up, and a majority (52%) expect further career advancement. Less than one-fifth (19%) of installers indicated that they were limited in career advancement by their lack of formal education or training. The overwhelming majority reported that career advancement opportunities arise from skill development through work experience (81%) and on-the-job training (78%). The survey also revealed low barriers to entry. Two-thirds (66%) of experienced incumbent installers say that they had no formal education or training that prepared them specifically for their career, and only 5% of those with formal educational credentials have received a bachelor's degree. Only half (50%) of solar employers consider a college degree important in their hiring process. Nearly half (48%) of employers surveyed said that they expect applicants for installer jobs to have less than a year of comparable work experience, and more than three-quarters (78%) expect less than three years of experience.

Solar installers earn high wages.

The median solar installer earns roughly $25 per hour, or $52,000 if they work full-time, year-round. According to the New York State Department of Labor, this is nearly $4,000 higher than the median installation, maintenance, and repair occupations salary of $48,060. In fact, of the six reasons employers identified as reasons for hiring difficulties with installation workers, demand for higher compensation ranked last.

Grid Modernization and Energy Storage

Firms in the smallest component of New York's clean energy workforce, grid modernization and energy storage, are growing at the fastest rate of firms in all clean energy technology categories. Between 2015 and 2017, these firms added jobs at a rate of 16%. Because the technology category is small, this only translates to an additional 220 new jobs. Nonetheless, rapid and sustained growth highlights this as an area of major opportunity for continued support and expansion. In fact, employers expect employment growth by another 130 workers (8%) through 2018 (Figure 43). The majority of workers in this technology category are engaged with energy storage technologies—about three-quarters or 1,221 workers—while the remainder spend most of their time supporting smart grid technologies (Figure 44).

grid modernization and energy storage are growing at the fastest rate of firms in all clean energy technology categories at 12.6% from 2016 to 2017

Figure 42. Grid Modernization and Energy Storage Employment Growth, 2015-2017

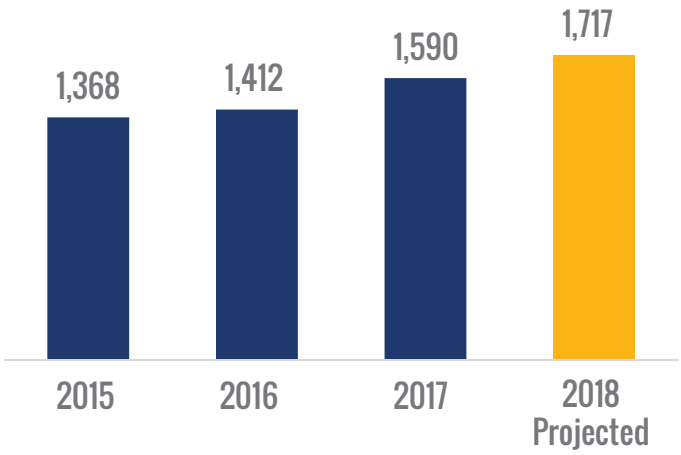
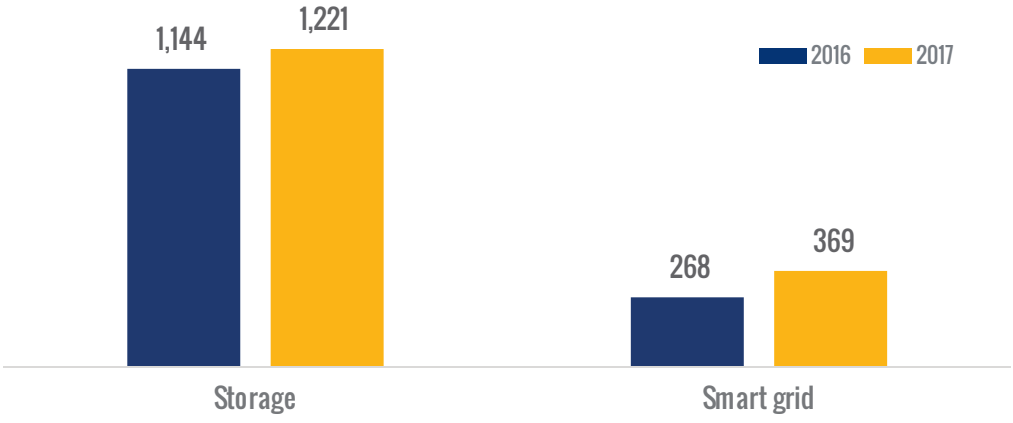


Figure 43. Grid Modernization and Energy Storage Employment by Sub-technology, 2016-2017



Renewable Fuels

The renewable fuels technology category has continued to see employment declines since 2015. Employers shed jobs at a rate of 12.6% in 2017, in addition to the 6% from 2015 to 2016. Overall, this translates to a decline of roughly 570 jobs in two years. However, employers are optimistic, anticipating the addition of 70 new jobs (2.8% growth) through 2018 (Figure 44).

The majority of renewable fuels workers spend most of their time working with woody biomass technologies (64% or 1,658 jobs). The rest of the workforce is engaged with ethanol and non-woody biomass products (Figure 45).

employment has declined since 2015, but employers are optimistic and anticipate 2.8% growth through 2018

Figure 44. Renewable Fuels Employment Growth, 2015-2017

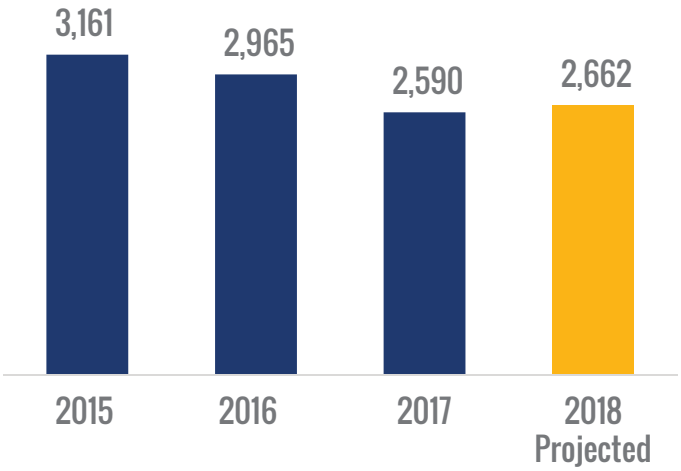
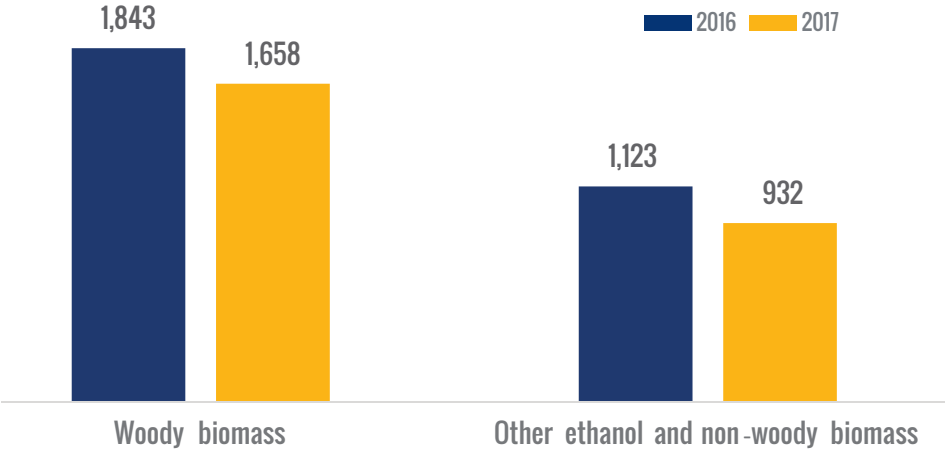


Figure 45. Renewable Fuels Employment by Sub-technology, Q4 2016[21]



Alternative Transportation

Jobs in the alternative transportation technology category also declined by about 6% since 2016. In total, these firms now employ almost 7,900 workers, compared to 8,200 in 2015. Nevertheless, employers indicated that they expect jobs to grow by an additional 140 workers (2%) through 2018 (Figure 47). Alternative transportation workers are largely concentrated in hybrid electric and electric vehicle technologies; together, these two sub-technologies account for roughly 5,500 workers, 70% of the category's total. The remainder of employment is spread across firms focused on plug-in hybrid, natural gas, and hydrogen and fuel cell vehicles (Figure 48).

In general, motor vehicle employment has declined across the nation, largely the result of U.S. firms losing market share to international competitors in the natural gas vehicles sub-technology category. The total number of natural gas vehicles in the U.S. has remained stagnant at roughly 160,000 since 2016.[22] Given this reality, it is not surprising that the almost 1,800 jobs shed by New York's alternative transportation technology category from 2016 to 2017 were in the natural gas sub-technology category.

employment has declined 6% since 2015, but 2% growth through 2018 is expected

Figure 46. Alternative Transportation Employment Growth, 2015-2017

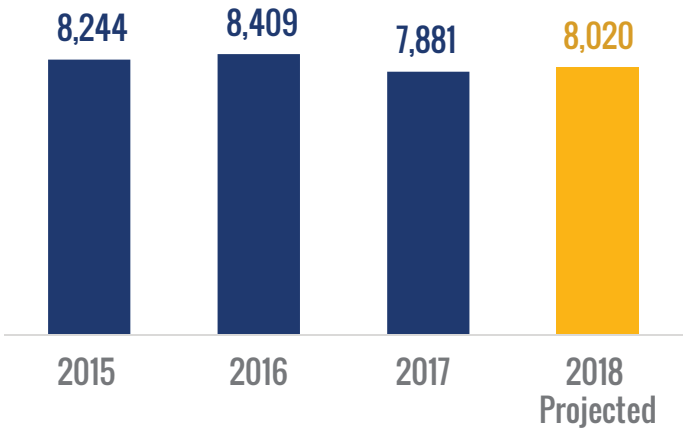
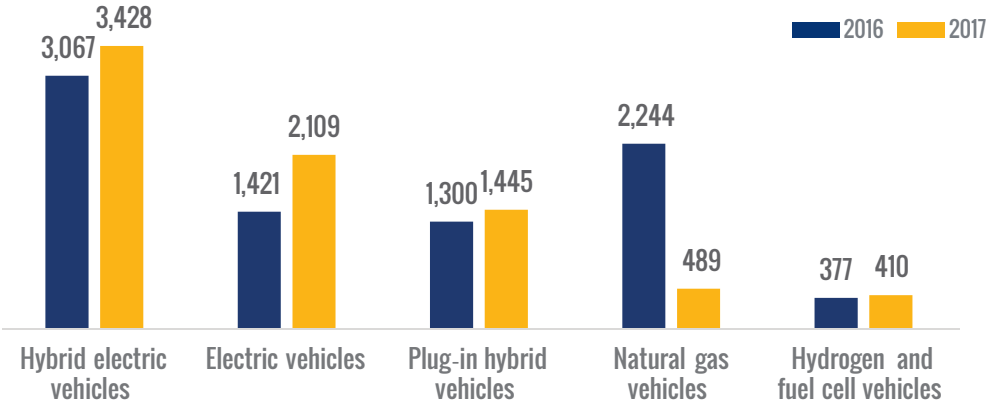


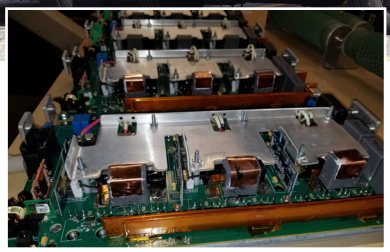
Figure 47. Alternative Transportation Employment by Sub-technology, 2016-2017



Company Name: **Unique Technical Services, Inc.**

Contact: **Joe Ambrosio**

Primary Technology: **Clean transportation vehicles, battery management, and control systems**



Unique Technical Services, LLC (UTS LLC) is a small firm that operates in Stony Brook, New York. The firm's 10-person team works in clean transportation, producing battery management devices, control systems, and hybrid buses. The organization has two main operations that contribute to their clean transportation work–manufacturing and engineering. UTS LLC has engineered and supported "clean" hybrid electric buses for Suffolk Transportation Services (Bayshore NY) and recently produced controls and battery management system for a "clean" all-electric delivery van for UPS for use in NYC.

The firm identified several benefits of working with clean transportation products in New York including a burgeoning clean energy industry, research and development resources from NYSERDA, an abundance of test labs, and attention surrounding metropolitan air quality. UTS LLC draws on New York State institutions in several ways. It has a close bond with NYSERDA and has been supported in many ways. They rely especially on the Transportation Group at NYSERDA and participates in active incentive programs including the Entrepreneurship-in Residence Program (EIR), Broadening Experiences in Scientific Training Consortium New York Battery and Energy Storage Technology Consortium (NY-BEST), and START-UP NY Program. The firm is also involved in the Manufacturing Technology Resource Consortium (MTRC) through Empire State Development and the Manufacturing Extension Partnership (MEP).

Clean Energy Innovation and Funding

Between 2011 and 2017, New York attracted a total of $8.4 billion in clean energy funding via 2,245 individual investment deals.

This 2018 New York Clean Energy Industry Report breaks out innovation investments in the clean energy economy and the remainder of clean energy funding into separate components. Discussing innovation metrics independently from the remainder of clean energy expenditures helps to identify the innovation-specific drivers, challenges, and opportunities for New York's clean energy firms. The Innovation section includes both innovation investment dollars and assets such as patents and peer-reviewed publications.

In keeping with this new structure, the Clean Energy Innovation and Funding section includes innovation-related investments. The subsequent section, Innovation in New York's Clean Energy Economy, reports on a subset of overall clean energy funding.

Clean Energy Funding

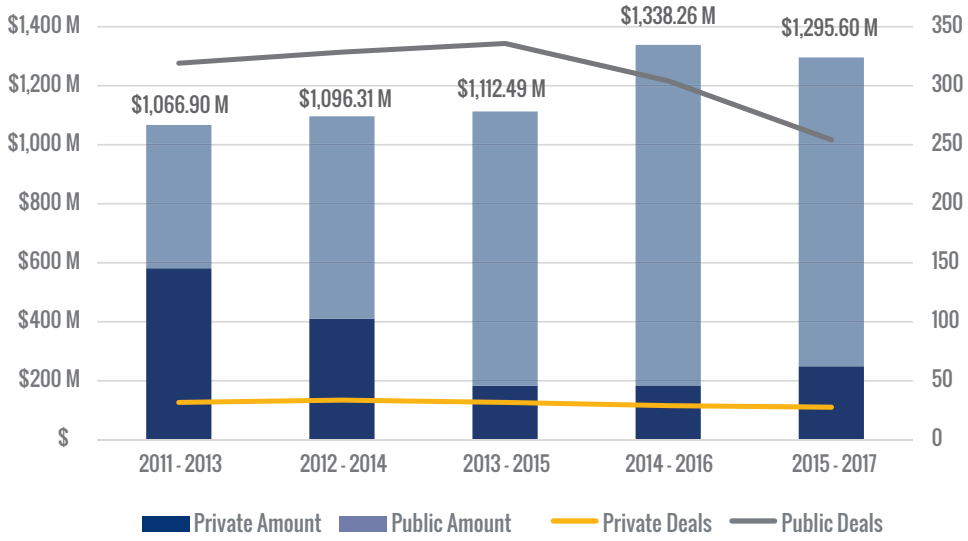
The 2017 New York Clean Energy Industry Report reported primarily on the venture-backed investments of companies in New York's innovation economy, together with some internal NYSERDA grant data. While useful for understanding the innovation economy in New York, these limited data do not reflect the market as a whole, especially as it relates to investments in later stage innovation and deployment, acceleration, market development, or wide commercial availability. The data discussed in this section are drawn from a combination of public and proprietary datasets that together account for public grant spending, including Cleantech Group i3, ARPA-E, Small Business Innovation Research and Small Business Technology Transfer programs, and NYSERDA grant funding; public benefit programs, which include all utility- and NYSERDA-sponsored rebate and incentive programs designed to increase consumption of clean energy goods and services; and private investments made by venture capitalists and entrepreneurs in clean energy technologies.

Between 2011 and 2017, New York attracted a total of $8.4 billion in clean energy funding via 2,245 individual investment deals.[14] There was a slight decline of 3.2% over the latest three-year rolling averages between 2014 and 2017, but clean energy funding generally has increased since 2011 by roughly 21.4%. At the same time, total deals have decreased, causing the average dollars per deal to go up. Two private investment deals by TerraGen Power made two exceptionally large private investment deals of $631 million in 2011 and $650 million in 2012, which disproportionately affect the shape of broader trends. Excluding these deals, the study found that total funding increased by 102% and private funding increased 61% during the 2011–2017 timeframe (Figure 10). It is important to note that limited access to investment data resulted in undercounting of the private funding amounts reported in this section

Firms in the energy efficiency technology category received more than $4.1 billion in clean energy funding over the last seven years, through nearly 1,200 separate investment deals. While private funding has decreased nearly 53% between the earliest and most recent three-year rolling averages, public funding has increased 119% during the same period. Across all types of funding, energy efficiency investment has increased 81% since the 2011–2013 rolling average (Figure 11).

By contrast, renewable electric power generation saw marked declines from 2011 through 2015 followed by a rebound. In the latest three-year rolling averages investments increased by 36%. In total, renewable electric power generation firms attracted nearly $3.6 billion in investment dollars between 2011 and 2017 through 351 deals. Between the rolling averages of 2013–2015 and 2015–2017, private investment increased by nearly 80% (Figure 12).

Figure 10. Overall Clean Energy Funding, Three-Year Rolling Averages, 2011-2017



Firms in the energy efficiency technology category received more than $4.1 billion in clean energy funding over the last seven years, through nearly 1,200 separate investment deals

Figure 11. Energy Efficiency Funding, Three-Year Rolling Averages, 2011-2017

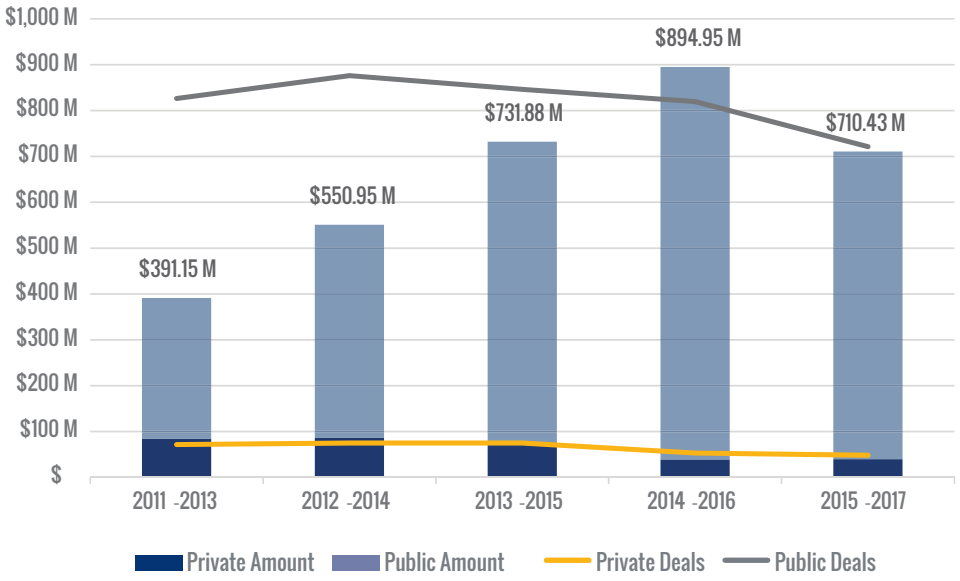
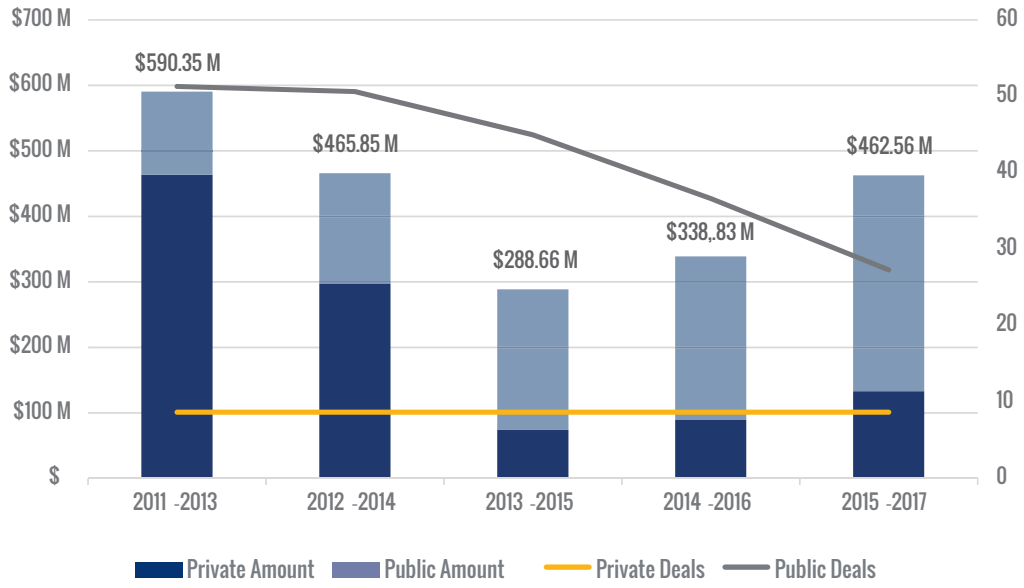


Figure 12. Renewable Electric Power Generation Funding, Three-Year Rolling Averages, 2011-2017



grid modernization and energy storage firms continuous increases year-over-year in investment dollars

renewable fuels firms almost $85 million in investment funding over 58 deals

alternative transportation over $155 million in investment funding over 248 deals

Despite accounting for only $406.2 million of total clean energy funding over the last seven years, grid modernization and energy storage firms have seen continuous year-over-year increases in investment dollars. Across the three-year rolling averages from 2011 through 2017, the technology saw funding increase by 129%. A declining number of deals over the same time period indicates—consistent with the broader trend—that average investment size per deal has increased (Figure 13).

Between 2011 and 2017, renewable fuels firms attracted almost $85 million in investment funding through 58 deal rounds. Clean energy funding for this technology has steadily increased, growing 45% between the earliest and latest three-year rolling averages. Private spending increased 29% while public funding increased by 67% during this period. (Figure 14).

Between 2011 and 2017, alternative transportation firms attracted just over $155 million in investment funding over 248 deals. Overall, this technology has seen funding decline since its peak of roughly $27.8 million in 2011. Public funding was the predominant source of investment, though it declined by nearly 26% between the earliest and latest three-year rolling averages (Figure 15).

Figure 13. Grid Modernization and Energy Storage Funding, Three-Year Rolling Averages, 2011-2017

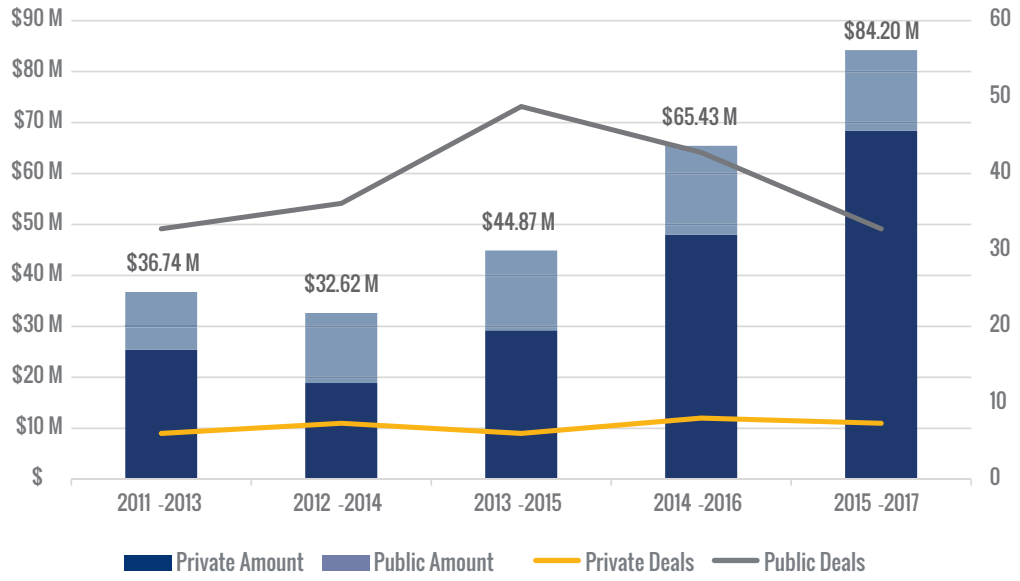


Figure 14. Renewable Fuels Funding, Three-Year Rolling Averages, 2011-2017

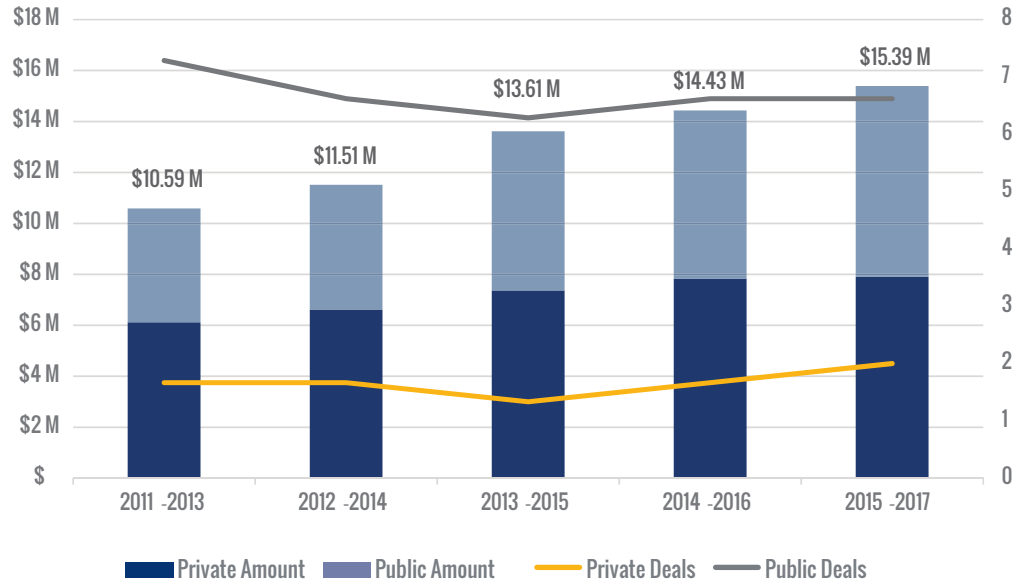
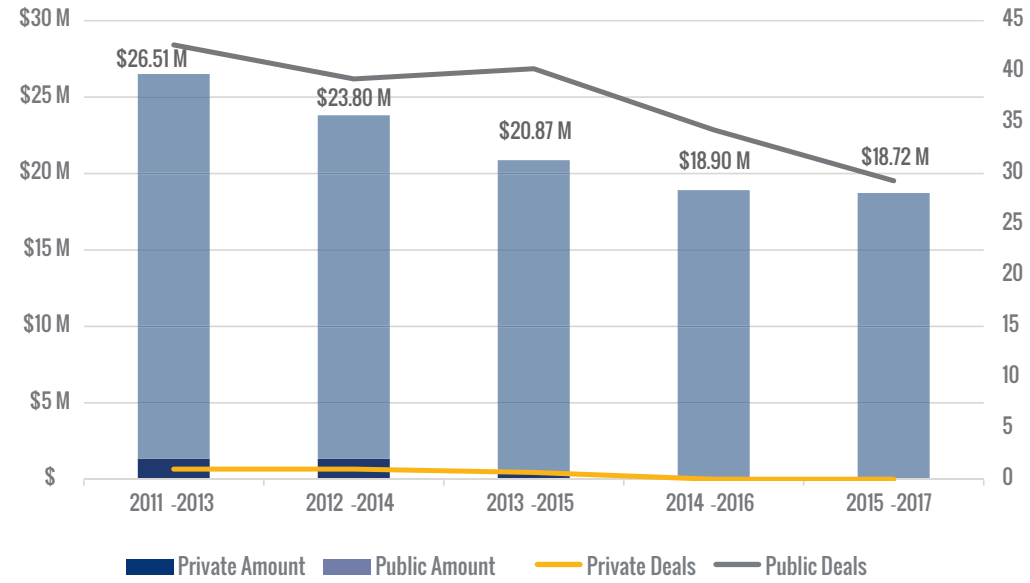


Figure 15. Alternative Transportation Funding, Three-Year Rolling Averages, 2011-2017



Innovation in New York's Clean Energy Economy

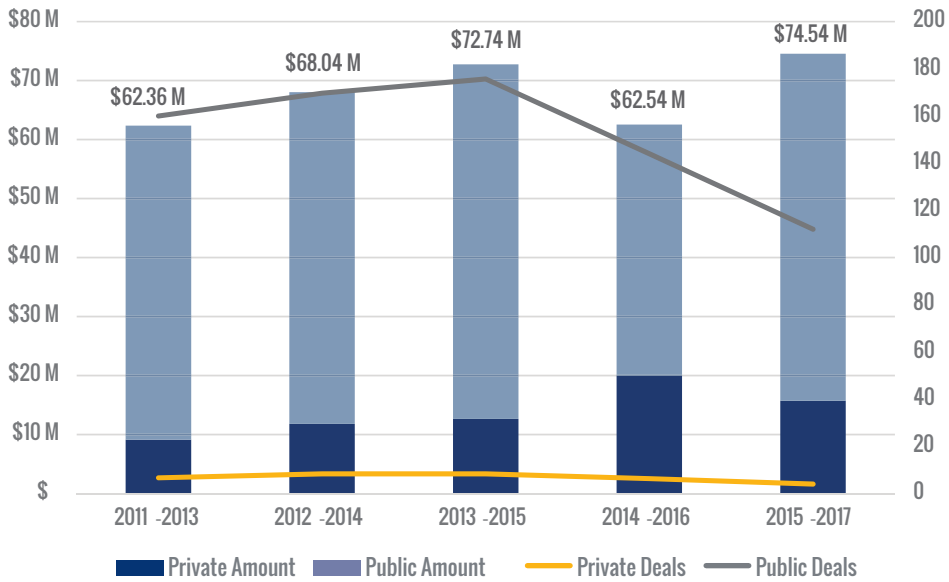
Innovation covers research and prototyping, demonstration and acceleration, as well as commercialization and growth. These phases are roughly based on NASA's Technology Readiness Levels (TRLs),[15] and are described here using data drawn from NYSERDA grant funding, federal datasets for SBIR/ STTR, ARPA-E, and SunShot, as well as the i3 Cleantech Group's investments database.

Phase I: Research and Prototyping

This stage, which begins with basic research and ideation, is typically carried out in universities and public laboratories and includes everything up to bench-testing of prototypes. Funding for these activities is almost always from public sources, though occasionally it includes angel or seed funding as well as private university funding. Other non-funding metrics useful for estimating this phase of activity include academic publications and patent application approvals. This stage is equivalent to NASA TRLs 1 through 4.

Early-stage research funding increased from $62 to $74.5 million (nearly 20%) over the latest three-year rolling averages. In total, between 2011 and 2017, clean energy companies and research centers that engage in Phase I clean energy research and prototyping attracted a total of $411 million through 1,011 deals. This accounts for almost 13% of total clean energy innovation investments for the state of New York over the last seven years. Between 2013 and 2016, Phase I investments declined slightly, but have since rebounded (Figure 16).

Figure 16. Overall Phase I Investments, Three-Year Rolling Averages, 2011-2017



Clean energy academic research has ramped up over the last eight years across New York State. Since 2010 there has been a steady increase in the number of clean energy-related journal publications by New York-based researchers. Over the last eight years, just under 900 peer-reviewed literature articles have been published across each of the five major technology areas (Figure 17). The largest body of academic articles is concentrated in the energy efficiency space, which comprised 43% of all clean energy-related journal publications since 2011. This is followed by alternative transportation, at roughly one-fifth of all clean energy-related publications (Figure 18).

Figure 17. Clean Energy Journal Publications, 2011-2017

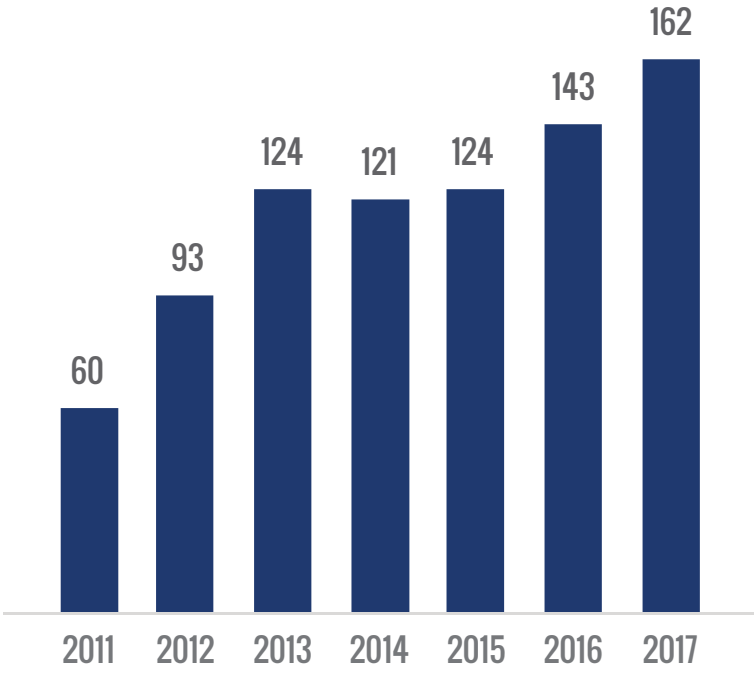
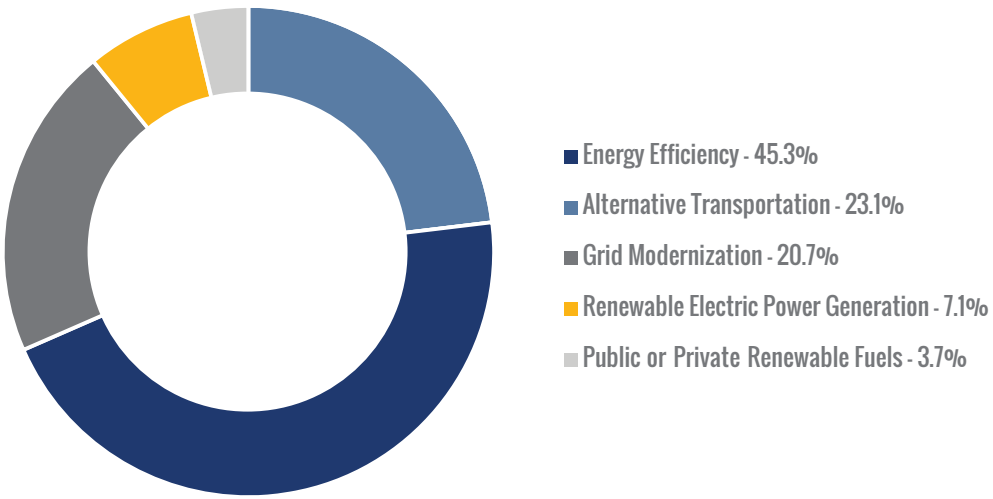


Figure 18. Clean Energy Journal Publications by Technology, 2010-2017



Excluding energy efficiency,

total number of Clean Energy patents filed by New York-based individuals and entities increased 28.8% between 2010 and 2017

Patent counts indicate both academic research activity and corporate research and development efforts, and typically trend with an industry's current and future growth. Excluding energy efficiency, the total number of clean energy patents filed by New York-based individuals and entities increased 28.8% between 2010 and 2017 (Figure 19).[16] Grid modernization and energy storage patents increased by more than 97%, while renewable fuels patents increased by 120%. Renewable electricity generation patents increased by the greatest amount: 140% between 2010–2017.

New York attracts large amounts of federal research funding and its universities and firms invest heavily in R&D. For 2018, NYSERDA's budget includes more than $21 million in federal grant funding. In 2015, New York State received $1 billion in federal funding, fourth in the nation. From 2006 to 2016, among the 20 states with the highest domestic R&D spending, New York was home to the highest compound annual growth rate (CAGR) on clean tech investments. New York's research universities also rank third in total research expenditures and in total licenses and options executed. The State also now ranks first overall in industry-sponsored university research expenditures, up from fourth in 2015. At $584 million, industry-sponsored research expenditures in 2017 accounted for over 10% of all R&D spending. This total marks a 6% increase since 2015, the largest such increase among the 10 states with the highest domestic R&D spending.

Phase II: Demonstration and Acceleration

This stage of innovation often involves startup firms' refinement of their technology and expansion of their commercial readiness. Activity in this phase draws in part on private capital, typically in the form of seed funding, and often also on grant programs aimed at economic development. Additional metrics useful for estimating activity in this phase include numbers of physical incubator or accelerator spaces, venture capitalist investors and early-stage venture investment, demonstration facilities, and technology transfer licenses. This stage is equivalent to TRL 5 through 7.

Phase II innovation investments accounted for the smallest portion of innovation funding in the years examined. In total, clean energy firms active in this stage of innovation attracted $176.3 million between 2011 and 2017 (more than 5% of total innovation dollars). Investments have remained steady for Phase II innovation, though there was a slight decline of about 8% since 2014. Public funding grew by 5% between the earliest and latest three-year rolling averages while private funding grew by more than 37% (Figure 20).

Figure 19. Clean Energy Patents 2010-2017

**Energy efficiency patent data unavailable for the year of 2017*

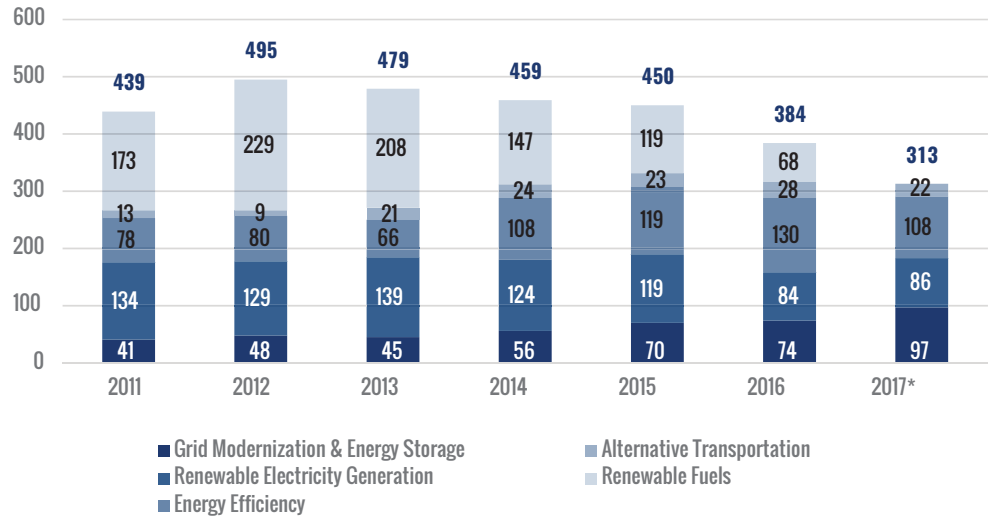
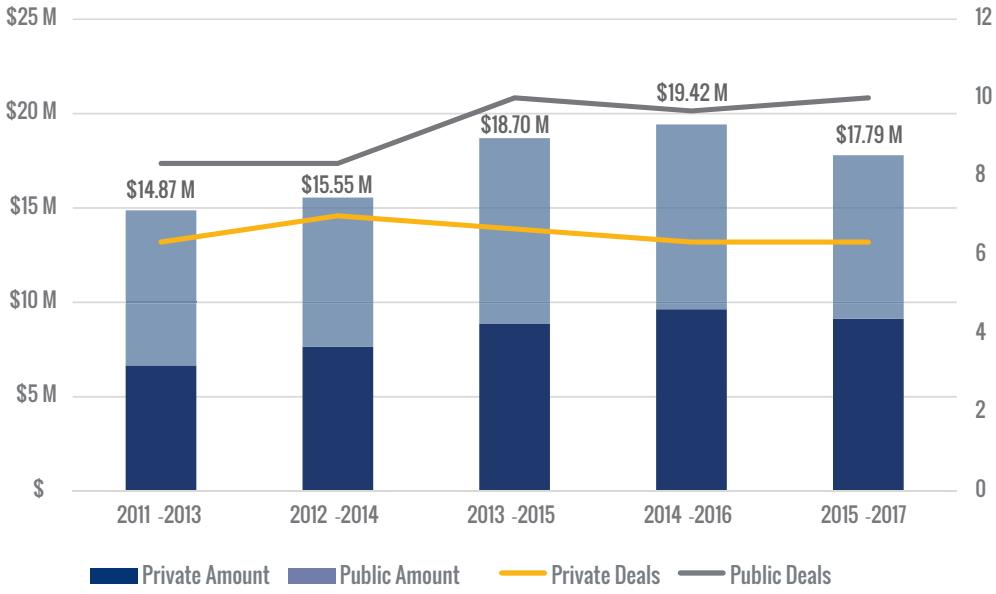


Figure 20. Overall Phase II Investments, Three-Year Rolling Averages, 2011-2017

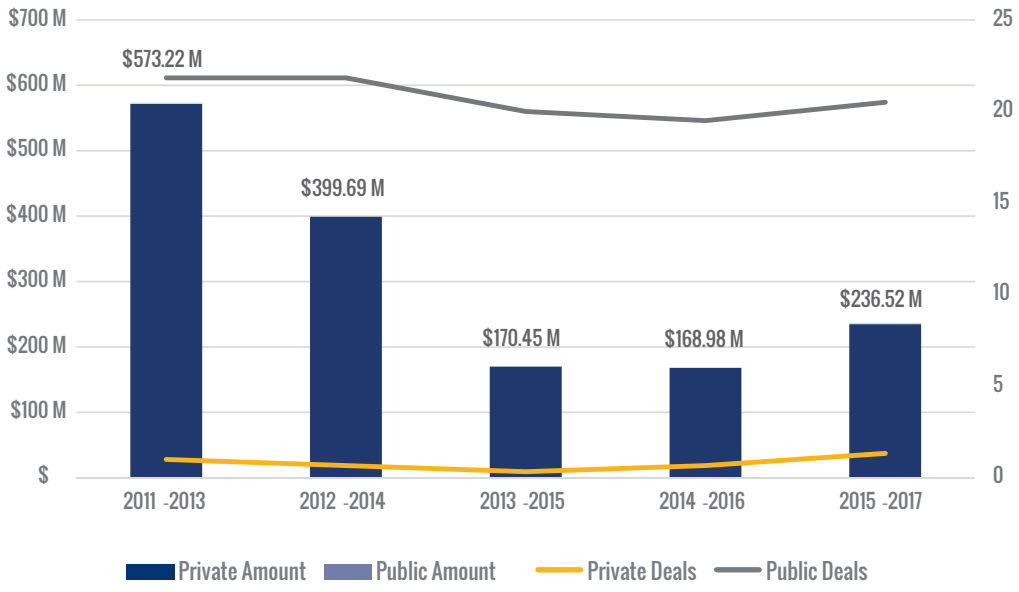


Phase III: Commercialization and Growth

In this final stage of innovation companies make fully developed products widely available. Useful metrics for this phase include quantities of venture capital and project finance, as well as economic development grant funding and tax incentives. This stage is equivalent to NASA TRL 8 through 9.

Clean energy firms with primary technologies in the commercialization and growth stage of innovation have attracted the largest proportion of innovation investments—more than 85% of total innovation funding over the last seven years. Funding for this innovation phase has also seen the greatest declines. Since 2011, measured using three-year rolling averages, investments have declined from a high of $573 million to roughly $237 million (58%). Phase III innovation investments have grown by 39% between the three-year rolling average of 2013 to 2015 and the latest rolling average—a period that saw no large outlier investments. Furthermore, an analysis, which excludes the two largest investments, reveals that Phase III innovation otherwise grew by nearly 62% between the earliest and most recent three-year rolling averages (Figure 21).

Figure 21. Overall Phase III Investments, Three-Year Rolling Averages, 2011-2017



Energy Efficiency Innovation Funding by Stage

Phase I Energy efficiency investments reached their peak during the 2013 through 2015 three-year period and made a modest recovery during the latest three-year period. Since the earliest three-year rolling average starting in 2011, early-stage innovation funding for energy efficiency has increased roughly 55.8%. Private phase I energy efficiency investments grew by 117% while public funding grew by more than 47% during this period. For energy efficiency, this phase is the second largest, amounting to $26.5 million in funding in 2017 (Figure 22).

Energy efficiency innovation funding in the demonstration and acceleration phase is the smallest energy efficiency funding phase and has remained relatively stable, though the latest three-year rolling average indicates that funding has decreased by almost 6% since the three-year period beginning in 2011. This decline in funding was due to a 21% decrease in public funding: private funding in the same period increased by 17% (Figure 23).

The commercialization and growth phase of energy efficiency innovation funding has seen steady declines since 2011. Measured using three-year rolling averages, it has declined by approximately 60% since the earliest three-year rolling average (Figure 24).

Phase I

$26.5 million in funding in 2017

Phase II

funding has remained mostly stable

Phase III

funding has declined 60% since earliest three-year rolling average

Figure 22. Energy Efficiency Phase I Investments, Three-Year Rolling Averages, 2011-2017

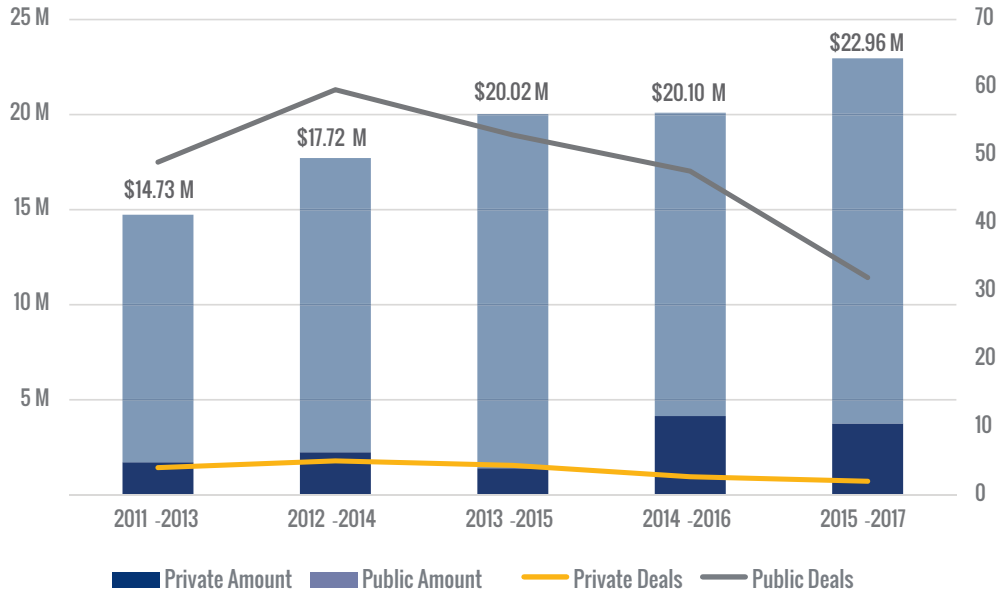


Figure 23. Energy Efficiency Phase II Investments, Three-Year Rolling Averages, 2011-2017

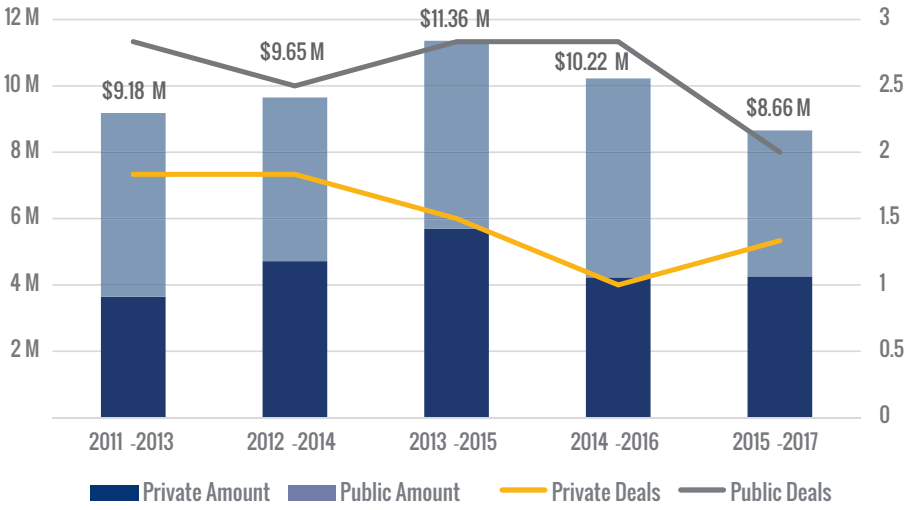
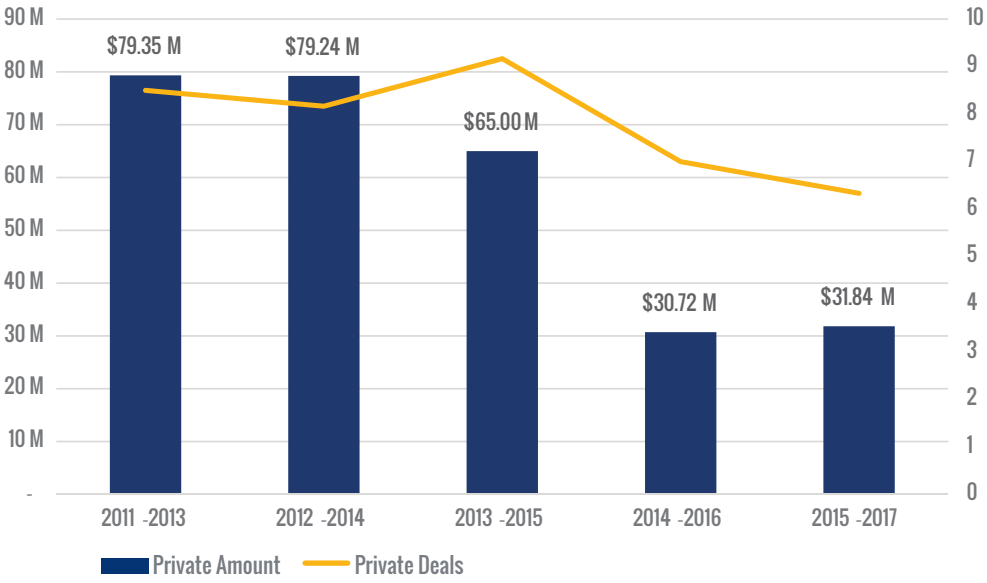


Figure 24. Energy Efficiency Phase III Investments, Three-Year Rolling Averages, 2011-2017

** These investments did not include any public spending.*



Renewable Electric Power Generation Innovation Funding by Stage

Early-stage research and development funding for renewable electric power generation has seen a 56% decline since the earliest three-year rolling average, though private funding grew by a dramatic 1,847%. The total amount of Phase I innovation funding for the latest three-year period for renewable electric power generation was $5,697,342 (Figure 25).

Funding in the second and smallest phase of development for renewable electric power generation has seen a 44% decline since the earliest three-year period. The total amount of Phase II innovation funding for the latest three-year rolling average for renewable electric power generation was $1,496,438. Public funding declined by 80% while private funding increased by nearly 19% during this time (Figure 26).

Phase III renewable electric power generation funding totaled $1.9 billion between the years of 2011 and 2017, making it by far the largest phase of renewable electric power generation funding. Between the first and last three-year periods shown, funding decreased by 72%. An analysis which excludes the two large outlying investments shows that Phase III renewable electricity generation increased steadily by 252% since the earliest three-year period (Figure 27).

Phase I public funding declined while private funding grew

Phase II funding has declined by 44%

Phase III funding totaled $1.9 billion between 2011 and 2017

Figure 25. Renewable Electric Power Generation Phase I Investments, Three-Year Rolling Averages, 2011-2017

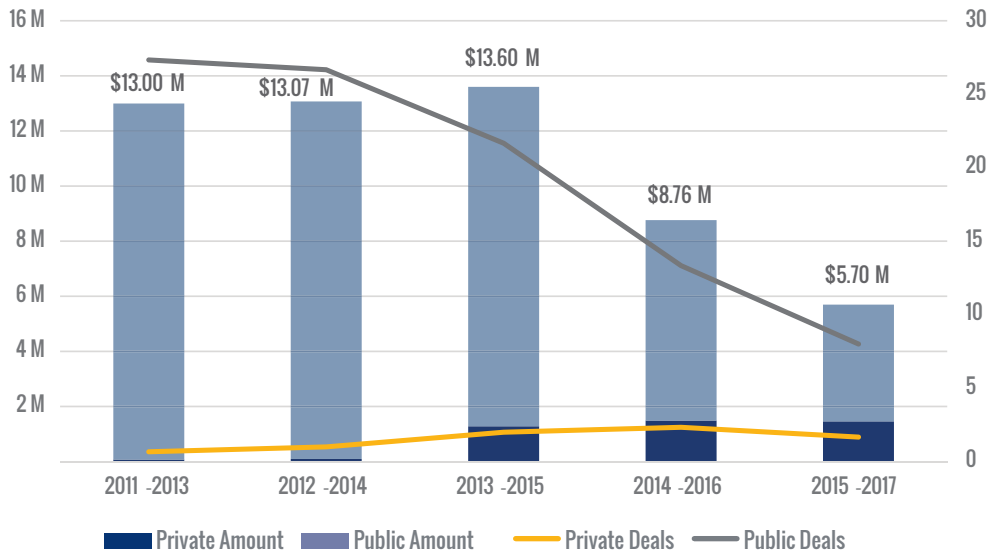


Figure 26. Renewable Electric Power Generation Phase II Investments, Three-Year Rolling Averages, 2011-2017

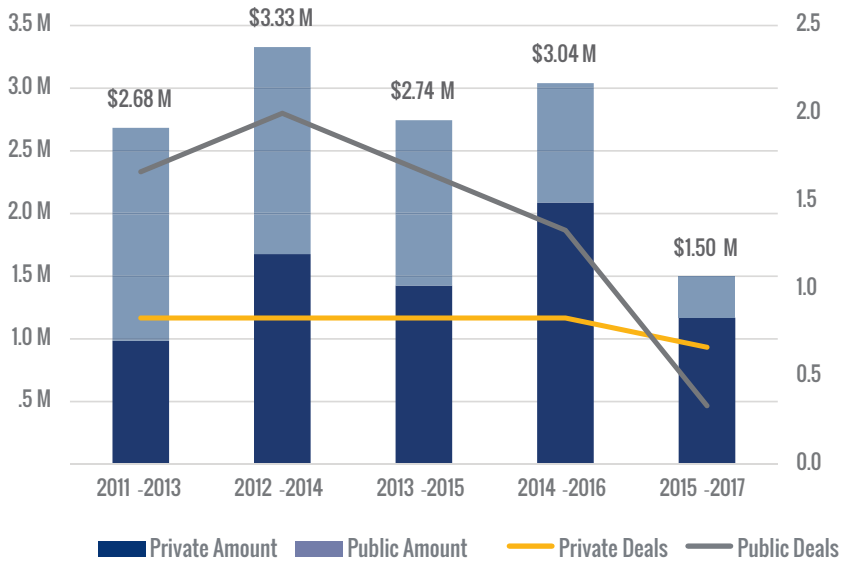
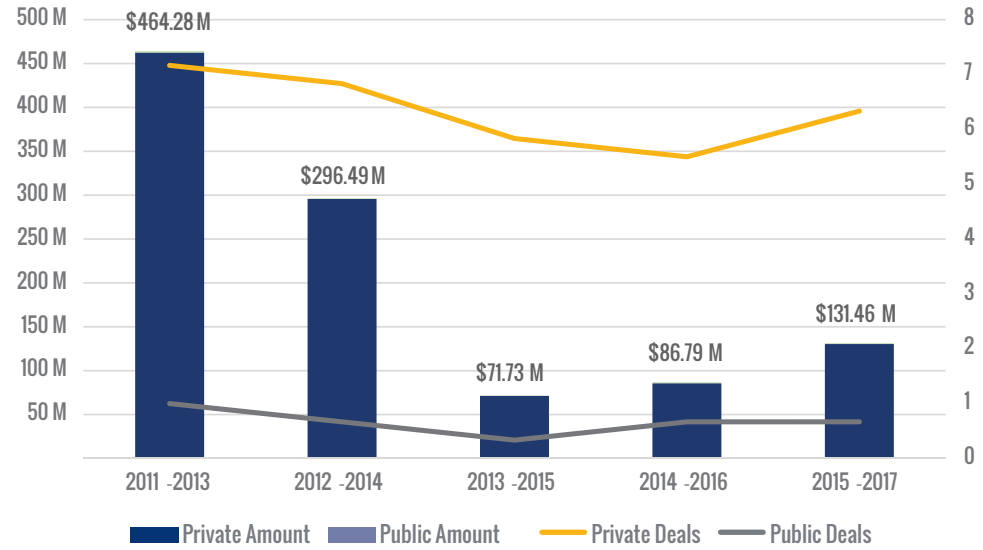


Figure 27. Renewable Electric Power Generation Phase III Investments, Three-Year Rolling Averages, 2011-2017

** Because the public amounts are small relative to the private ones, they do not appear prominently.*



Grid Modernization and Energy Storage Innovation Funding by Stage

The first phase of grid modernization and energy storage innovation funding has seen a 25% decline since the first three-year rolling average. Between 2011 and 2017, this phase has received a total of $63.7 million, making it the second largest innovation funding phase for this technology (Figure 28).

The second phase of funding has seen a relatively steady increase. Between the first and last three-year rolling averages, funding has increased by more than 121%. Since 2011, this phase has seen just over $25 million of funding, making it the smallest of the three phases (Figure 29).

The commercialization and growth phase for grid modernization and energy storage has also seen relatively steady increases in investment. Between the first and the latest three-year rolling average, funding has more than doubled, growing a tremendous 181%. All told, funding raised for this phase has totaled more than $270 million, making it the largest of the three phases for this technology category (Figure 30).

Phase I

$63.7 million in funding 2011 to 2017

Phase II

funding has increased 121% since first three-year rolling average

Phase III

funding as grown 181% since first three-year rolling average

Figure 28. Grid Modernization and Energy Storage Phase I Investments, Three-Year Rolling Averages, 2011-2017

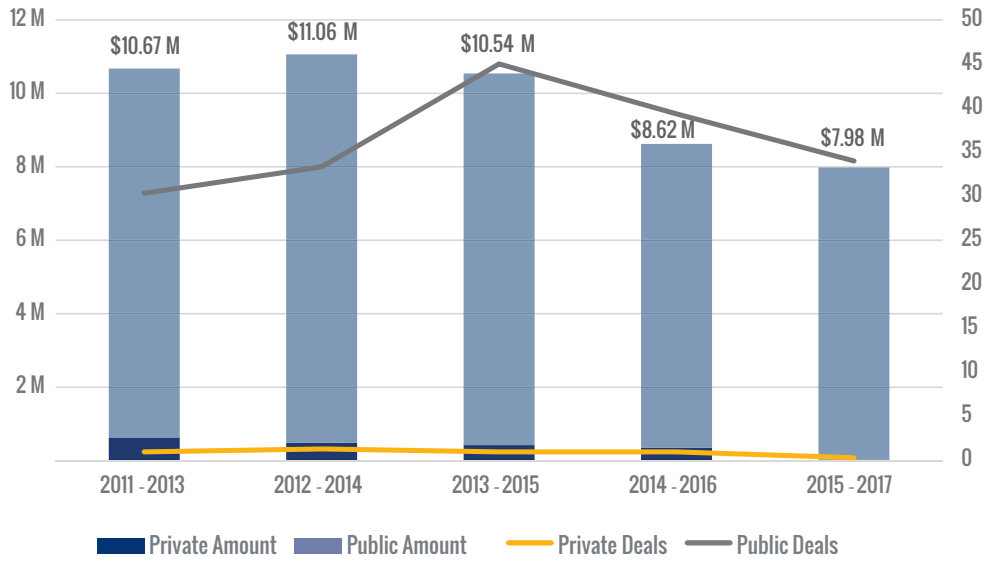


Figure 29. Grid Modernization and Energy Storage Phase II Investments, Three-Year Rolling Averages, 2011-2017

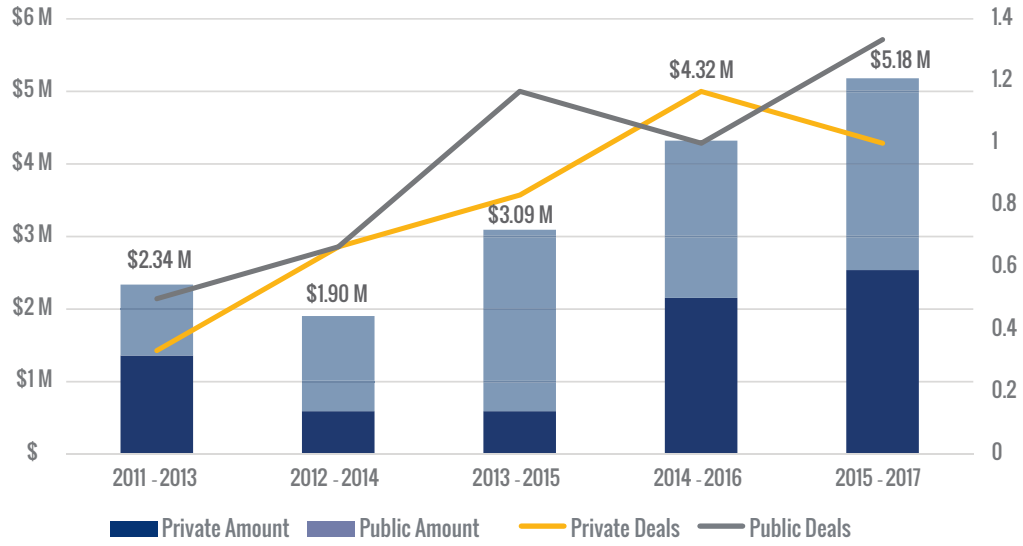
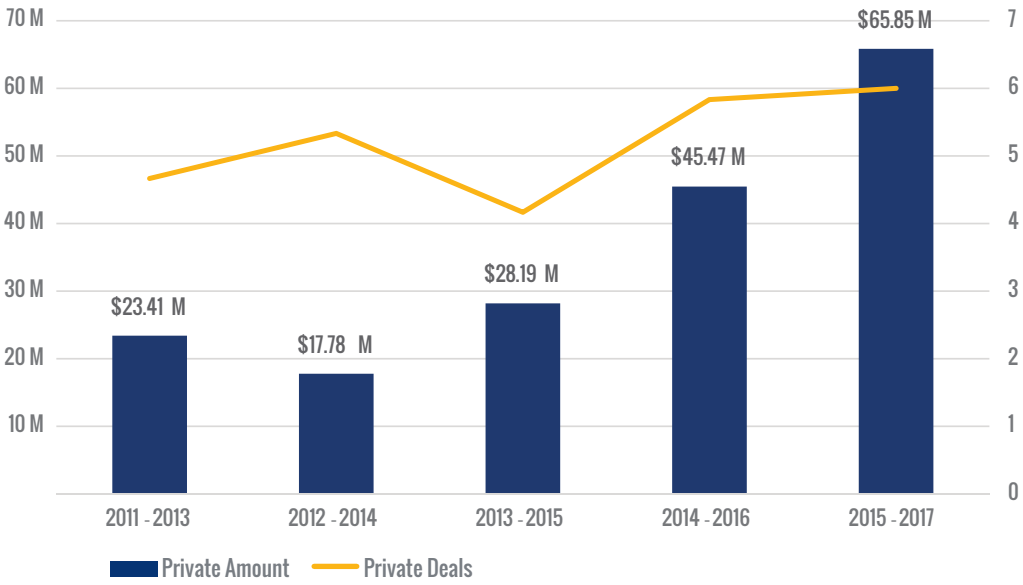


Figure 30. Grid Modernization and Energy Storage Phase III Investments, Three-Year Rolling Averages, 2011-2017

** These investments did not include any public spending.*



Renewable Fuels Innovation Funding by Stage

Phase I

151% growth with $12 million in funding since first three-year rolling average

Phase II

funding has leveled out

Phase III

funding increased 27% since first three-year rolling average

The early research and investment stage funding for renewable fuels has grown 151% between the first and latest three-year period, though it is now below its peak. This phase is the second largest for renewable fuels, totaling almost $12 million between 2011 and 2017 (Figure 31).

Phase II funding has leveled out, but saw 75% growth between the earliest and latest three-year periods. It is also the smallest phase within renewable fuels, having received $5.5 million between 2011 and 2017 (Figure 32).

Phase III for renewable fuel innovation funding has seen consistent and steady growth, resulting in a 27% increase in funds raised between the earliest and latest periods measured. Between the years of 2011 and 2017, this phase attracted a total of more than $41 million in investments, making it the largest phase of funding for renewable fuels (Figure 33).

Figure 31. Renewable Fuels Phase I Investments, Three-Year Rolling Averages, 2011-2017

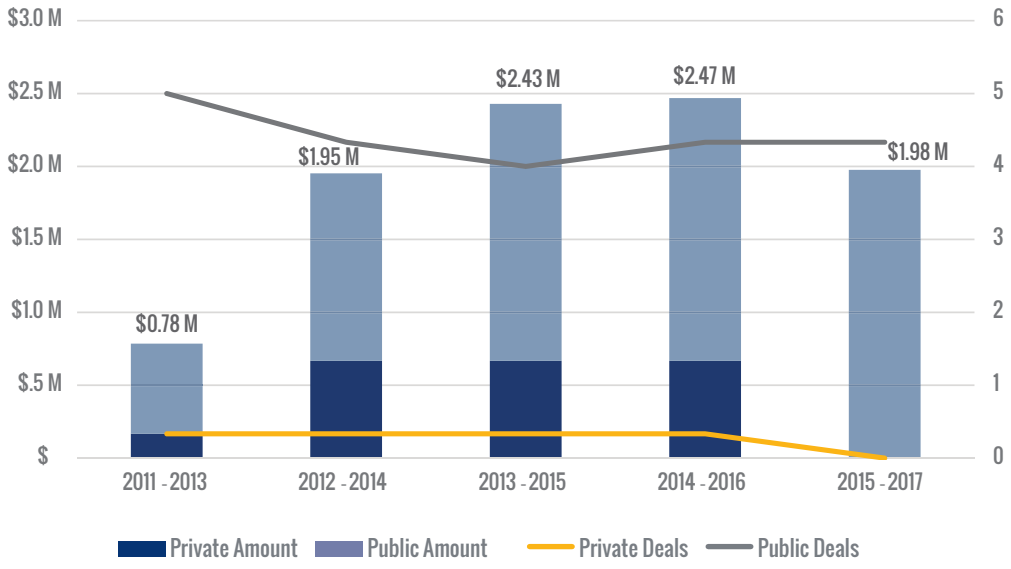


Figure 32. Renewable Fuels Phase II Investments, Three-Year Rolling Averages, 2011-2017[17]

*These investments did not include any public spending

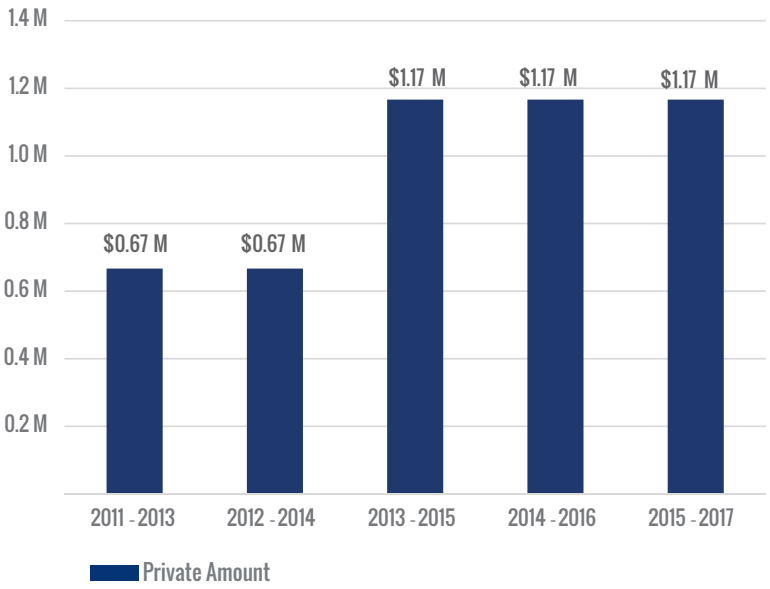
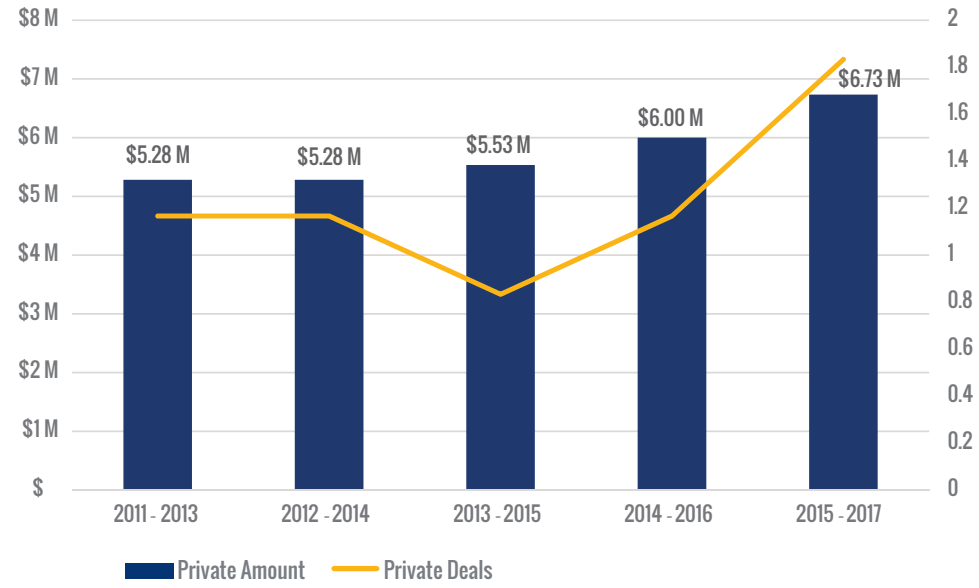


Figure 33. Renewable Fuels Phase III Investments, Three-Year Rolling Averages, 2011-2017

*These investments did not include any public spending



Alternative Transportation Innovation Funding by Stage

Innovation funding for Phase I of alternative transportation totaled nearly $29 million, making it the largest of this technology's funding phases. This phase has seen a steady decline in funding, falling 39% between the earliest and latest three-year averages (Figure 34).

The second phase of alternative transportation innovation funding saw a consistent but modest rise in funding. Raising only a total of $3.8 million between 2011 and 2017, this phase was the smallest of the three for this technology (Figure 35).

The third phase of funding for alternative transportation innovation investments was somewhat inconsistent and irregular. Funding for this phase totaled $4.6 million between 2011 and 2017, making it the second largest phase of innovation funding for alternative transportation. That amount was the result of $2.7 million (private) invested in 2012 and over $1.9 million (public) in 2017.

Phase I
funding totalled nearly $29 million

Phase II
funding as been consistent but modest with a total growth of $3.8 million 2011 to 2017

Phase III
funding totalled $4.6 million 2011 to 2017

Figure 34. Alternative Transportation Phase I Investments, Three-Year Rolling Averages, 2011-2017

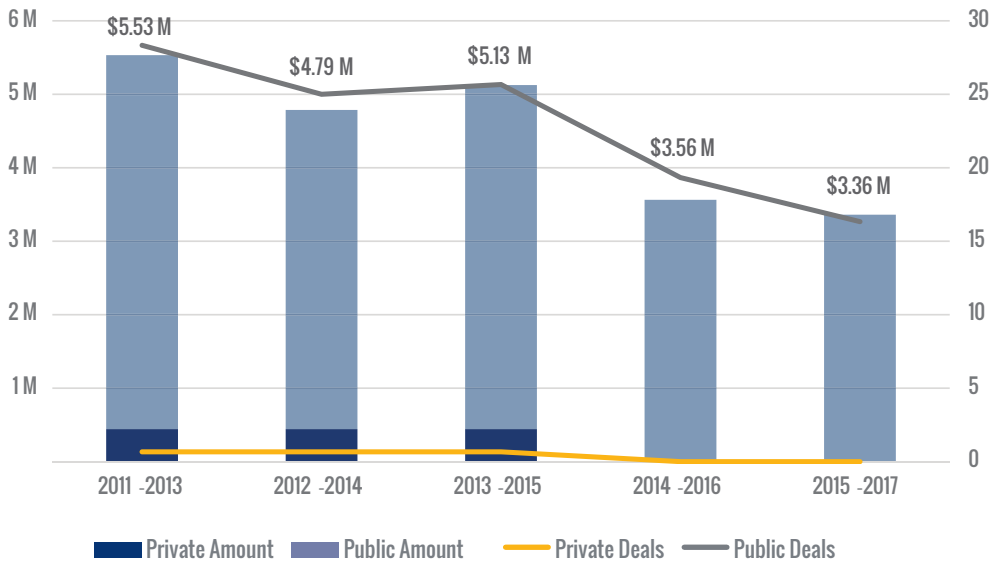
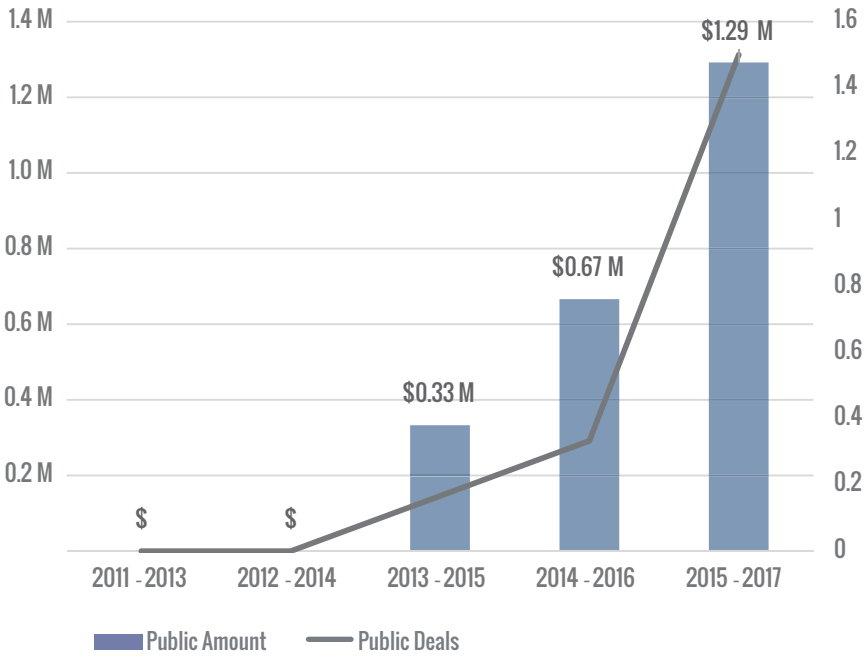


Figure 35. Alternative Transportation Phase II Investments, Three-Year Rolling Averages, 2011-2017

**These investments did not include any private spending*



Appendix A:

Economic Impact of Clean Energy Job Growth in New York

Introduction

NYSERDA commissioned BW Research to estimate the economic impact of the net change in clean energy jobs in New York from 2016 to 2017. The first step in this analysis was to extract a New York-specific subset of the United States Energy and Employment Report's (USEER) national dataset. The USEER uses NAICS codes to categorize the jobs that it disaggregates into major technology and sub-technology categories and related value chains. The energy jobs methodology used for USEER is identical to the one used for the 2017 New York Clean Energy Industry Report (NYCEIR).

To determine the size of the overall clean energy economy in New York, BW Research conducted a further round of modeling. The research team started with the change in energy jobs calculated using the USEER methodology and entered those values into the Economic Impact Analysis for Planning (IMPLAN), an input-output model that traces spending and infrastructural developments through the economy. IMPLAN calculated the impacts of the changes in various categories of New York clean energy jobs on output, earnings, and value added in New York's wider economy. This appendix describes that methodology, its outputs, and the analytic results revealed by those outputs.

Methodology

BW Research used IMPLAN to determine the economic impact of the change in clean energy jobs within New York's borders in 2017. The cumulative effects of the net change in clean energy jobs were quantified, and the results categorized into direct, indirect, and induced effects. Direct effects are those associated with the initial job creation (or loss), and occur within the clean energy industry. Indirect effects include responses to the net change in clean energy jobs, felt throughout clean energy firms' supply chains. Induced effects result from household spending by workers at clean energy industry firms and firms in the industry's supply chains.

Model Input

To develop the economic model in IMPLAN, BW Research identified the clean energy job net change in New York State, disaggregated by NAICS code between 2016 and 2017, as calculated for the 2018 NYCEIR. This number was termed in-scope jobs. All job changes from 2016 to 2017, whether positive or negative, were then added as inputs to IMPLAN by NAICS code, based on the crosswalk from NAICS to IMPLAN codes (Figure 48). The study area was set as New York State, the event year was set to 2017, and the local purchase percentage (LPP) was set to 100% since it was known that these job changes occurred in the State.

Figure 48: Economic Impact Analysis Model

Model Output

Results from the economic impact analysis included employment[23] (full- and part-time jobs), labor income, value added, and total output. Output includes total revenues or sales (for retail and wholesale trade, output = gross margin and not gross sales). Value added is the total output minus the cost of inputs from outside the firm; it is a measure of the contribution to the Gross Regional Product made by the company(ies) or industry(ies). Labor income includes all forms of employment income, such as employee compensation (wages and benefits) and proprietor income (i.e., payments received by self-employed individuals and unincorporated business owners). All these economic impacts are added to present a sum total for the State's overall clean energy economy.

Addressing Supply and Value Chain Double-Counting

Because the jobs data inputted to IMPLAN included direct and indirect jobs, there was a risk that IMPLAN's outputs would reflect double counting. To explain, when using jobs as an input (as we do in our analysis) compared to sales or expenditures, it is important to determine whether the jobs counted should be considered direct or indirect jobs. For example, new construction jobs entered in IMPLAN have an impact through the entire clean energy industry value chain (e.g., by prompting the purchase ENERGY STAR boilers), as well as in non-energy industries (e.g., the worker buys milk with the new wages, supporting New York dairy farmers). So, if the supply chain jobs are entered in IMPLAN as direct jobs and the model also counts them as an indirect impact of new construction jobs, then double-counting has inflated the impacts of clean energy industry growth.

How then to determine the number of in-scope energy jobs that should be counted in IMPLAN as direct or indirect jobs, without eliminating activity that was not in initially included in the NYCEIR data? To address the double-counting challenge, the research team adopted the following methodology.

Step 1: Run detailed, individual models for each in-scope industry by IMPLAN code

The research team ran detailed models for each in-scope industry by IMPLAN code and analyzed the indirect jobs created by each in-scope industry. By creating individual models for each IMPLAN code, the team gained a better understanding of the jobs created in different indirect industries by changes in each in-scope industry.

Step 2: Compare the number of direct + indirect jobs by industry estimated in IMPLAN with the initial in-scope jobs

This step included looking at the number of direct + indirect jobs by industry and comparing it with the initial in-scope jobs by industry. Doing this enabled the team to analyze the supply chain jobs that are created by each in-scope industry and then adjust the in-scope jobs number appropriately.

Step 3: Adjust (decrease) the initial in-scope jobs based on the direct + indirect jobs calculated in the IMPLAN model

This step reduced the counts of in-scope jobs based on the direct + indirect jobs estimated by IMPLAN. For example, if IMPLAN, based on in-scope construction jobs, calculated that x number of indirect jobs were created in wholesale trade, the team would exclude that x number from the initial in-scope jobs in wholesale trade since they were already accounted for as indirect construction jobs.

This step addresses the fundamental challenge of this study, namely determining the proportion of in-scope jobs that should be considered direct or indirect (supply-chain) jobs. Following this methodology avoided counting in-scope jobs twice, once as the direct result of clean energy industry activity and again as an indirect result of that activity.

Step 4: Re-run the IMPLAN model with the "adjusted" in-scope jobs by industry

After running several individual and collective models, the last step was to re-run the IMPLAN model one more time with the adjusted number of in-scope jobs by industry. The industries that needed input adjustments (due to their role in other industries' supply chains) included legal services, wholesale trade, architectural, engineering, and related services, other financial investment activities, management consulting services, software publishers, grantmaking and social advocacy organizations, and semiconductor and related device manufacturing.

Final Output

Direct = "adjusted" in-scope industry jobs by sector to account for the indirect jobs IMPLAN calculates

Indirect = indirect jobs produced by the model in both in- and out-of-scope industries

Induced = all induced jobs calculated in IMPLAN

Results

Economic Impacts of Clean Energy Jobs on New York State

Between 2016 and 2017 there was a positive net change of 5,586 jobs in a variety of industries. The industries with the largest job growth were plumbing, heating and air-conditioning contractors, electrical contractors, legal offices, computer programming services, and drywall and insulation. The industries experiencing the largest job losses were semi-conductor and related devices manufacturing, sheet metal manufacturing, fabricated structural metal manufacturing, chemical products merchant wholesalers, and site preparation contractors.[24]

This important step addresses the fundamental challenge of this study, which is determining the proportion of in-scope jobs that should be considered direct or indirect (supply-chain) jobs. This methodology avoided double-counting the in-scope jobs that would occur if all of them would be considered direct jobs.

As previously discussed, the 5,586 net jobs were adjusted to account for overlap, and based on this adjustment it was determined through modeling that there was a total direct impact of 5,327[25] jobs created by clean energy economic activity, an indirect impact of 1,339 jobs created, and an induced impact of 2,419 jobs created, for a total of 9,085 jobs in New York in 2017. These jobs were responsible for $697 million in labor income. (Table 5). With the creation of each direct clean energy job in New York, another 0.70 jobs are also created, yielding a total (the sum of direct, indirect, and induced) of 1.71 jobs. Of each 1.71 jobs, indirect jobs account for 0.25 and induced jobs for the remaining 0.45.

Induced impacts were larger than indirect impacts; 27% of the jobs created were induced and 15% were indirect

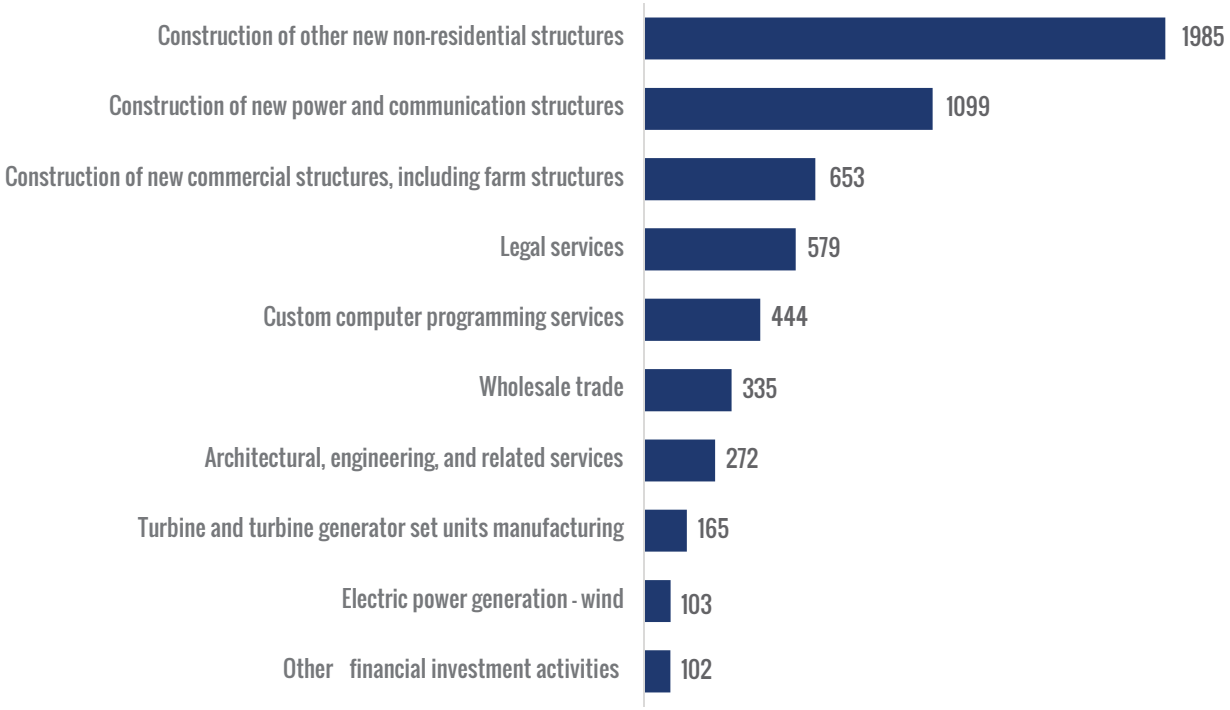
Table 5. Total Economic Impact of the Net Change in Clean Energy Jobs in New York State, 2016-2017

Impact Type	Employment	Labor Income
Direct Effect	5,327	$455,236,964
Indirect Effect	1,339	$100,385,716
Induced Effect	2,419	$141,515,921
Total Effect	**9,085**	**$697,138,600**

Direct (or Clean Energy) Industries

The clean energy industries with the largest direct job growth include construction of nonresidential structures, construction of new power and communication structures and new commercial structures, legal services, and computer programming services (Figure 49).

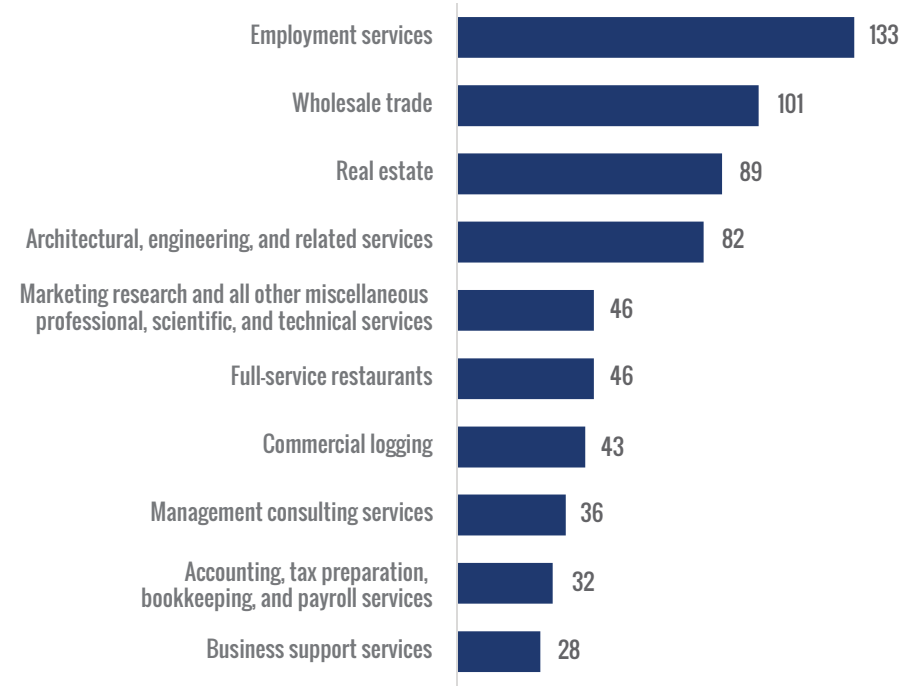
Figure 49. Top 10 Clean Energy Industries in New York State by Employment, 2017



Indirect (or Supply Chain) Industries

Among the industries that make up the supply chain for New York's clean energy sector, those that saw the largest job growth from 2016 to 2017 were employment services, wholesale trade, real estate, architectural and engineering services, and marketing research and other professional services (Figure 50).

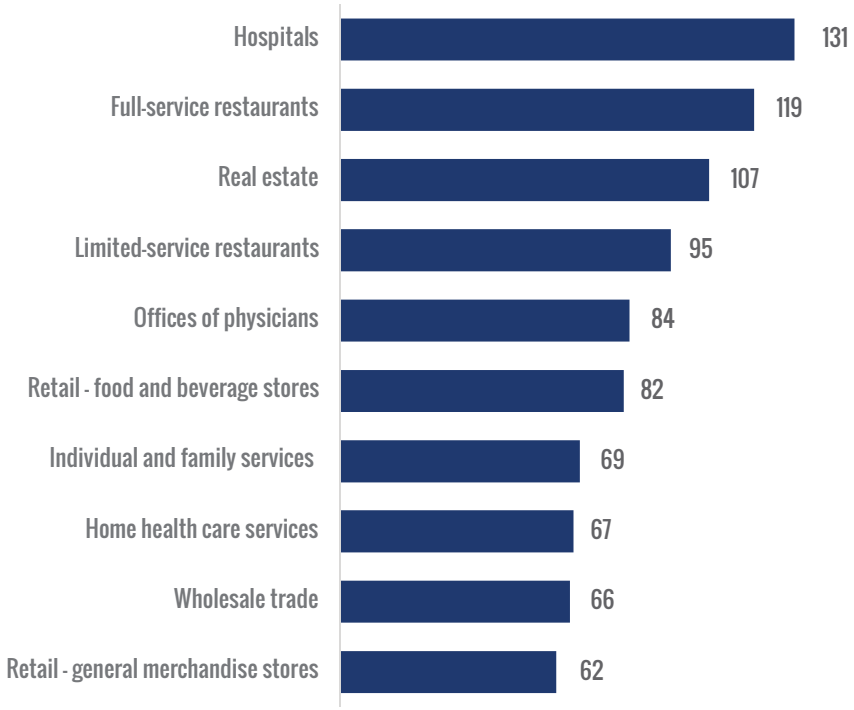
Figure 50. Top 10 Supply Chain (Indirect) Industries in New York State by Employment, 2017[26]



Induced Industries

Whereas clean energy supply chain industries feel the effects of clean energy firms' additional investments and spending, other industries feel the more indirect ("induced") effects of clean energy workers' in-State spending. These include hospitals, full-time restaurants, real estate, limited-service restaurants, and physicians' offices (Figure 51). Recognizing the job growth induced by clean energy worker spending, along with direct and indirect job growth, provides a holistic view of the impacts New York clean energy industry growth has had in the State.

Figure 51. Top 10 Induced Industries in New York State by Employment, 2017[27]



Fiscal Impacts

New York's clean energy economy makes meaningful annual contributions to federal, State, and local taxes. New York's clean energy jobs are responsible for over $103 million in State and local taxes and almost $161 million in federal taxes (Table 6). More then half of the State and local portion of these taxes (60%) are levied on production and imports (e.g., sales, property, motor vehicles), 30% are household taxes (e.g., income, property, and motor vehicle license taxes), 8% are corporate taxes (dividends and corporate income), and 2% are employee compensation taxes. Of the federal taxes levied, 41% are household taxes, 39% are employee compensation taxes, 13% fall on corporations, 4% on production and imports, and 3% on proprietor income.

Table 6. Impact of New York Clean Energy Jobs on Taxes, 2017

Taxes	Impact on Taxes
State and Local Taxes	$103,438,893
Federal Taxes	$160,905,089

Additional Outputs

Job Distribution

As mentioned previously, this study's economic analysis used multiple individual models to understand the relationship between direct and indirect jobs across multiple industries. This approach makes it possible to estimate the distribution of direct, indirect, and induced jobs created in New York by activity in the clean energy industry. For example, as Table 7 shows, the legal services jobs created by clean energy industry activity are predominantly a direct result of that activity—that is, the money flowing to law firms results with minimal exceptions in the hiring of lawyers and staff to work on clean energy sector deals and cases. By contrast, the money flowing from the clean energy industry to personal and household goods repair and maintenance firms results in the hiring of employees whose work relates indirectly or not at all to clean energy industry activity (Table 7).

Table 7. Type of Job Created by In-Scope Industry[28]

Description	Direct	Indirect	Induced
Legal services	93%	4%	3%
Wholesale trade	50%	30%	20%
Architectural, engineering, and related services	66%	30%	3%
Turbine and turbine generator set units manufacturing	99%	1%	0%
Other financial investment activities	64%	8%	28%
Management consulting services	36%	48%	16%
Power boiler and heat exchanger manufacturing	99%	1%	0%
Metal window and door manufacturing	95%	5%	0%
Management of companies and enterprises	0%	47%	53%
Lighting fixture manufacturing	96%	3%	0%
Personal and household goods repair and maintenance	0%	43%	57%
Software publishers	66%	12%	22%
Commercial and industrial machinery and equipment repair and maintenance	0%	71%	29%
Grantmaking, giving, and social advocacy organizations	23%	0%	77%
Heating equipment (except warm air furnaces) manufacturing	81%	16%	3%
Mineral wool manufacturing	91%	6%	3%
All other miscellaneous electrical equipment and component manufacturing	99%	1%	0%
Wiring device manufacturing	89%	11%	1%
Motor and generator manufacturing	99%	1%	0%
Industrial gas manufacturing	97%	3%	0%
Fabricated structural metal manufacturing	95%	5%	0%
Semiconductor and related device manufacturing	98%	1%	0%

Out-of-Scope Industries

One benefit of using an economic model like IMPLAN is that it identifies job growth in industries that are affected by the clean energy industry but are not part of that industry. Identifying job growth in these out-of-scope industries provides a better idea of the overall size of New York's clean energy economy and will also help to improve estimates of in-scope industries in future years. Table 8 provides a list of New York's Clean Energy supply-chain industries not included in the original dataset (by IMPLAN sector) and the jobs attributable to clean energy industry growth in those industries.

Table 8. New York's Clean Energy Out-of-Scope Indirect Industries

Description	Indirect Jobs (2017)
Marketing research and all other miscellaneous professional, scientific, and technical services	46
Commercial logging	43
Accounting, tax preparation, bookkeeping, and payroll services	32
Business support services	28
Scenic and sightseeing transportation and support activities for transportation	27
Office administrative services	26
Truck transportation	23
Maintenance and repair construction of nonresidential structures	19
Investigation and security services	18
Commercial and industrial machinery and equipment rental and leasing	18
Advertising, public relations, and related services	15
Other concrete product manufacturing	9
Insurance agencies, brokerages, and related activities	9
Computer systems design services	9
Other computer related services, including facilities management	9
Data processing, hosting, and related services	9
Environmental and other technical consulting services	9

Conclusion

In 2017, the clean energy economy in New York was responsible for adding and supporting 5,327 jobs directly, 1,339 jobs indirectly, and inducing a further growth of 2,419 jobs—a total of **9,085 jobs** (Table 9).

Table 9. Impact of New York's clean Energy Jobs, 2017

Impact Type	Employment
Direct Effect	5,327
Indirect Effect	1,339
Induced Effect	2,419
Total In-State Effect	**9,085**

This aggregate economic activity yielded **$697 million** in total labor income and resulted in $160.9 million paid in federal taxes and $103 million in State and local taxes.

Appendix B:
Methodology

The research methodology employed for this report, including the survey instrument and sampling plan, has been reviewed rigorously 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 (2016 USEER & 2017 USEER) and has been used increasingly as a tool for measuring clean energy industry jobs and businesses across multiple states, including in California, Massachusetts, Florida, Illinois, Iowa, Missouri, Ohio, Pennsylvania, Rhode Island, Tennessee, and Vermont.

Data Sources

Jobs and Businesses Data

Jobs and business data are collected from federal data sources, State data sources and employer surveys; survey data references the 12 months between Q4 2016 and Q4 2017. 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.

Investment Capital and Innovation Data

This report uses investment data from Cleantech Group's i3 Platform, which it supplements with the following datasets: ARPA-E, SBIR/STTR awards from the Department of Energy, NYSERDA grants, loans, and consumer incentives, utility rebates and incentives, and SunShot Initiative funding. The i3 data platform was selected for this analysis since every investment included in the database is independently cited and can be verified, unlike many other collections that do not disaggregate their data. The Platform is a comprehensive catalogue of innovative clean energy companies worldwide; its datasets can be filtered by technology, investment type, geography, and time frame. The data reported indicate both total dollar amounts and "deals," meaning the number of individual investment agreements closed.

The following delineation was created to understand the potential funding and data sources to gather and compile a comprehensive dataset for this year's report.

Public Return on Investment: Includes all public loans for clean energy programs and public projects such as infrastructure improvements (including energy efficiency upgrades to State-owned buildings), publicly-owned renewable energy projects or facilities, and publicly-owned or sponsored demonstration projects and facilities, such as those funded by NYSERDA or NY Green Bank.

Public Consumer Incentive Programs: Public incentive programs designed to increase consumption of clean energy goods and services.[29] Includes all utility- and NYSERDA-sponsored rebate and incentive programs.

Private Return on Investment: Investments made by venture capitalists and entrepreneurs in support of clean energy technologies, particularly during demonstration, acceleration, and commercialization phases. The research team and NYSERDA conducted an exhaustive search of sources for private investments for non-venture backed companies, including various forms of project and asset financing deals. It was determined that segments of these data relevant exclusively to New York are simply not available in an accessible form.

Private Out-of-Pocket Spending (excluded in this 2018 report): While an assessment of this category of spending is possible, it requires a nuanced approach that incorporates income and other detailed market data. This is recommended as an addition to the 2019 report to establish a more reliable baseline dataset.

Patent and Publications Data

This report uses patent data filings from the United States Patent and Trademark Office (USPTO) together with analytics provided by NYSERDA and 1790 Analytics. Publications data is pulled from the Clarivate Analytics platform. Specifically, this report used Clarivate's publication research intelligence service brand called "Derwent Innovation." Peer-reviewed journal articles are extracted from various collections, including *Web of Science*, *Current Contents Connect*, *Conference Proceedings*, and *Inspec*. This platform does not yet provide disaggregated publications data by sub-technologies. Publications data was pulled by searching select clean technology keywords with a publication year range of 2010 through 2017 for New York State. For the purposes of this study, the following filters were applied.

Renewable Electric Power Generation

- Nuclear electricity generation
- Hydro marine electricity generation
- Geothermal electricity generation
- Fuel cells hydrogen electricity generation
- Biomass electricity generation
- Wind electricity generation
- Solar electricity generation

Energy Efficiency

- Energy efficiency technology
- Semiconductors energy efficiency
- Green building construction
- Grid modernization and energy storage
- Smart grid
- Grid energy storage

Renewable Fuels

- Ethanol renewable fuel
- Biodiesel renewable fuel
- Cellulosic renewable fuel
- Fuel cells hydrogen renewable fuel
- Geothermal renewable fuel

Alternative Transportation

- Electric vehicle charging management software
- Natural gas vehicle refueling infrastructure
- Electric vehicle charging and management
- Battery switching station infrastructure
- Charge stations infrastructure
- Compressed natural gas vehicles
- Fuel cell vehicles
- Alternative fuel vehicles
- Plug-in hybrid
- Hybrid electric vehicle
- Electric vehicles

Survey Methodology

The 2018 New York Clean Energy Jobs data uses data prepared under a Memorandum of Understanding between the Energy Futures Initiative (EFI) and the National Association of State Energy Officials (NASEO) on New York energy employment.[30] These public data are refined and customized for New York based on NYSERDA's definition of the Clean Energy industry. Supplemental surveys for Energy Efficiency and Solar employers and employees were conducted on behalf of NYSERDA by BW Research Partnership, Inc.

Supplemental Employer and Employee Survey Methodology

Supplemental surveys were administered to a list of known clean energy industry employers as well as to online panels of energy efficiency and Solar employers and employees.

A standard supplemental survey instrument was administered to web panels and distributed by email, with more than 3,000 emails sent to energy efficiency and Solar employers across New York. The survey instrument was programmed internally by BW Research employees and each respondent was assigned a unique ID to prevent duplication.

In total, approximately 75 employers and 110 employees participated in the supplemental survey effort. The surveys were administered between January 23, 2018 and March 23, 2018 and averaged 10 minutes in length.

Appendix C:
Wage Data

Estimates of wages for New York's clean energy industry were derived from two forms of national-level data captured by Bureau of Labor Statistics (BLS). Specific occupational data were estimated using survey data and monthly data reports from the BLS Occupational Employment Statistics series (table AC-1). The data shown here are pulled directly from that series.

Table AC-1. Hourly wage ranges by BLS Standard Occupation Classification (SOC)

Standard Occupational Classification	Occupation Title	10th Percentile	Median	90th Percentile
17-2071	Electrical Engineers	$30.11	$47.20	$72.19
17-2141	Mechanical Engineers	$27.48	$41.56	$62.92
17-2199	Engineers, All Other	$25.48	$44.62	$71.13
41-4011.07	Solar Sales Representatives	$21.95	$41.84	$82.08
47-2131	Insulation Workers, Floor, Ceiling, and Wall	$10.14	$18.51	$30.48
47-2231	Solar Photovoltaic Installers	$15.63	$18.90	$26.56
49-9071	Maintenance and Repair Workers, General	$11.58	$20.41	$33.78
49-9081	Wind Turbine Service Technicians	$17.15	$24.32	$37.07
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$16.12	$26.62	$42.95
13-1199.01	Energy Auditors	$21.13	$36.39	$61.96
11-9199.09	Wind Energy Operations Managers	$25.59	$52.70	$95.82
11-9199.10	Wind Energy Project Managers	$25.59	$52.70	$95.82
17-2199.10	Wind Energy Engineers	$25.48	$44.62	$71.13
47-1011.03	Solar Energy Installation Managers	$23.44	$38.32	$62.92
17-2199.11	Solar Energy Systems Engineers	$25.48	$44.62	$71.13
47-4099.02	Solar Thermal Installers and Technicians	$15.25	$29.28	$57.28

Current wages as reported by the BLS Quarterly Census of Employment and Wages for six-digit industries were used for estimating wages for clean energy technologies (provided by Economic Modeling Specialists, Intl: www.economicmodeling.com). The estimates relied on industry-mix to determine wages by technology and were weighted by incidence and relative employment. Industry mix is the proportion of industries (by six-digit NAICS) that contribute to technology employment. For example, the industry-mix for clean electric power generation includes the following.

221111	Hydroelectric Power Generation
221114	Solar Electric Power Generation
221115	Wind Electric Power Generation
221116	Geothermal Electric Power Generation
221117	Biomass Electric Power Generation
221330	Steam and Air-Conditioning Supply
237110	Water and Sewer Line and Related Structures Construction
237130	Power and Communication Line and Related Structures Construction
238210	Electrical Contractors and Other Wiring Installation Contractors
238220	Plumbing, Heating, and Air-Conditioning Contractors
238290	Other Building Equipment Contractors
238320	Painting and Wall Covering Contractors
238390	Other Building Finishing Contractors
326199	All Other Plastics Product Manufacturing
332312	Fabricated Structural Metal Manufacturing
332322	Sheet Metal Work Manufacturing
333414	Heating Equipment (except Warm Air Furnaces) Manufacturing
333611	Turbine and Turbine Generator Set Units Manufacturing
333914	Measuring, Dispensing, and Other Pumping Equipment Manufacturing
334413	Semiconductor and Related Device Manufacturing
334512	Automatic Environmental Control Manufacturing for Residential, Commercial, and Appliance Use
335121	Residential Electric Lighting Fixture Manufacturing
335312	Motor and Generator Manufacturing
335911	Storage Battery Manufacturing
335999	All Other Miscellaneous Electrical Equipment and Component Manufacturing
423610	Electrical Apparatus and Equipment, Wiring Supplies, and Related Equipment Merchant Wholesalers
523930	Investment Advice
541110	Offices of Lawyers
541211	Offices of Certified Public Accountants
541310	Architectural Services
541320	Landscape Architectural Services
541330	Engineering Services
541370	Surveying and Mapping (except Geophysical) Services
541611	Administrative Management and General Management Consulting Services
541612	Human Resources Consulting Services
541613	Marketing Consulting Services
541614	Process, Physical Distribution, and Logistics Consulting Services
541618	Other Management Consulting Services
541690	Other Scientific and Technical Consulting Services
541713	Research and Development in Nanotechnology
541714	Research and Development in Biotechnology (except Nanobiotechnology)
811211	Consumer Electronics Repair and Maintenance
811212	Computer and Office Machine Repair and Maintenance
811213	Communication Equipment Repair and Maintenance
811219	Other Electronic and Precision Equipment Repair and Maintenance
811310	Commercial and Industrial Machinery and Equipment (except Automotive and Electronic) Repair and Maintenance
811412	Appliance Repair and Maintenance

Appendix D:

Leading Indicators

This study sought to identify leading indicators for clean energy employment. With only three years of comprehensive employment data, robust time-series regression analyses are not yet feasible. The following measures should to be tracked over future years to provide further insight into the drivers of clean energy sector growth.

Cost to Consumer: The inverse relationship between product cost and supply is a fundamental economic principle. Across the US, from 2008 to 2017, the cost of wind power declined 75% while generation increased from 26 gigawatts to 89 gigawatts, and a 71% decline in utility-scale solar costs helped expand capacity by 24,000 MWDC.[31]

Deployed Capacity: Similarly, the positive relationship between deployment and employment of clean energy products is well documented across the nation. As the solar market share of electrical generation grew from 0.1% to nearly 2% from 2010 to 2017, the industry experienced an over 150% increase in employment.

Renewable Portfolio Standards: The U.S. Department of Agriculture detailed the impact of RPS adoption in a 2013 memo, citing multiple studies that confirmed positive relationships between RPS adoption and clean energy deployment.[32] An Indiana University study suggests stringency is critical to the impact of a renewable mandate.[33]

Household Income: A 2012 study on variables contributing to spatial distribution of residential PV confirmed that higher income brackets were statistically significant and positively associated with residential solar PV share.[34]

Utility Prices: Consumer clean energy spending has long been assumed to be inversely related with costs of utility-provided electricity. However, there have been limited studies on this point since a 1988 academic article asserted that “increases in the probability of installing solar water heating are more than proportional to increases in the price of conventional energy sources.”[35]

Voting/Parties: Political ideology is correlated with spending and support for clean energy policies. A 2012 solar study found evidence that voting tendencies of a zip code closely aligned with PV installations.[36]

Public Expenditures: A 2011 study on government green purchasing power found that “clean energy funds have a significant impact on the share of renewable energy.”[37] There is an immediate benefit in measuring the direct impact of New York public spending on clean energy.

Private Investments: This study proposes to track the economic impacts of private investments across various clean energy sectors over time. Little relevant literature or accessible collections of observations exist.

Resource Availability: Economic principles suggest that there should be a correlation between renewable energy installations and the renewable energy potential at a given location, but the existing literature provides mixed empirical support for the proposition. A 2012 residential solar study found that a 1 kWh increase in potential solar capacity increases expected count of solar PV installations by 89.2%, but could not account for limited installation in states like Florida.[38]

End Notes

1 High-efficiency HVAC includes a small but growing amount of renewable heating and cooling devices.

2 These numbers differ somewhat from those reported by The Solar Foundation for 2017. As explained, this owes to a difference in the scope of workers counted: The Solar Foundation's year-over-year numbers cover only workers who spend a majority of their time on solar projects; this report's numbers cover workers who spend any of their time on solar projects.

3 Investments data for this report is displayed using three-year rolling averages to provide a more legible representation of trends over time. Because clean energy funding tends to have large spikes, or outlier years, three-year rolling averages serve to smooth out these outliers.

4 Statewide employment statistics are from the Bureau of Labor Statistics, Quarterly Census of Employment and Wages, total covered employment for New York between June 2016 and 2017. Extracted on 24 May 2018.

5 Majority-time workers are those that spend at least 50 percent, if not more, of their labor hours on clean energy-related business activities.

6 These are clean energy workers that dedicate all their labor hours to the clean energy portion of business.

7 Racial categories are based on U.S. Census categories.

8 The numbers for racial categories in each column sum to more than 100% because, per U.S. Census methodology, Hispanics may be of any race and so are also counted in applicable race categories.

9 Insufficient data were available to provide reliable estimates of the demographic breakdown of workers in the other three technology categories considered in this report.

10 "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.

11 See previous endnote for what "other" and "other support services" includes.

12 Swings in reported hiring difficulty reflect that the question is only asked of employers who participated in hiring activity over the previous 12 months, so the pool of employers surveyed changes annually. For more information on survey methodology and sampling plans, please refer to Appendix B.

13 Sample sizes for grid modernization and energy storage, renewable fuels, and alternative transportation were too small to indicate hiring difficulty trends with accuracy.

14 Like the 2017 Clean Energy Industry Report, this report describes the most recent available data on investments and innovation in a multi-year context. This approach reveals trends and allows for comparisons across years. Using three-year rolling averages makes it easier to see trends in the data.

15 https://www.nasa.gov/directorates/heo/scan/engineering/technology/txt_accordion1.html

16 Data for 2017 energy efficiency patents were not available as of the publishing of this report.

17 NYSERDA Department of Public Service. New Efficiency: New York. April 2018.

18 The Solar Foundation, National Solar Jobs Census, 2017.

19 NY-Sun Incentive Program, Residential, and Small Commercial: https://nysolarmap.com.

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

21 http://www.iangv.org/current-ngv-stats/

22 Employment refers to the annual average of monthly jobs (same definition used by QCEW, BLS, and BEA, nationally) and it includes both full- and part-time jobs.

23 Based on the NYCEIR jobs' NAICS code.

24 This number is different than the initial net change since some of the NYCEIR jobs were distributed into direct and indirect jobs as part of the methodology to avoid double counting.

25 As a result of the 2017 Clean Energy Net Job Change in New York.

26 As a result of the 2017 Clean Energy Net Job Change in New York.

27 Note: Industries with 100% direct jobs are not included in this table.

28 This includes energy efficiency, renewable energy, grid modernization and energy storage, alternative fuels, and clean transportation technologies.

29 https://www.usenergyjobs.org/

30 “Revolution Now.” NRDC, 10 Apr. 2018, www.nrdc.org/revolution-now.

31 Xiarchos, Irene M, and William Lazarus. Factors Affecting the Adoption of Wind and Solar-Power Generating Systems on U.S. Farms. US Department of Agriculture, 2013.

32 “States Boost Renewable Energy and Development with Energy Standards.” News at IU Bloomington, Indiana University, 23 July 2018.

33 Kwan, Calvin Lee. “Influence of Local Environmental, Social, Economic and Political Variables on the Spatial Distribution of Residential Solar PV Arrays across the United States.” Energy Policy, vol. 47, 2012.

34 Durham, Catherine A., et al. “The Impact of State Tax Credits and Energy Prices on Adoption of Solar Energy Systems.” Land Economics, vol. 64, no. 4, 1988.

35 Kwan.

36 Xiarchos.

37 Kwan.

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