New York Clean Energy Industry Report 2021

NEW YORK STATE OF OPPORTUNITY. | NYSERDA

Letter from NYSERDA President and CEO

Dear Partners and Friends,

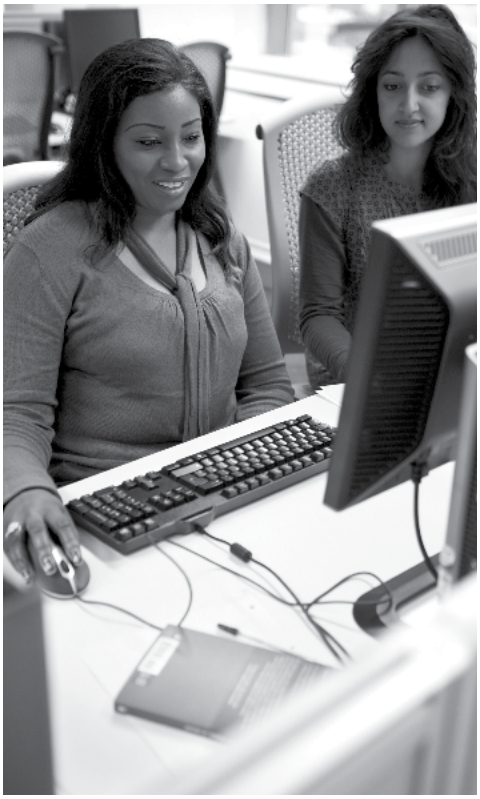
I am delighted to present the findings of NYSERDA's 2021 New York Clean Energy Industry Report — an in-depth review of important sector-specific job patterns and trends within the State. This year's report provides a deep dive into offshore wind, alternative transportation, and workforce development for priority populations — all of which are essential for future job growth and creating a more diverse and equitable workforce.

Under Governor Kathy Hochul's visionary leadership, New York State is committed to the most aggressive clean energy and climate agenda in the country. New York's Climate Leadership and Community Protection Act (Climate Act) sets goals to achieve 70% of renewable energy sources by 2030, establish a zero-carbon electricity sector by 2040, and reduce greenhouse gas emissions by 85% from 1990 levels by 2050. This ambitious framework is underpinned by a commitment to a just clean energy transition that creates jobs, fosters a green economy, and builds healthier communities.

This report, focusing on data from the end of 2020, shows that New York lost approximately 6,000 clean energy jobs amidst the COVID-19 pandemic. This represents the first employment decline since this annual reporting series began in 2015. However, New York's clean energy industry fared better than in neighboring states, as well as the overall statewide economy. Amid the pandemic, New York also made modest employment gains in key sectors, including wind energy, clean and alternative transportation, energy storage, and grid modernization. This resilience demonstrates the critical role that clean energy plays in simultaneously advancing economic development and combating climate change.

Further key findings from the 2021 report include:

- New York had 157,700 clean energy workers at the end of 2020, representing 12% workforce growth since 2015.
- New York's clean energy economy was more resilient than the industry nationwide. Clean energy jobs declined 9% nationally, compared to just 4% in New York.
- Energy efficiency — New York's largest clean energy sector — was hardest hit by the pandemic. Following a growth rate of 15% from 2016 to 2019, energy efficiency jobs declined by nearly 5% between 2019 and 2020.
- Wind energy employment grew by 1%, with further job growth expected over the next five to ten years to develop New York State's goal of 9,000 megawatts (MW) of offshore wind power.



To support continued industry growth and a just transition to clean energy, NYSERDA is committed to identifying workforce shortages and challenges.

The 2021 report focuses in-depth on **barriers and opportunities** for increasing priority population employment in clean energy. This report reveals that New York's clean energy workers are less diverse than the overall State workforce and the vast majority of industry employers view diversity and inclusion as important but lack strategies and plans for achieving it. These trends and findings will help inform and support NYSERDA's workforce training and investment efforts.

As the recovery from the COVID-19 pandemic continues, the clean energy industry has demonstrated its ability to both create and retain quality jobs for all New Yorkers. **Together, we will continue to lead the nation on climate action by building a sustainable future and economy for all New Yorkers**.

Best,
Doreen M. Harris — President and CEO, NYSERDA

Doreen M. Harris

This 2021 New York Clean Energy Industry Report is the fifth in a series of reports tracking clean energy employment across the State. The report was commissioned by the New York State Energy Research and Development Authority (NYSERDA) in order to better understand the composition of the clean energy economy in the State. This year's report follows in the aftermath of the COVID-19 pandemic.

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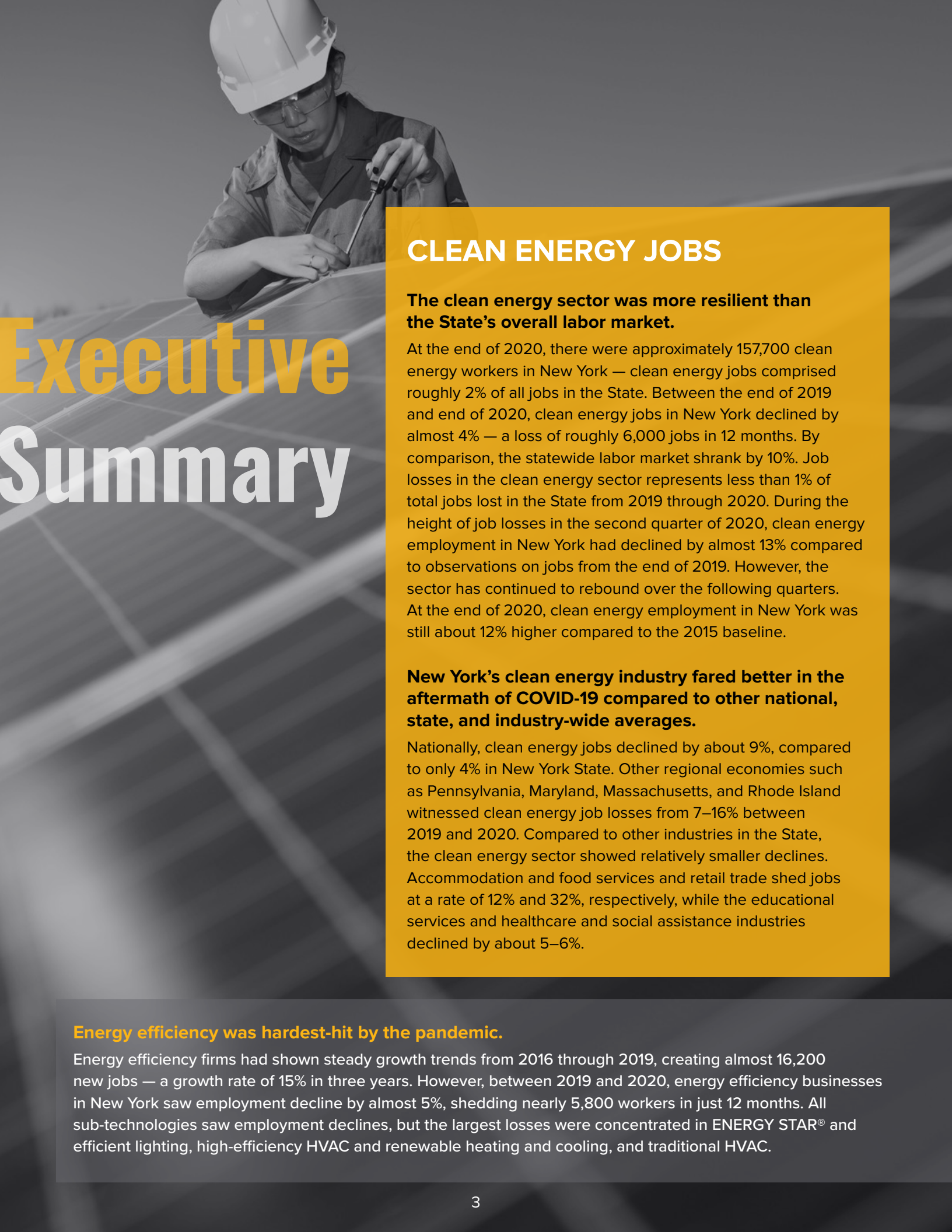


Executive Summary

CLEAN ENERGY JOBS

The clean energy sector was more resilient than the State's overall labor market.

At the end of 2020, there were approximately 157,700 clean energy workers in New York — clean energy jobs comprised roughly 2% of all jobs in the State. Between the end of 2019 and end of 2020, clean energy jobs in New York declined by almost 4% — a loss of roughly 6,000 jobs in 12 months. By comparison, the statewide labor market shrank by 10%. Job losses in the clean energy sector represents less than 1% of total jobs lost in the State from 2019 through 2020. During the height of job losses in the second quarter of 2020, clean energy employment in New York had declined by almost 13% compared to observations on jobs from the end of 2019. However, the sector has continued to rebound over the following quarters. At the end of 2020, clean energy employment in New York was still about 12% higher compared to the 2015 baseline.

New York's clean energy industry fared better in the aftermath of COVID-19 compared to other national, state, and industry-wide averages.

Nationally, clean energy jobs declined by about 9%, compared to only 4% in New York State. Other regional economies such as Pennsylvania, Maryland, Massachusetts, and Rhode Island witnessed clean energy job losses from 7–16% between 2019 and 2020. Compared to other industries in the State, the clean energy sector showed relatively smaller declines. Accommodation and food services and retail trade shed jobs at a rate of 12% and 32%, respectively, while the educational services and healthcare and social assistance industries declined by about 5–6%.

Energy efficiency was hardest-hit by the pandemic.

Energy efficiency firms had shown steady growth trends from 2016 through 2019, creating almost 16,200 new jobs — a growth rate of 15% in three years. However, between 2019 and 2020, energy efficiency businesses in New York saw employment decline by almost 5%, shedding nearly 5,800 workers in just 12 months. All sub-technologies saw employment declines, but the largest losses were concentrated in ENERGY STAR® and efficient lighting, high-efficiency HVAC and renewable heating and cooling, and traditional HVAC.

Despite economy-wide job losses, alternative vehicle employment in New York climbed during the COVID-19 pandemic.

This sector saw jobs grow by almost 5% — an increase of nearly 400 workers — mirroring nationwide trends. This job growth was driven largely by the hybrid electric and electric vehicle sub-technologies, as all other sub-technologies saw job losses from 2019 through 2020. Nationally, alternative transportation jobs grew by 3% over the same time. Job growth in New York's alternative transportation sector accounted for 5% of all new alternative transportation jobs in the U.S. between 2019 and 2020. The alternative transportation sector also showed an increase in intensity-adjusted employment; between 2019 and 2020, the number of intensity-adjusted clean energy jobs in alternative transportation increased by just over 6%.

The wind sector also saw employment growth from 2019 through 2020.

Wind energy firms continued their growth trend from 2016, adding another 50 jobs to the labor market, for an increase of just over 1%. This follows on the sector's continued growth from 2016 through 2019, when wind energy firms grew by 31% and added almost 900 jobs to the clean energy labor market.

The energy storage sector saw a slight uptick in employment between 2019 and 2020. After increasing by 61%, or 700 jobs, from 2016 through 2019, energy storage firms in New York grew by an additional 2%, or roughly 40 jobs, between 2019 and 2020.

Solar accounted for the largest share of job losses in the renewable electric power generation sector.

Solar firms across New York shed roughly 420 jobs during the pandemic, resulting in an approximate 3% decline from 2019 through 2020.

Firms involved in clean energy installation activities accounted for the majority of job losses.

Between 2019 and 2020, the installation segment declined by about 6%, shedding 5,700 jobs in 12 months. Other value chain segments that saw job losses include other support services, sales and distribution, and clean energy manufacturing. By comparison, the professional services segment saw an increase of clean energy-related jobs; clean energy professional service jobs grew by almost 2%, or about 340 jobs. Utility jobs related to clean energy also grew slightly — just over 1%, or 170 jobs.

HIRING AND COVID-19 HIGHLIGHT

Few employers reported hiring activity in 2020.

Almost eight in ten (77%) surveyed clean energy employers reported that they have an adequate number of qualified clean energy workers to meet their current needs. Only 23% of businesses indicated that they currently do not have ansufficient number of workers. Of those, 86% reported currently searching for new employees to fill open positions. About nine in ten (85%) employers who were hiring in 2020 reported overall difficulty — the sum of very and somewhat difficult survey responses — between 2019 and 2020.

Of firms impacted by the COVID-19 business closures and social distancing measures, a small proportion reported having to permanently lay off clean energy workers.

In fact, a slight majority of firms (51%) indicated that they did not have to layoff, furlough, or reduce pay for their clean energy staff. Of the 47% of firms that indicated their workforce had been impacted by COVID-19 restrictions, 29% of the workforce were furloughed, 23% were temporarily laid off, 19% of workers suffered a reduction in hours, and almost 16% had reduced pay and/or benefits. About 13% of firms reported they had to permanently lay off clean energy staff.

The majority of firms reported receiving emergency financial relief.

About six in ten (59%) clean energy businesses in New York reported receiving emergency financial relief through the Paycheck Protection Program (PPP).

About one in five (21%) indicated receiving support through the Economic Injury Disaster Loan (EIDL).

SECTOR SPOTLIGHTS: OFFSHORE WIND AND ALTERNATIVE TRANSPORTATION

With the nation's most aggressive offshore wind development goals, New York can expect to see job growth in offshore wind-related occupations over the coming five to ten years as offshore wind projects are developed.

With 4,300 MW of offshore wind projects currently underway and another 4,700 MW in the pipeline, New York has set the standard for offshore wind development in the United States. Guaranteed project labor agreements with local unions ensure that jobs associated with this growing industry are sourced in-state, indicating the region can expect to see job growth in the critical occupational and industry segments required to fuel offshore wind project development.

New York has an above-average concentration of jobs required for the planning and development phase of offshore wind project development.

These are mainly professional services occupations, such as engineers and technicians, managers, analysts, lawyers, and architects involved in the initial stages of offshore wind project design and development. Offshore wind-related planning and development jobs are roughly 9% more concentrated in New York compared to the national average, indicating the State is already positioned to supply the engineers and architects needed to support the initial planning and design phases for the State's offshore wind project pipeline.

Jobs in manufacturing, operations and maintenance, and construction are less concentrated in New York compared to the national average.

These are the key components of developing a successful domestic offshore wind industry, and they represent the bulk of job creation. Altogether, these three phases are estimated to account for 65% of job growth from offshore wind-related industry expansion. These jobs are engaged throughout project construction and build out and during the project's lifespan, which is typically 20 years or more. In particular, developing a local supply chain by leveraging in-State manufacturing capacity to support wind turbine and other component equipment production and assembly will be pivotal to ensuring further in-state job growth from offshore wind industry expansion; this is especially important given initiatives to increase use of in-state manufacturers.

Future research into occupational skill profiles and employer needs can inform regional workforce development initiatives.

The data presented in this report is meant to provide an overview of the key occupations that support offshore wind project development. These findings can be a jumping-off point from which additional research may be conducted to identify more specific, near-term job training needs in the State. Given the results of this report, it is likely that near-term training for construction and installation jobs will be essential in New York over the coming years. Further research could include occupational deep dives into the jobs and segments identified here that are key to offshore wind development but have lower concentrations of workers in the State, such as manufacturing and construction; these will be pivotal to ensuring a successful domestic offshore wind industry. Employer round tables and executive interviews can provide more qualitative and region-specific information on needs and bottlenecks. Understanding where businesses identify skill and supply gaps will become increasingly important as the development of these offshore wind projects ramp up in the future.

The manufacturing industry represents a small segment of economic activity in New York.

The manufacturing industry overall accounted for 2% of all business establishments in the State and almost 5% of total jobs in 2020. Looking closer at a subset of the overall manufacturing industry, the potential universe of alternative transportation supply chain manufacturers,[1] represented 16% of all manufacturing establishments and 30% of all manufacturing jobs across the State. These firms and jobs are largely concentrated in three counties across New York — Erie, Monroe, and Suffolk — and account for about a third of manufacturing capacity in the State.

Survey data from New York's potential universe of alternative transportation supply chain industries indicate the State is poised for advanced electric vehicle supply chain growth.

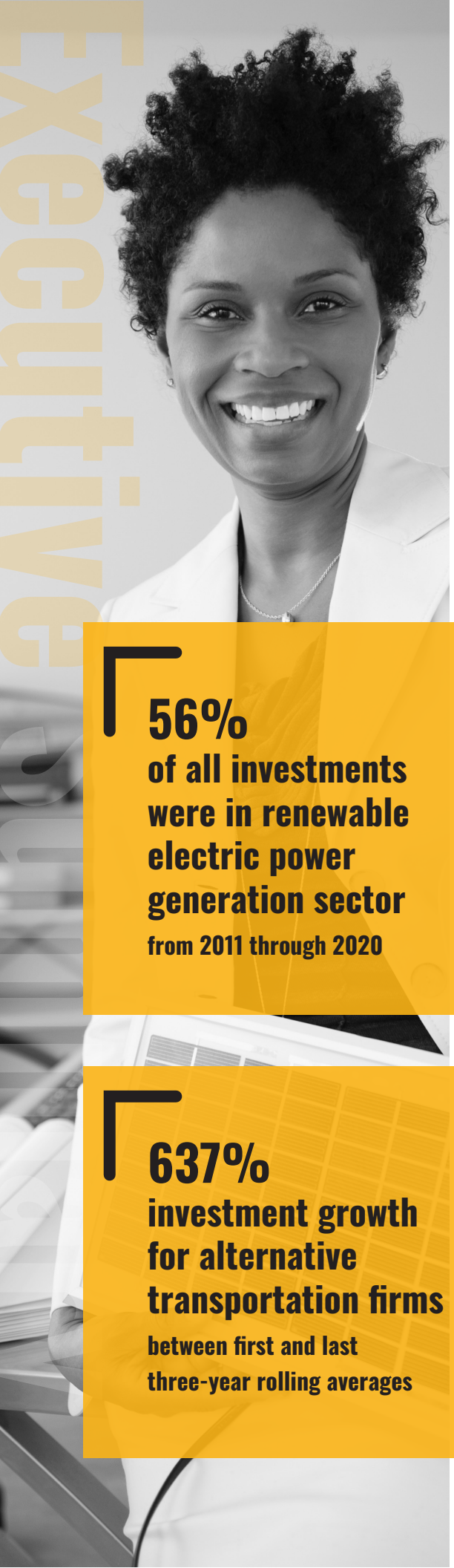
The majority of surveyed manufacturers (65%) indicated their organization has excess production capacity, meaning they could produce more goods and components given additional investments of capital. When asked about their level of agreement and interest in the opportunity presented within the electric vehicle market, 68% of surveyed manufacturers agreed that they are interested in the opportunity electric vehicles present for their business. Another 63% indicated that their current offering of goods and services are transferable and could be used by the electric vehicle industry.

Potential electric vehicle manufacturers indicated they require policy, capital, equipment access, and talent/ workforce support in order to participate in and support the alternative transportation market.

The majority of surveyed manufacturers also indicated that they would need to make significant capital investments to serve the electric vehicle industry (58%), while 47% agreed there are policy challenges inhibiting the growth of a profitable business in the electric vehicle industry.

Almost half (47%) of firms reported their staff would need additional training to serve the electric vehicle industry, while 53% of firms disagreed that there is sufficient local qualified talent to grow a profitable business in the electric vehicle industry. Fewer than four in ten firms agreed that there is sufficient availability of affordable raw materials, components, and other necessary equipment to grow a profitable business in the electric vehicle industry.

53% disagreed that there is sufficient local qualified talent to grow a profitable business in the electric vehicle industry



56%
of all investments were in renewable electric power generation sector
from 2011 through 2020

637%
investment growth for alternative transportation firms
between first and last three-year rolling averages

CLEAN ENERGY INVESTMENTS

Investment in New York clean energy companies saw continual growth from 2011 through 2020.

In total, clean energy firms in New York received $9 billion in investment dollars across 5,643 deals. Between the first and last three-year rolling averages of 2011 to 2013 and 2018 to 2020, clean energy investments in New York grew by 148% while the number of deals increased by 54%.

The majority of investments examined for this report are from public entities.

Public investments accounted for 80% of investments or $7 billion and 5,492 deals from 2011 through 2020. Between 2011 and 2020, public expenditures into New York's clean energy economy saw continual growth, resulting in a cumulative growth rate of 110%.

Phase III investments for technology commercialization and growth comprise the majority of investment dollars for New York's clean energy economy.

Altogether, Phase III investments[2] comprised 90% of total investments, or roughly $8 billion. Phase III investments saw continued growth from 2011 through 2020, rising by 193% over the first and last three-year rolling average.

Renewable electric power generation accounts for the majority of investments, but the alternative transportation sector saw the greatest growth in investment dollars over the last several years.

Investments in the renewable electric power generation sector accounted for 56% of all investments from 2011 through 2020. Between the first and last three-year rolling averages, alternative transportation firms saw investments grow by 637%, with significant years of investment in 2016, 2019, and 2020. Following alternative transportation, renewable electric power generation firms saw investments grow by a cumulative 431%, followed by renewable fuels and grid modernization and energy storage. Energy efficiency firms saw a slight decline in investments of almost 13%.

90%
believe creating an environment with equal access to employment opportunities was either important or very important

DIVERSITY AND PRIORITY POPULATIONS

The clean energy sector continues to lack racial, ethnic, and gender diversity.

Clean energy demographics remain largely unchanged compared to 2019. In general, women, Hispanic or Latinx, Asian, and Black or African American workers are underrepresented in New York's clean energy industry compared to the State's labor market overall. Black or African American workers are especially underrepresented in the clean energy sector, at almost nine points below the statewide labor market average. Black or African American workers represent 8% of the State's clean energy workforce, but account for 17% of all workers in the State.

Clean energy firms recognize the importance of diversity, equity, and inclusion but have few formal policies and programs in place to foster it.

The majority of employers agree that equal opportunity and diverse/inclusive workplaces are important to company culture, innovation, and profitability, yet few clean energy companies reported having formal policies in place to recruit diverse populations. More than 90% of companies reported that creating an environment with equal access to employment opportunities regardless of gender, race, or ethnicity was either important or very important to their company. When asked about actual diversity-related policies and programs, firms were most likely to report a company policy to respond to incidents of discrimination (88%), but fewer than 40% of firms have actual policies, strategies, or programs in place to increase the number of female, ethnic or racial minority, LGBTQ+, and Veteran hires, and only 15% of employers indicated they have plans to implement diversity policies or programs in the future. Seven in ten firms also reported they do not actively recruit the formerly incarcerated, homeless individuals, or individuals with disabilities.

Few clean energy firms work with local training providers or unions to recruit clean energy workers.

Only about three in ten surveyed clean energy employers (31%) reported working with local training providers to recruit clean energy workers, while only 13% of clean energy firms indicated they work with local unions to find qualified clean energy workers.

23% Hispanic or Latinx

20% Black or African American

never considered working in the clean energy industry

Women and ethnic and racial minorities were least likely to report having considered or actively searched for a career in clean energy.

Roughly nine in ten (91%) men indicated they had either considered or actively searched for clean energy job opportunities; this was 6.5 points higher compared to female respondents.

At the same time, a quarter of Hispanic or Latinx respondents (23%) and one in five Black or African American respondents (20%) reported they had never considered working in the clean energy industry, compared to 9% of Asian and 11% of White respondents.

White and Hispanic or Latinx clean energy workers and Veterans felt more positively about their company's diversity, equity, and inclusion.

Across the board, these populations were more likely to report overall workplace equity and inclusion, including diversity in leadership positions, a sense of belonging, and equitable recruitment, hiring, and promotion practices at their clean energy firm compared to Asian and Black or African American workers or non-Veterans.

Hispanic or Latinx and Asian workers were most likely to report considerable challenges to their clean energy career advancement. In particular, Hispanic or Latinx clean energy workers were most likely to indicate that getting the relevant work and/or industry experience and developing technical skills and expertise were considerable challenges to advancing their clean energy career, while Asian clean energy workers were most likely to indicate that getting comfortable and confident communicating with employers as well as developing resumes and related materials were considerable challenges. Asian and Hispanic or Latinx workers were also more likely to indicate that overcoming prejudice or bias in the workplace was a considerable challenge to advancing their clean energy career compared to White and Black or African American clean energy workers.

Introduction

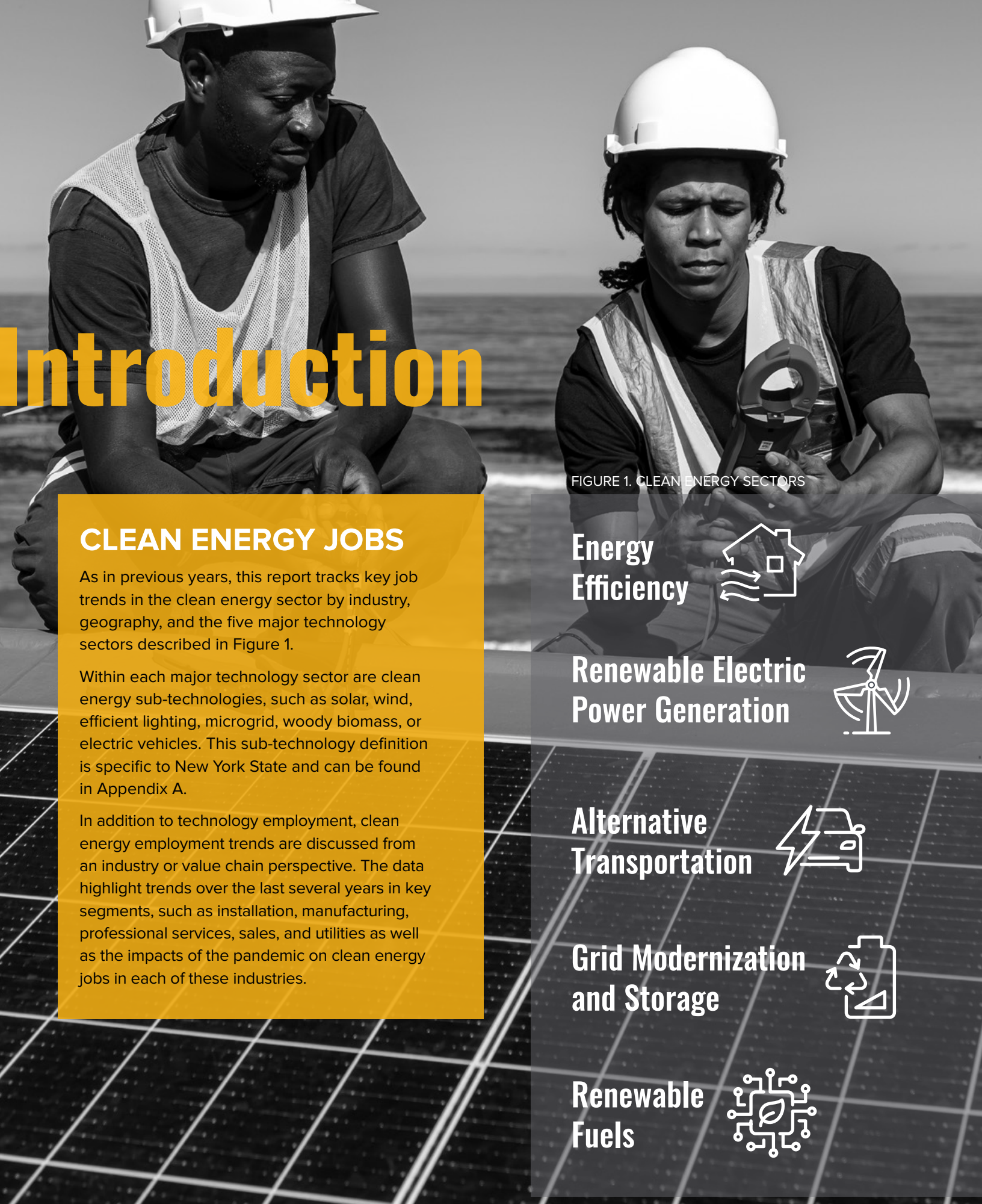
CLEAN ENERGY JOBS

As in previous years, this report tracks key job trends in the clean energy sector by industry, geography, and the five major technology sectors described in Figure 1.

Within each major technology sector are clean energy sub-technologies, such as solar, wind, efficient lighting, microgrid, woody biomass, or electric vehicles. This sub-technology definition is specific to New York State and can be found in Appendix A.

In addition to technology employment, clean energy employment trends are discussed from an industry or value chain perspective. The data highlight trends over the last several years in key segments, such as installation, manufacturing, professional services, sales, and utilities as well as the impacts of the pandemic on clean energy jobs in each of these industries.

FIGURE 1. CLEAN ENERGY SECTORS



Deep Dive: Offshore Wind and Alternative Transportation

DEEP DIVE SECTORS: OFFSHORE WIND AND ALTERNATIVE TRANSPORTATION

In addition to tracking total clean energy jobs by technology and industry, this year's report includes supplemental analyses into specific sectors of the clean energy economy. These deep dives are focused on growing segments of clean energy activity, such as offshore wind and alternative vehicles. Increasing national and State-level policies focused on developing a strong domestic offshore wind industry have necessitated the need to better understand the workforce and training needs for offshore wind projects. New York aims to have 9,000 MW of offshore wind developed by 2035, one of the most aggressive goals in the nation. With ambitious offshore wind targets in place and multiple commitments to use domestic labor, the State can expect to see job growth across the key industry and occupational segments needed for the design, construction, and maintenance of offshore wind developments. As such, it is increasingly important to understand what types of jobs will be required to grow and develop a local offshore wind supply chain and how best to ensure an adequate domestic labor supply to meet New York's offshore wind goals.

9,000 MW

of offshore wind developed by 2035

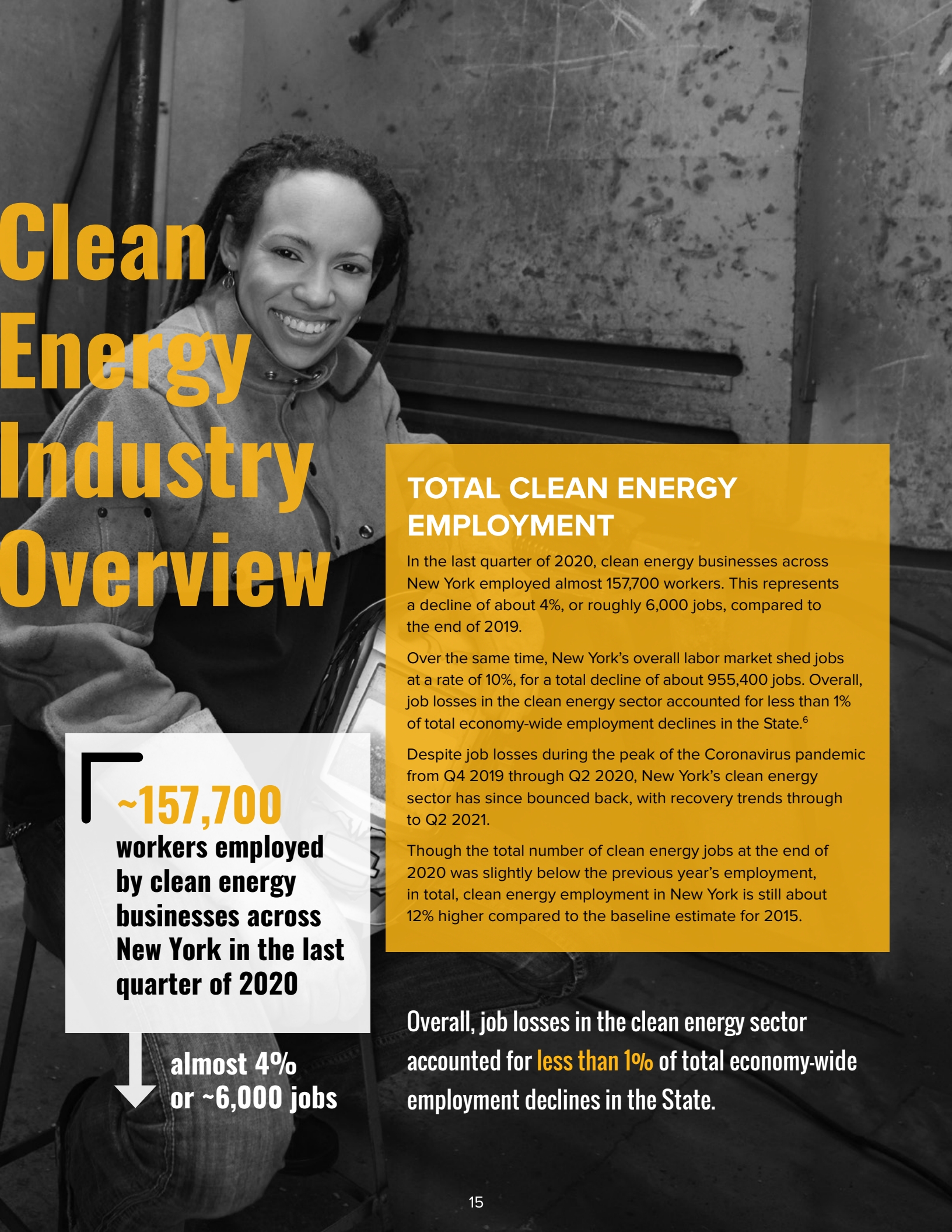
This year's Clean Energy Industry Report includes a deeper look at the types of occupations that support offshore wind project development. More specifically, the research identifies (a) the key occupations involved in each distinct phase of offshore wind project development[3] and (b) the historical growth trends and concentration of these jobs in New York. For more detail and to review the full analysis, please refer to Page 28 of this report. It is important to note this research is only a first look at the offshore wind occupational supply in New York. As demand for these workers increases over the coming years, future studies may focus more specifically on occupational skill profiles and regional training capacities to further inform curriculum and program development. Additionally, economic impact research and analyses may be conducted to understand in more detail which industries and occupations will see projected employment growth over the next several decades.[4]

In 2021, Governor Kathy Hochul signed legislation setting a goal for all new passenger cars and trucks sold in New York State to be zero emissions by 2035. In order to understand the capabilities, qualifications, and interest of New York's manufacturing sector to meet the growing demand for alternative vehicles and component parts, results for a supplemental survey are profiled on page 35 of this report. Findings from this additional research component are meant to assist NYSERDA in supporting local businesses as they retool and upskill workers to enter the growing alternative transportation market.

PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

Under NYSERDA's Clean Energy Workforce Development and Training Program, access to training, internships, and funding is especially focused on providing opportunities for individuals from disadvantaged communities and to priority populations; these include Veterans, Native Americans, individuals with disabilities, low-income households, and the previously incarcerated.[5] As such, also included in this year's report is a supplemental analysis that examines access to clean energy employment opportunities for priority populations. This section identifies specific challenges or barriers priority demographics face in entering the clean energy labor market. In addition to worker perspectives, the priority population research also includes data on clean energy business' outreach, policies, and programs as they relate to increasing the number of diverse and priority workers in New York's clean energy sector. These data can help guide NYSERDA in designing and developing programs and services that increase participation from and outreach to priority population demographics across the State.

Clean Energy Industry Overview



TOTAL CLEAN ENERGY EMPLOYMENT

In the last quarter of 2020, clean energy businesses across New York employed almost 157,700 workers. This represents a decline of about 4%, or roughly 6,000 jobs, compared to the end of 2019.

Over the same time, New York's overall labor market shed jobs at a rate of 10%, for a total decline of about 955,400 jobs. Overall, job losses in the clean energy sector accounted for less than 1% of total economy-wide employment declines in the State.[6]

Despite job losses during the peak of the Coronavirus pandemic from Q4 2019 through Q2 2020, New York's clean energy sector has since bounced back, with recovery trends through to Q2 2021.

Though the total number of clean energy jobs at the end of 2020 was slightly below the previous year's employment, in total, clean energy employment in New York is still about 12% higher compared to the baseline estimate for 2015.

~157,700
workers employed by clean energy businesses across New York in the last quarter of 2020

almost 4% or ~6,000 jobs

Overall, job losses in the clean energy sector accounted for less than 1% of total economy-wide employment declines in the State.

FIGURE 2. CLEAN ENERGY EMPLOYMENT IN NEW YORK, 2015-2020

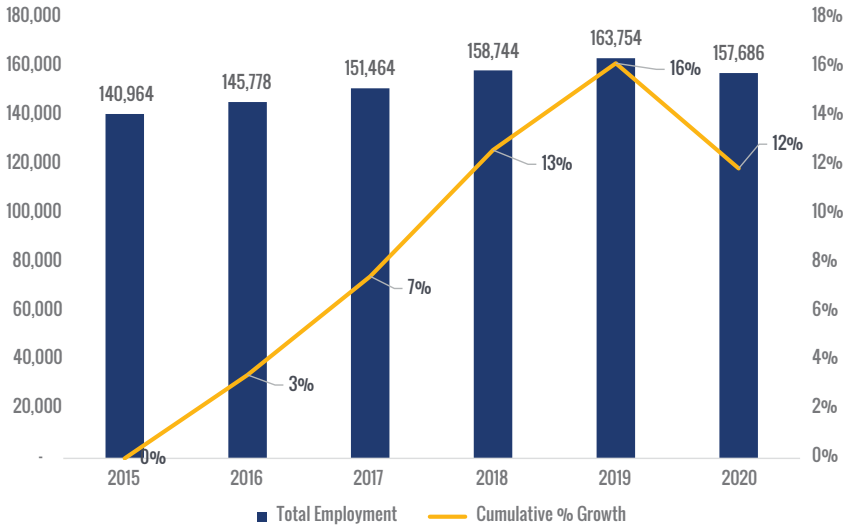
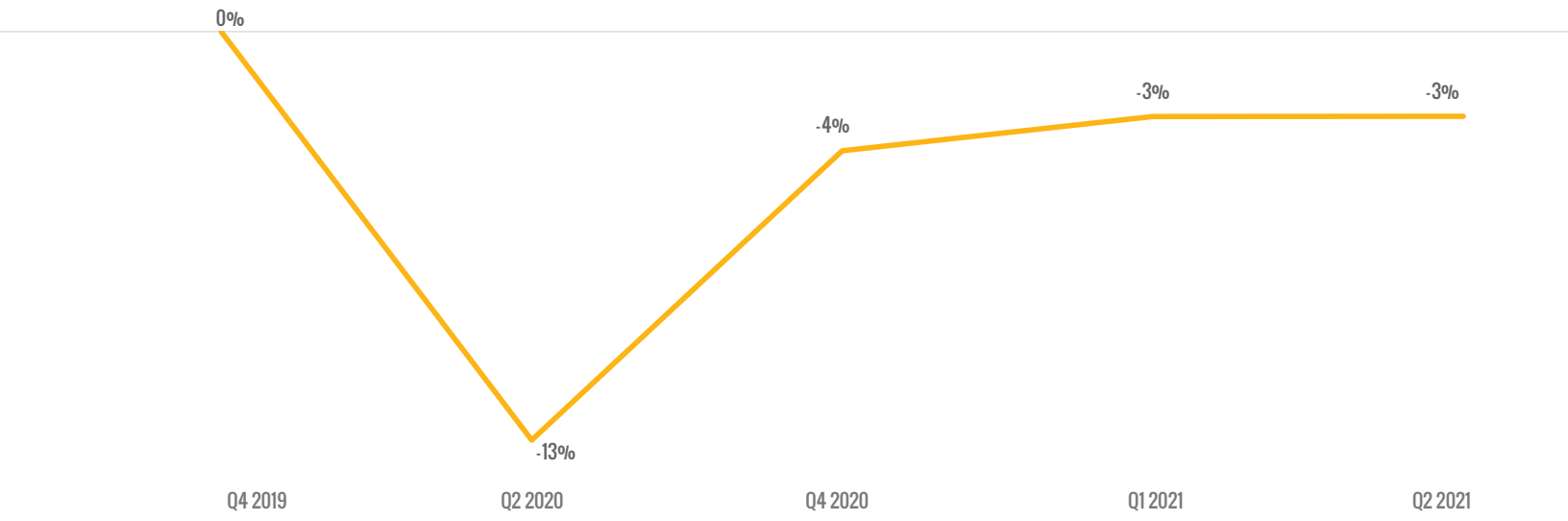


FIGURE 3. CLEAN ENERGY INDUSTRY COVID-19 RECOVERY, Q4 2019 – Q2 2021[7]

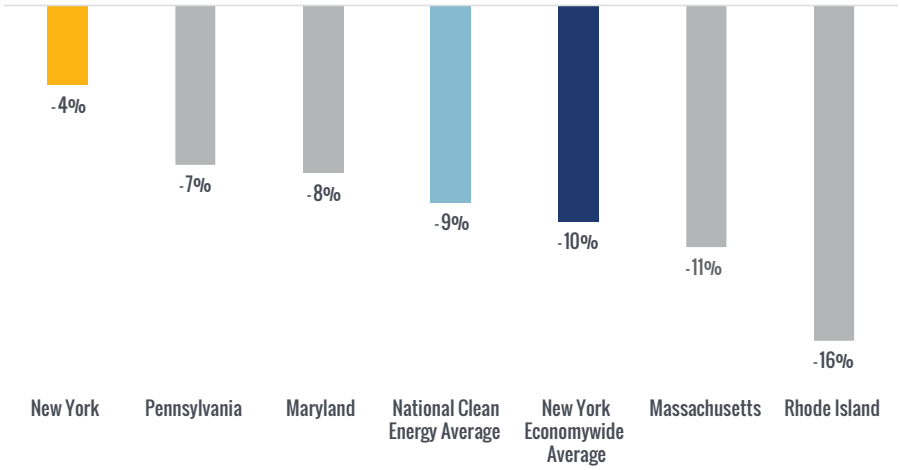


Compared to the national average and other statewide clean energy economies, New York's clean energy labor market fared significantly better.

Nationally, clean energy jobs declined by about 9%, compared to a decline of roughly 4% in New York.

Clean energy businesses in New York also shed jobs at a lower rate compared to other regional clean energy economies such as Pennsylvania and Maryland.

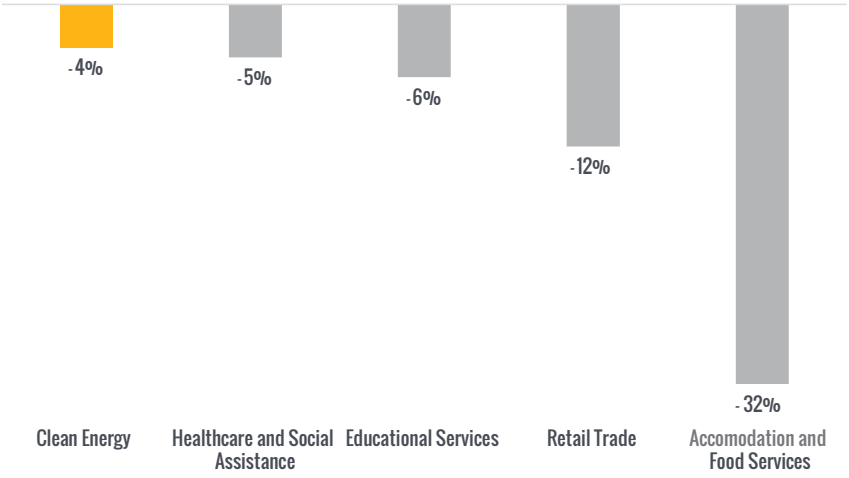
FIGURE 4. CLEAN ENERGY EMPLOYMENT CHANGE BY REGION, 2019-2020



At the same time, the clean energy sector in New York showed lower rates of decline compared to other industries like healthcare, education, retail trade, and accommodation and food services.

In fact, job losses in the accommodation and food services industry were about 29 percentage points higher than clean energy while job losses in retail trade were roughly eight points higher.

FIGURE 5. EMPLOYMENT CHANGE BY INDUSTRY IN NEW YORK, 2019-2020[8]



Energy efficiency remains the largest segment of clean energy jobs in New York, accounting for about three-quarters (76%) of total clean energy employment. Following energy efficiency, renewable electric power generation firms comprise about 15% of all clean energy jobs across the State.

From 2016 through 2019, clean energy employment grew across nearly all five sectors, with the exception of renewable fuels. Energy efficiency saw the greatest absolute job growth, rising by almost 15% for a total of 16,200 new jobs. Grid modernization and energy storage jobs grew by the highest relative rate, at 62% growth or almost 900 new jobs.

The impacts of the pandemic were felt across the energy efficiency, renewable electric power generation, and renewable fuels sectors, though job losses in renewable fuels had been trending in previous years. Energy efficiency was the hardest-hit sector, shedding a net 5,800 jobs between the last quarters of 2019 and 2020 — a decline of roughly 5%. Renewable electric power generation firms declined by about 3%, for a net loss of about 640 jobs in 12 months.

In contrast, the alternative transportation sector saw employment grow by almost 400 workers, an increase of 5% from 2019 through 2020, while the grid modernization and storage sector increased jobs by about 1%, or roughly 20 new workers. Growth in alternative transportation mirrors the national average; nationally, alternative transportation jobs grew by 3% over the same time. In fact, alternative vehicle job growth in New York represented 5% of all new jobs in this sector from 2019 through 2020.

energy efficiency

76% of clean energy jobs

15% absolute growth

16,200 new jobs

[2016-2019]

grid mod and energy storage

62% relative growth

900 new jobs

[2016-2019]

alternative transportation

5% growth

400 new jobs

[2019-2020]

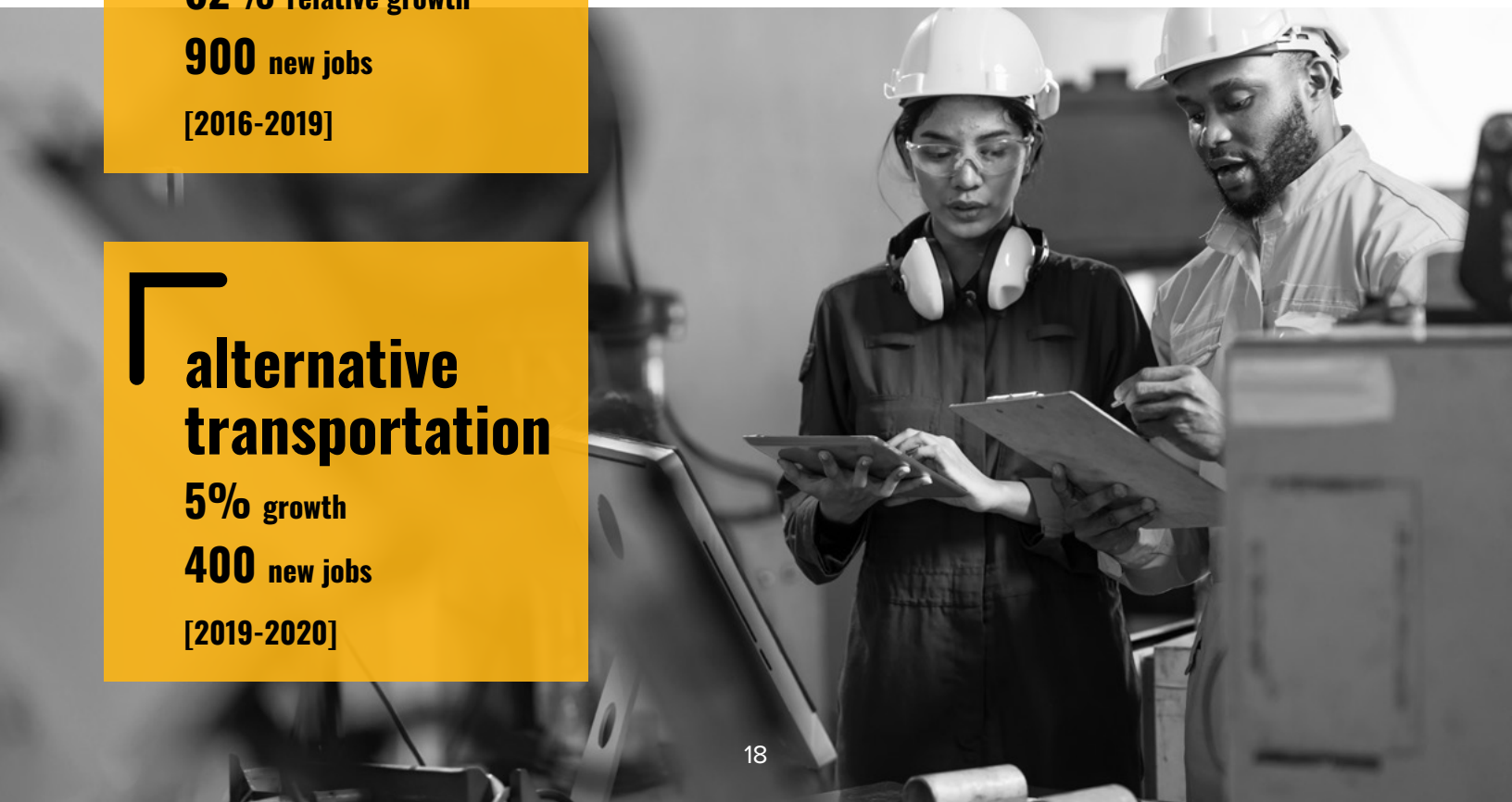


FIGURE 6. CLEAN ENERGY EMPLOYMENT BY TECHNOLOGY SECTOR, 2016-2020

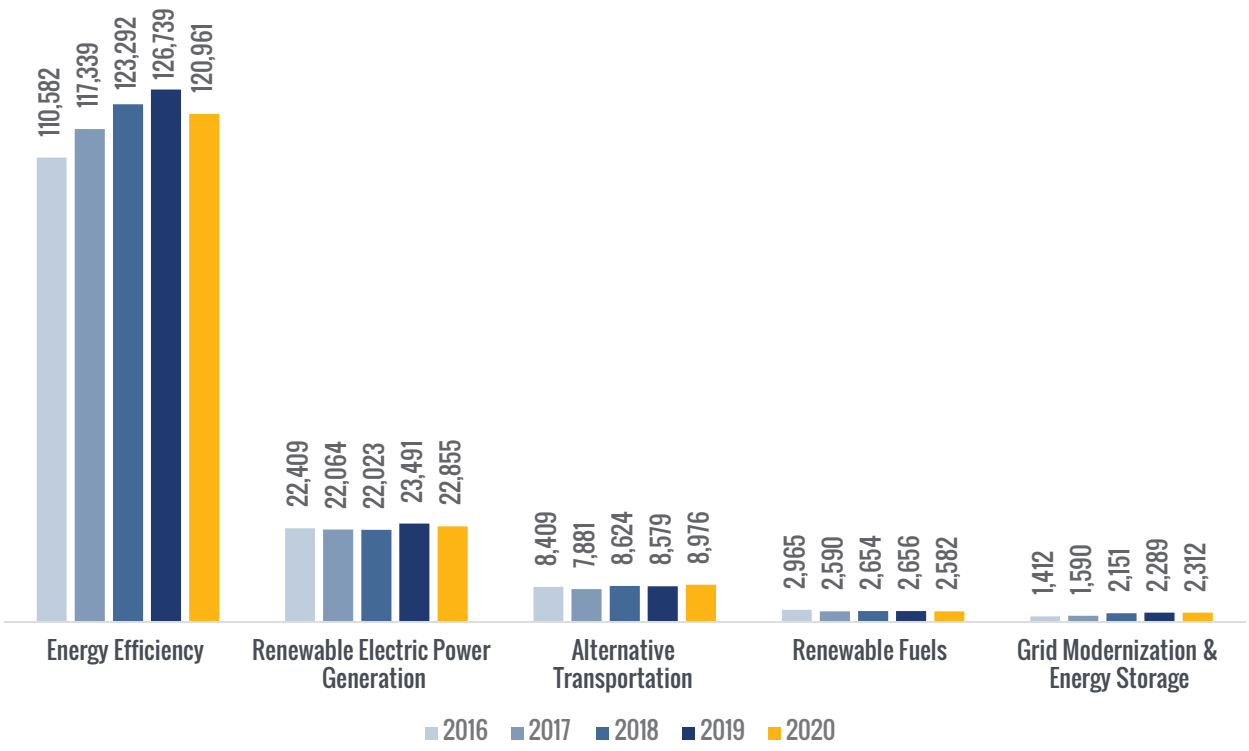
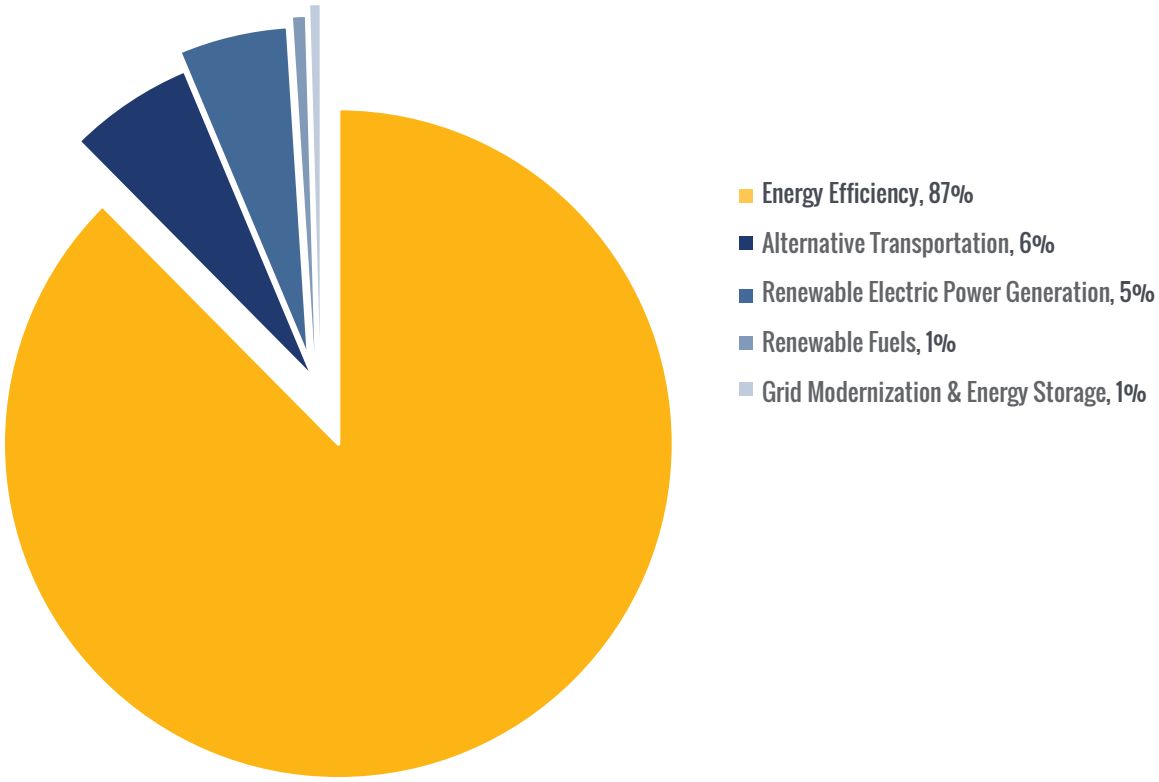


FIGURE 7. CLEAN ENERGY ESTABLISHMENTS BY TECHNOLOGY, 2020



intensity explaination

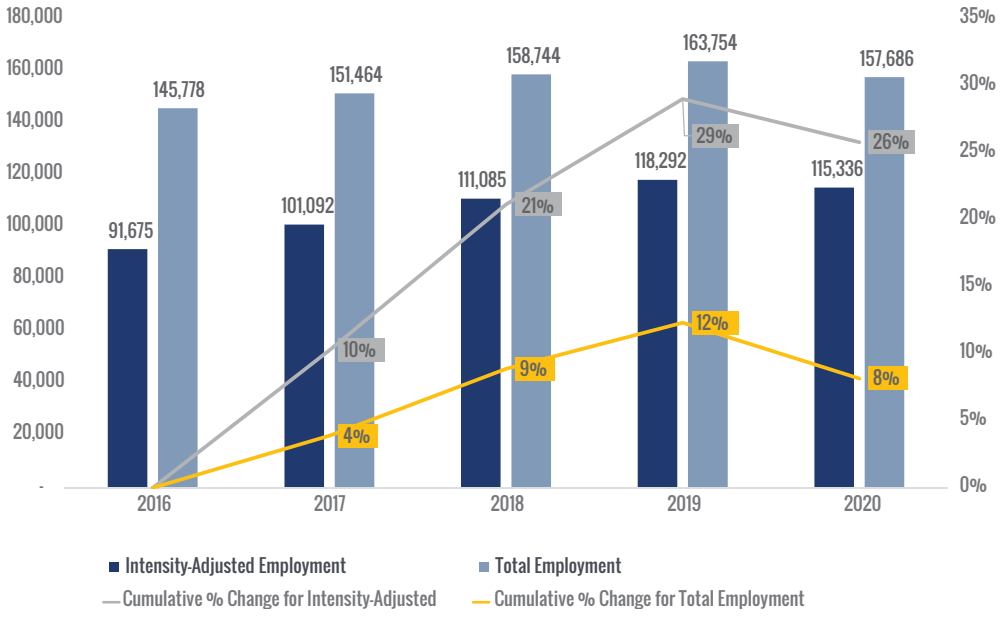
a traditional HVAC worker might have spent only a third of their work week installing or maintaining energy-efficient HVAC technologies in 2016. If a state began offering rebates in 2017 for efficient heat pumps, that traditional HVAC worker would likely be spending more of their labor hours or work week installing high-efficiency heat pumps.

CLEAN ENERGY EMPLOYMENT INTENSITY

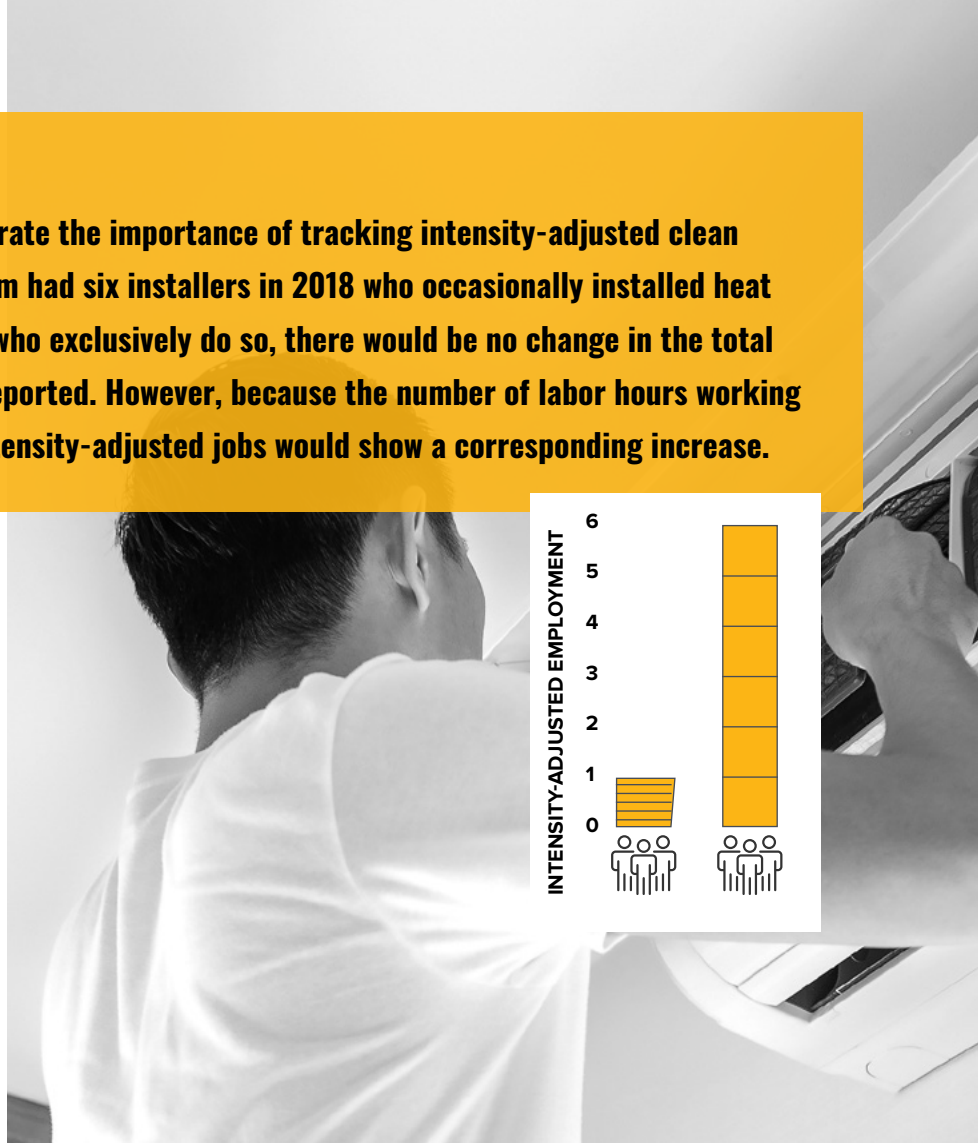
Intensity-adjusted clean energy job metrics are used to identify the concentration, or intensity, of clean energy activities. The clean energy employment featured in Figure 2 includes all workers that dedicate any amount of their labor hours or work week to clean energy goods and services. As such, an electrician who spends only a quarter of their work week installing or servicing solar panels would be counted as a clean energy worker in Figure 2. The intensity-adjusted clean energy employment metric weights each of these jobs according to how much time workers were reported to spend on clean energy activities; the categories include less than half of their labor hours, half to the majority of their labor hours, or all of their labor hours.[9]

An increase in total employment would indicate that there are more workers in the labor market overall servicing clean energy technologies, while an increase in intensity-adjusted employment indicates that these workers are dedicating a larger proportion of their work week and labor hours to clean energy-specific activities; this could be the result of increased policy support or financial incentives spurring market demand for clean energy goods and services. This increase in activity per worker would not necessarily result in overall job growth in Figure 2 but would be captured as an increase in intensity-adjusted clean energy employment in Figure 8.

FIGURE 8. INTENSITY-ADJUSTED CLEAN ENERGY EMPLOYMENT, 2016-2020



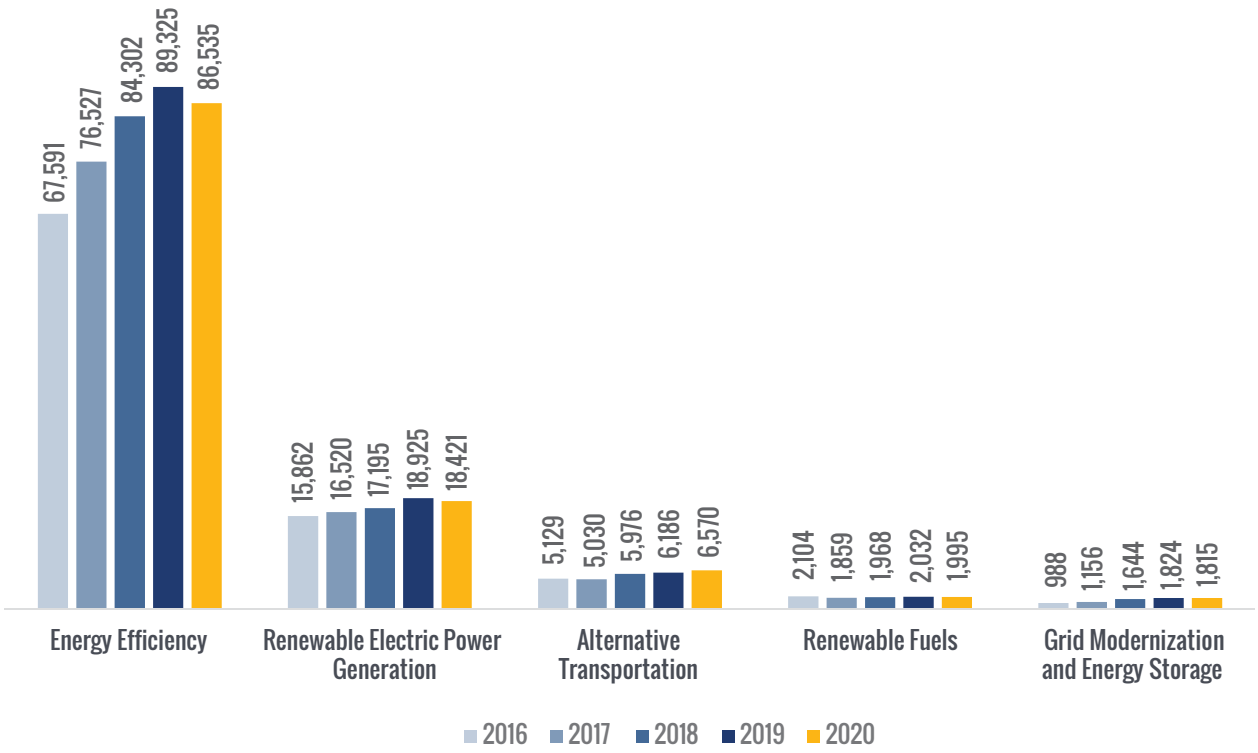
An example can illustrate the importance of tracking intensity-adjusted clean energy employment. If an HVAC firm had six installers in 2018 who occasionally installed heat pumps, and now has six installers who exclusively do so, there would be no change in the total number of clean energy workers reported. However, because the number of labor hours working with heat pumps has increased, intensity-adjusted jobs would show a corresponding increase.



Intensity-adjusted clean energy employment in New York declined by almost 3% between 2019 and 2020. Overall, however, intensity-adjusted jobs were still about 26% higher at the end of 2020 compared to the 2016 baseline.

By technology sector, energy efficiency showed the greatest relative decline in intensity-adjusted employment (-3%), followed by renewable electric power generation (-3%), and renewable fuels (-2%). Intensity-adjusted employment in the alternative transportation sector grew by 6% over the same time.

FIGURE 9. INTENSITY-ADJUSTED CLEAN ENERGY EMPLOYMENT BY TECHNOLOGY, 2016-2020



The proportion of workers who spend at least 50% of their labor hours on clean energy-related activities stayed fairly flat in 2020, remaining either steady or fluctuating between one percentage point above or below the 2019 figures. Similar trends were observed for the proportion of workers who spend 100% of their time on clean energy-related activities. The most notable shift was in the grid modernization and storage sector, where the proportion of 100% workers in this sector decreased by three percentage points, though this change is likely still within the margin of error.

FIGURE 10. 50% CLEAN ENERGY WORKERS BY TECHNOLOGY, 2016-2020

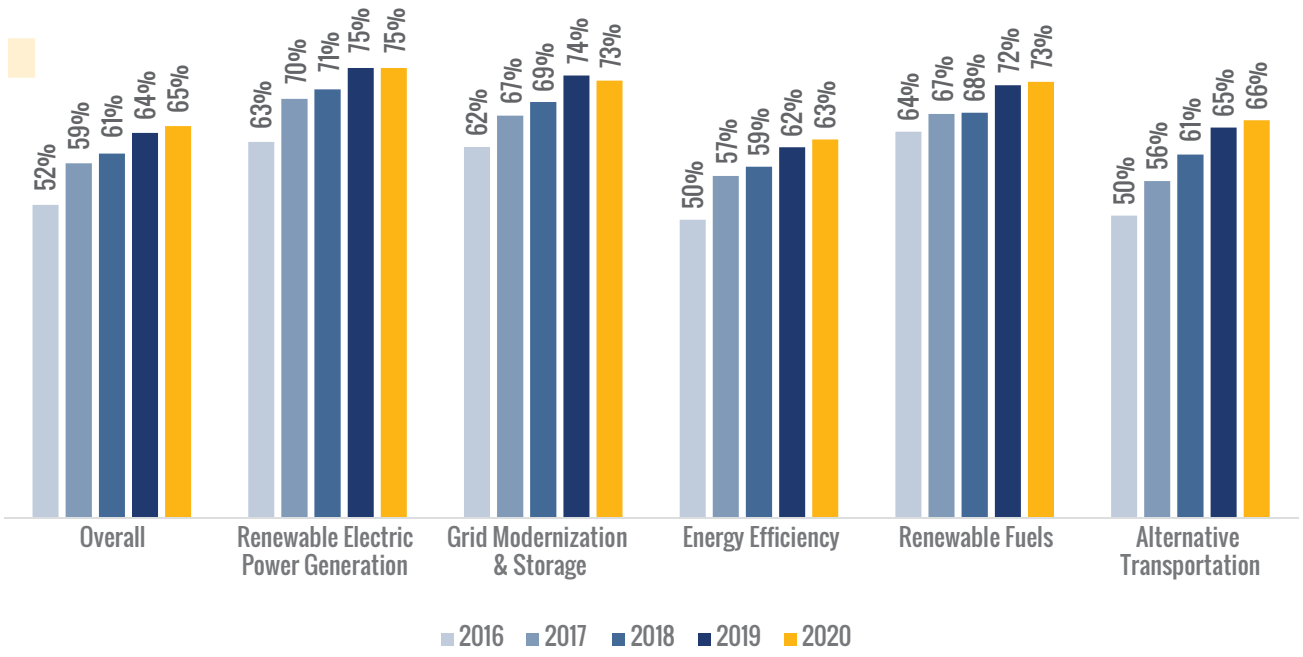


FIGURE 11. 100% CLEAN ENERGY WORKERS BY TECHNOLOGY, 2016-2020

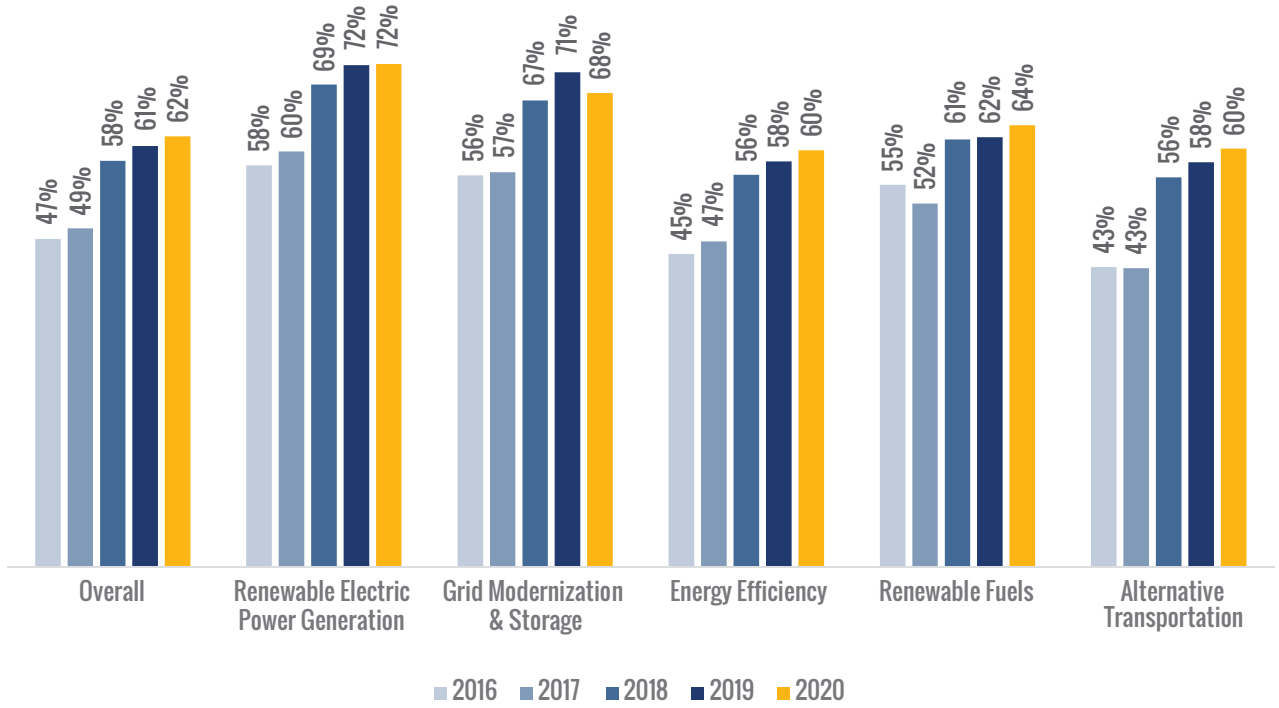
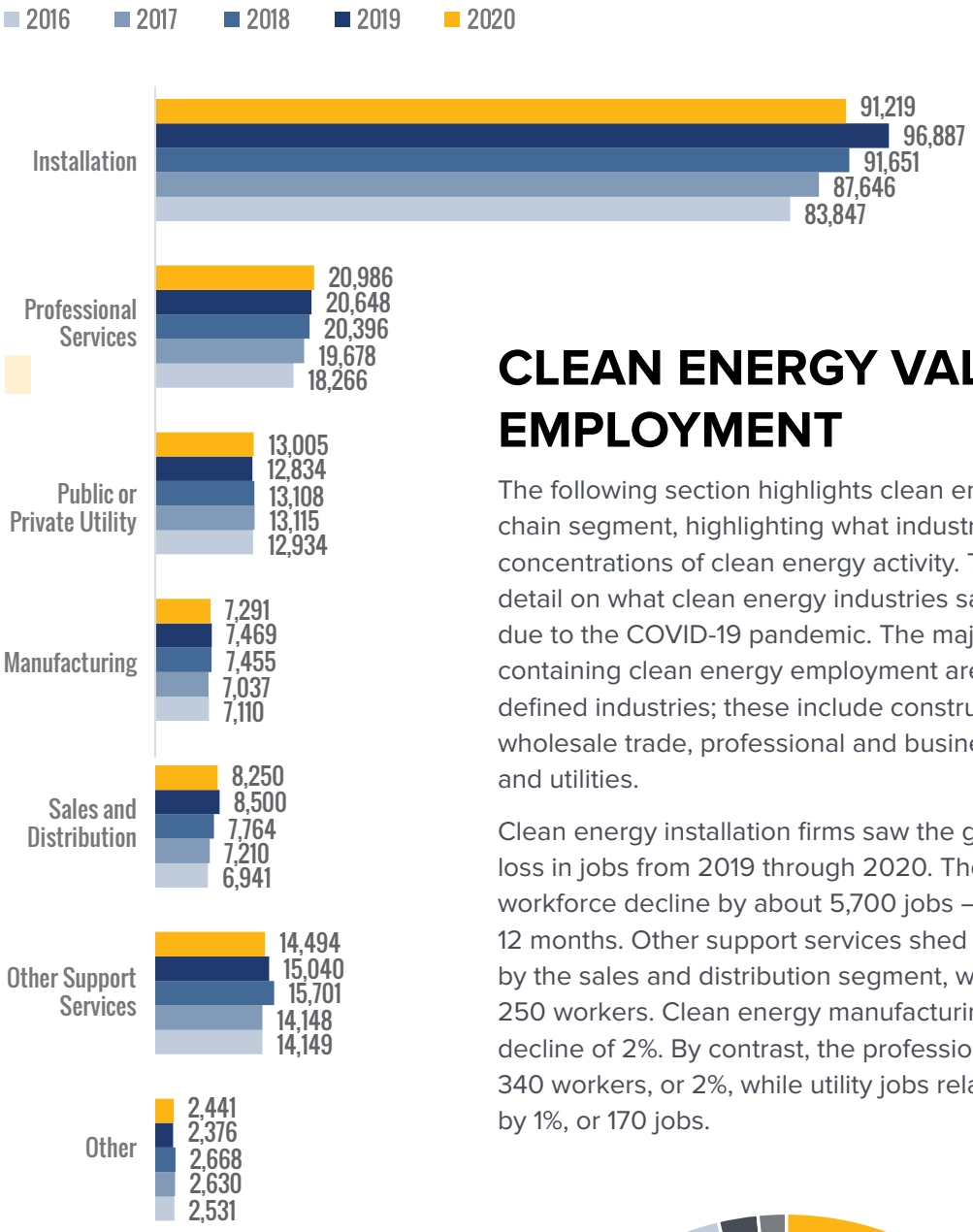


FIGURE 12. CLEAN ENERGY EMPLOYMENT BY VALUE CHAIN SEGMENT, 2016-2020

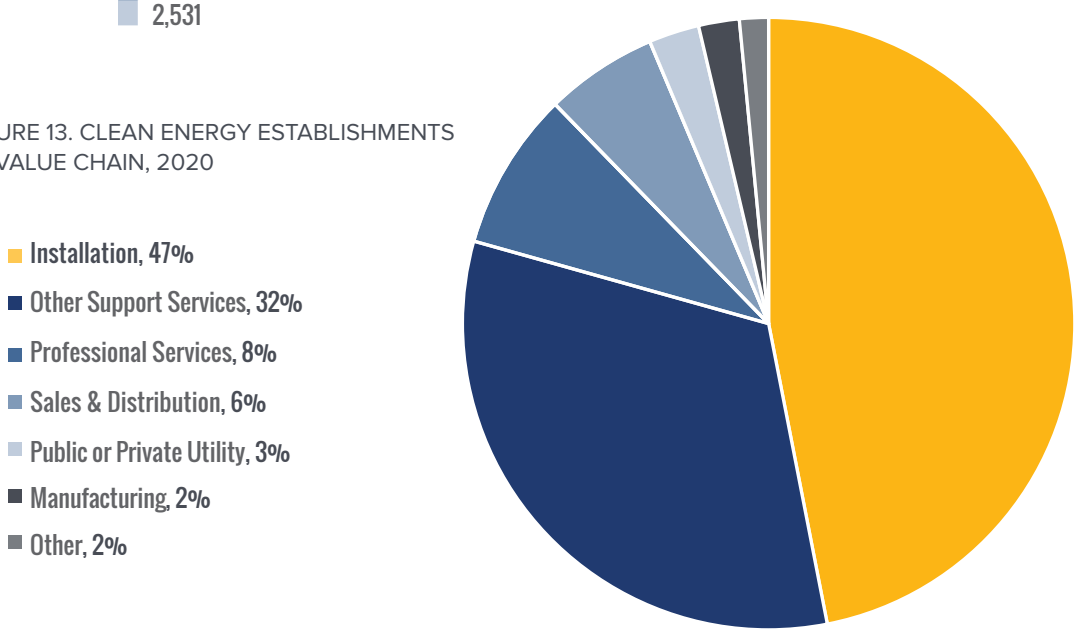


CLEAN ENERGY VALUE CHAIN EMPLOYMENT

The following section highlights clean energy employment by value chain segment, highlighting what industries in New York have high concentrations of clean energy activity. This year's report also includes detail on what clean energy industries saw employment declines due to the COVID-19 pandemic. The major value chain segments containing clean energy employment are comparable to federally defined industries; these include construction, manufacturing, wholesale trade, professional and business services, other services, and utilities.

Clean energy installation firms saw the greatest absolute and relative loss in jobs from 2019 through 2020. These businesses saw the workforce decline by about 5,700 jobs — a decrease of roughly 6% in 12 months. Other support services shed about 550 jobs (-4%), followed by the sales and distribution segment, which declined by about 3%, or 250 workers. Clean energy manufacturing firms shed 180 jobs, for a decline of 2%. By contrast, the professional services industry grew by 340 workers, or 2%, while utility jobs related to clean energy also grew by 1%, or 170 jobs.

FIGURE 13. CLEAN ENERGY ESTABLISHMENTS BY VALUE CHAIN, 2020



Detailed Clean Energy Sector Employment

ENERGY EFFICIENCY

The energy efficiency sector encompasses all workers involved in the research, manufacture, sales, installation, repair, or professional service support of technologies and services designed to improve the efficiency of commercial, residential, and industrial buildings. The following are sub-technologies included in this sector: ENERGY STAR® appliances, lighting, and HVAC systems; advanced building materials and insulation technologies; solar thermal water heating and cooling; and other energy-efficient technologies and processes like recycled building materials or reduced water consumption products and appliances.

Following steady growth from 2016 through 2019, all energy efficiency sub-technologies saw employment declines from 2019 through 2020. Job losses across energy efficiency sub-technologies were largely concentrated in ENERGY STAR and efficient lighting, high-efficiency HVAC and renewable heating and cooling, and traditional HVAC. Each of these sub-technologies lost upwards of about 1,500 jobs each, totaling 4,900 altogether. Other energy efficiency technologies also declined by roughly 470 jobs while advanced building materials shed 440 workers.

Specifically, the heat pump sector saw jobs decline by almost 10%, or 630 jobs.

FIGURE 14. HEAT PUMP EMPLOYMENT, 2019-2020

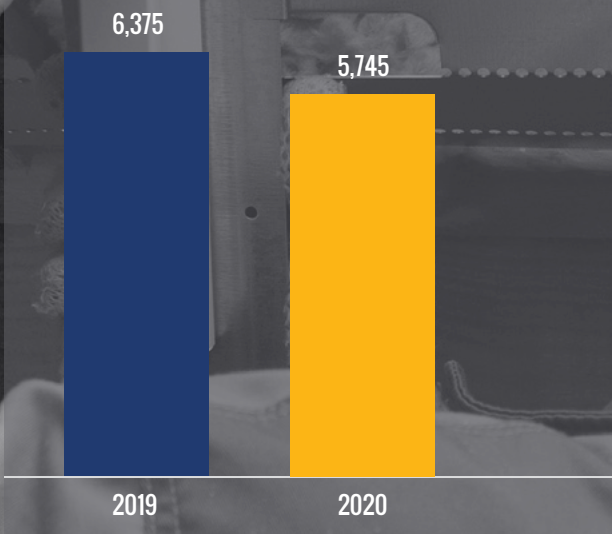
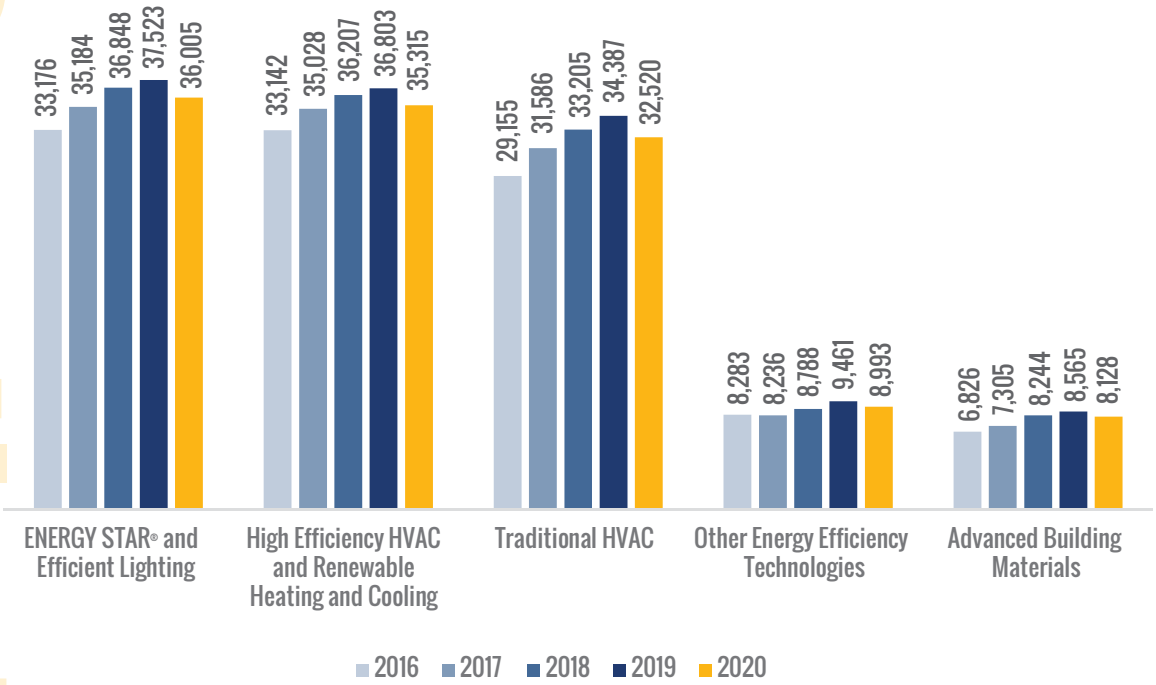


FIGURE 15. ENERGY EFFICIENCY EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2020[10]



clean energy generation jobs encompass all workers engaged in the research, development, production, manufacture, sales, installation, repair, maintenance, or professional service support of carbon-free electricity generating technologies.

RENEWABLE ELECTRIC POWER GENERATION

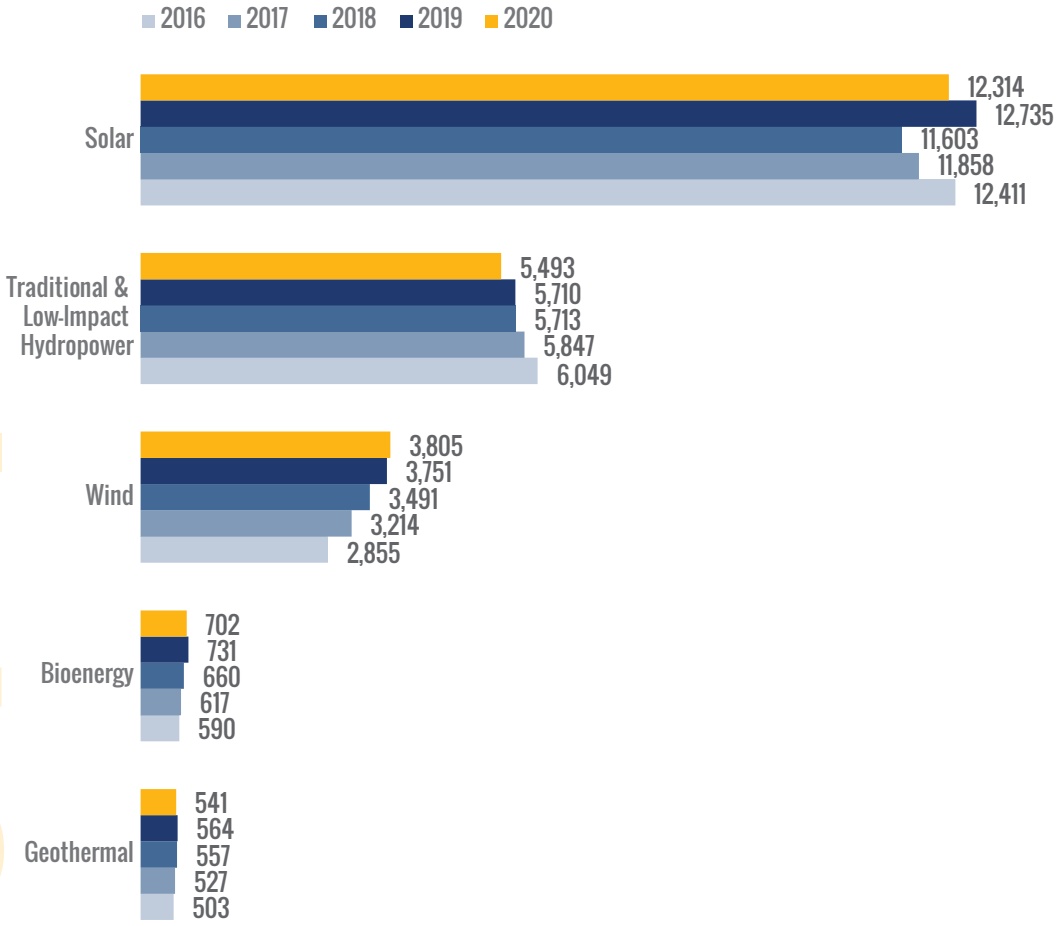
Clean energy generation technologies include solar, wind, geothermal, bioenergy, and hydropower.

Nearly all sub-technologies in renewable electric power generation, with the exception of wind, saw job losses from 2019 through 2020. Despite economy-wide job losses during this period, wind energy firms in New York grew by 1%, resulting in the creation of more than 50 new wind jobs in 12 months. This follows on the growth trajectory from 2016 through 2019, where wind firms added almost 900 new jobs to the clean energy labor market — an increase of 31%.[11]

The solar sector saw the greatest amount of job losses, shedding about 420 workers from 2019 through 2020 for a decline of 3%. Following solar, traditional and low-impact hydropower firms declined by 4%, or 217 jobs, followed by bioenergy, with a loss of 30 jobs and a decline of 4%, and geothermal, with a decline of 4% or about 20 jobs.

Detailed Sector Employment

FIGURE 16. RENEWABLE ELECTRIC POWER GENERATION EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2020[12]



A DEEPER DIVE:

OFFSHORE WIND IN NEW YORK

5 offshore wind projects in active development, totaling ~4,300 MW

almost halfway toward the 9,000 MW goal

STATEWIDE TARGETS AND CAPACITIES

With a goal to produce 9,000 MW of offshore wind-powered electricity, New York State is poised to become a central player in the rapidly growing national offshore wind industry. This goal was set in the Climate Leadership and Community Protection Act (Climate Act) and is expected to support approximately 30% of New York's electricity demand. To date, New York has five offshore wind projects in active development, totaling about 4,300 MW. Almost halfway toward the 9,000 MW goal, New York's current offshore wind project portfolio represents the largest suite of planned offshore wind projects in the nation.[13] In total, estimates for potential offshore wind energy production hold that the New York Bight[14] area of shallow waters could support up to 11,500 MW of energy production.[15]

ECONOMIC AND LABOR MARKET BENEFITS

Offshore wind commitments that create and grow a local industry have the potential to produce numerous economic benefits, including job growth and local tax revenues. If fully realized, the development phase for 11,500 MW of offshore wind capacity in New York Bight would support an estimated 100 jobs annually between 2022 and 2029. The construction and build out phase would support an annual 32,200 jobs from 2025 through 2030. Assuming a 30-year lifespan, the operation and maintenance of 11,500 MW in offshore wind developments would support about 5,800 high-quality jobs annually from 2025 through 2055 in varying occupations such as marine operators, wind turbine technicians, and plant managers. The annual labor income created from these offshore wind projects is an estimated $3.3 billion annually, with an additional roughly $200 million in yearly tax revenue.[16]

The State's most recent offshore wind solicitation of up to 2,500 MW was the largest of its kind in the United States. The contracts awarded to Empire Wind 2 and Beacon Wind for a combined 2,490 MW will help New York reach its expectations of 5,000 new local offshore wind jobs and $6 billion of in-State expenditures.[17, 18] NYSERDA has long recognized the value of project labor agreements, and has made prevailing wage requirements within its large-scale renewables programs(i.e., for construction phases of renewable energy projects 5 MW or larger)[19] These make for higher wages, work preservation, and more local jobs through union referral systems that allow contractors to access pools of skilled and trained workers.[20]

A DEEPER DIVE: OFFSHORE WIND IN NEW YORK

18 distinct occupations

5 phases for development

> **Planning and Development**

> **Manufacturing and Assembly**

> **Construction and Installation**

> **Operations and Maintenance**

> **Support Services**

Relying on a comprehensive review of existing offshore wind workforce literature — both in New York and at the national level — the research team created a detailed occupational map of key jobs required for offshore wind project development.[21] This proprietary database includes all occupations involved in each phase of offshore wind project development and is segmented by project phase[22] and occupational group.

All statewide occupational data was sourced from the Bureau of Labor Statistics Occupational Employment Statistics database for May 2020 and supplemented with the JobsEQ labor market database where needed. All data is referenced using Standard Occupational Classification (SOC) codes.

OFFSHORE WIND OCCUPATIONS

The occupation map identifies 118 distinct occupations for offshore wind and organizes the offshore wind project development into five phases: Planning and Development, Manufacturing and Assembly, Construction and Installation, Operations and Maintenance, and Support Services.

It is important to note that these 118 distinct occupations are not exclusive to each phase, as some occupations are needed across multiple phases.

A DEEPER DIVE: OFFSHORE WIND IN NEW YORK

The following is a brief description of each phase:

Planning and Development takes at least two years, typically longer, depending on the project.[23] For New York's projected development, this phase would take roughly seven years.[24] This phase is responsible for an estimated 2% of lifetime costs according to previous offshore wind projects abroad.[25] Eventually, this stage will account for an estimated 15% of the direct workforce addition in the U.S. offshore wind industry.[26] The database currently identifies 46 occupations within this phase, including engineers, financial analysts, and lawyers.

The **Manufacturing and Assembly** phase takes several years — though offshore wind original equipment manufacturers (OEMs) will likely be involved in supplying multiple projects or orders at once. This phase is responsible for an estimated 44% of lifetime costs. It is estimated that job creation in this phase will account for 7% of total job additions in the U.S. offshore wind industry. The database currently identifies 77 occupations within this phase, including engineers, metal workers, operators, assemblers, and administrative staff.

Construction and Installation on average takes two to five years and is responsible for about 12% of lifetime costs. Many of the jobs in this phase are temporary but, in total, will account for an estimated 41% of the direct U.S. workforce increase while New York works to meet the offshore wind targets over the next five to ten years. The database currently identifies 71 occupations within this phase, including crane operators, electricians, mechanical engineers, line workers, and welders.

The **Operations and Maintenance** (O&M) phase can take 20 years or more, depending on lease and energy agreements, and accounts for 40% of lifetime costs. Workers involved in regular inspection and repair of the structure, general operations of an offshore wind local industry, and finances are expected to account for 17% of direct U.S. workforce addition from an expanded offshore wind industry. The database currently identifies 62 occupations within this phase, including administrative staff, wind turbine technicians, marine operators, and plant managers.

Support Services — including transportation, training, research, and consulting — account for the final 20% of estimated direct U.S. workforce additions to arise from an expanded offshore wind market. These services occur during all phases, with involvement lasting months or years depending upon the project. The database currently identifies 38 occupations within this phase, including meteorologists, vessel mechanics, lawyers, and policy experts.

A DEEPER DIVE: OFFSHORE WIND IN NEW YORK

Estimated life-cycle for the planned New York project is about 30 years

Although this report does not analyze the end-of-cycle phase of an offshore wind project in New York, it is an important long-term consideration. The estimated life-cycle for the planned New York project is about 30 years, at which point the structures will need to be decommissioned. The decommissioning of an offshore wind project can be costly and although it would only be an issue by 2060 for New York's offshore wind goals, it is a project phase that requires high costs and different occupations. This phase of an offshore wind project has the most uncertainty, since there are few specific regulations in place to work as a guide on what should be done, and few offshore wind projects have been decommissioned as of 2021.

It is important to note that a decommissioning phase, just like the planning and construction phases, must be specific to the qualities and location of the project, therefore, a general plan for decommissioning is very difficult. Asides from decommissioning, an offshore wind farm could potentially be repowered or refurbished, but it is not possible to assume the end-of-cycle direction of a particular project, since it only occurs over two decades.[27] Research from the University of Strathclyde in the UK presents further information on the end-of-cycle phase of an offshore wind project, and can be found in Appendix E.

Table 1 provides an overview of the number of distinct occupations within each offshore wind project development phase, as well as the total number of jobs in New York as of 2020 and a location quotient (LQ) for each phase. It should be noted that because occupations can overlap across multiple phases, the number of occupations will sum to more than the 118 distinct occupations in the database. Similarly, total jobs as of 2020 will include overlap across these occupations, and double-counting will occur if jobs are summed across project phases.

Location quotients measure the relative labor supply for an industry or occupational group in New York compared to the labor supply in the United States; the LQ metric helps measure a region's specialization relative to a larger geographic area (typically the national average).

For example, a location quotient of 1.5 indicates that an occupation is 1.5 times, or 50%, more concentrated in New York compared to its proportion of total jobs in the nation overall.

Looking at location quotients by project phase, New York has a relatively low concentration of offshore wind jobs related to manufacturing and assembly. This is not surprising, as the overall manufacturing industry in New York is a small component of the State's jobs. In 2020, the manufacturing industry comprised roughly 5% of total jobs in New York, compared to approximately 10% across the U.S.[28]

A DEEPER DIVE: OFFSHORE WIND IN NEW YORK

By comparison, the State has above-average representation for jobs related to the planning and development of offshore wind projects. These jobs are primarily professional service positions that support the initial phases of offshore wind project design and development and include mainly engineers and technicians, managers, analysts, lawyers, and architects.

Compared to the national average, the concentration of construction and O&M jobs in New York is slightly lower. These two phases will ultimately account for the largest component of work in an offshore wind industry, representing an estimated 58% of workforce additions. There is significant overlap of job types across these phases, including construction and other trades workers, administrative support, maritime and port workers, and management positions.

TABLE 1. OFFSHORE WIND OCCUPATIONS BY PROJECT PHASE

Project Phase	Number of Occupations in each Category	Total Jobs in New York, 2020[29]	Location Quotient (LQ)
Planning and Development	46	1.21 million	1.09
Manufacturing and Assembly	77	1.88 million	0.91
Construction and Installation	71	1.81 million	0.96
Operations and Maintenance (O&M)	62	1.60 million	0.94
Support Services	38	690,000	1.04

A DEEPER DIVE: OFFSHORE WIND IN NEW YORK

TABLE 2. OFFSHORE WIND-RELATED OCCUPATIONAL CATEGORIES/ GROUPINGS

- Administration and Finance
- Construction and Assembly Workers
- Consultants, Scientists, and Researchers
- Directors and Executives
- Education
- Engineers and Technicians
- Legal and Permitting
- Management
- Maritime, Port, and Aircraft Workers
- Public Relations and Marketing
- Trade Workers
- Transportation and Logistics

Offshore wind-related occupations can also be organized into 12 occupational categories or groupings. Table 2 displays the broad occupational groups that are required to complete offshore wind projects.

For a complete list of all occupations found to be pertinent to domestic offshore wind development, refer to Appendix D of this report.

FIGURE 17. OFFSHORE WIND PROJECT PHASES

30+ YEARS OF OFFSHORE WIND PROJECT

Planning and Development
- 4–7 years
- CAPEX: 15% of Lifetime Costs
- 46 Occupations

Manufacturing and Assembly
- 1–3 years
- CAPEX: 15% of Lifetime Costs
- 77 Occupations

Construction and Installation
- 12–5 years
- CAPEX: 12% of Lifetime Costs
- 71 Occupations

Operations and Maintenance
- 20+ years
- CAPEX: 40% of Lifetime Costs
- 62 Occupations

Decommission

Support Services > Occurs during all phases > CAPEX: 20% of Lifetime Costs > 38 Occupations

hybrid and electric vehicle sub-technologies

12% and 8% growth

640 new jobs

[2019-2020]

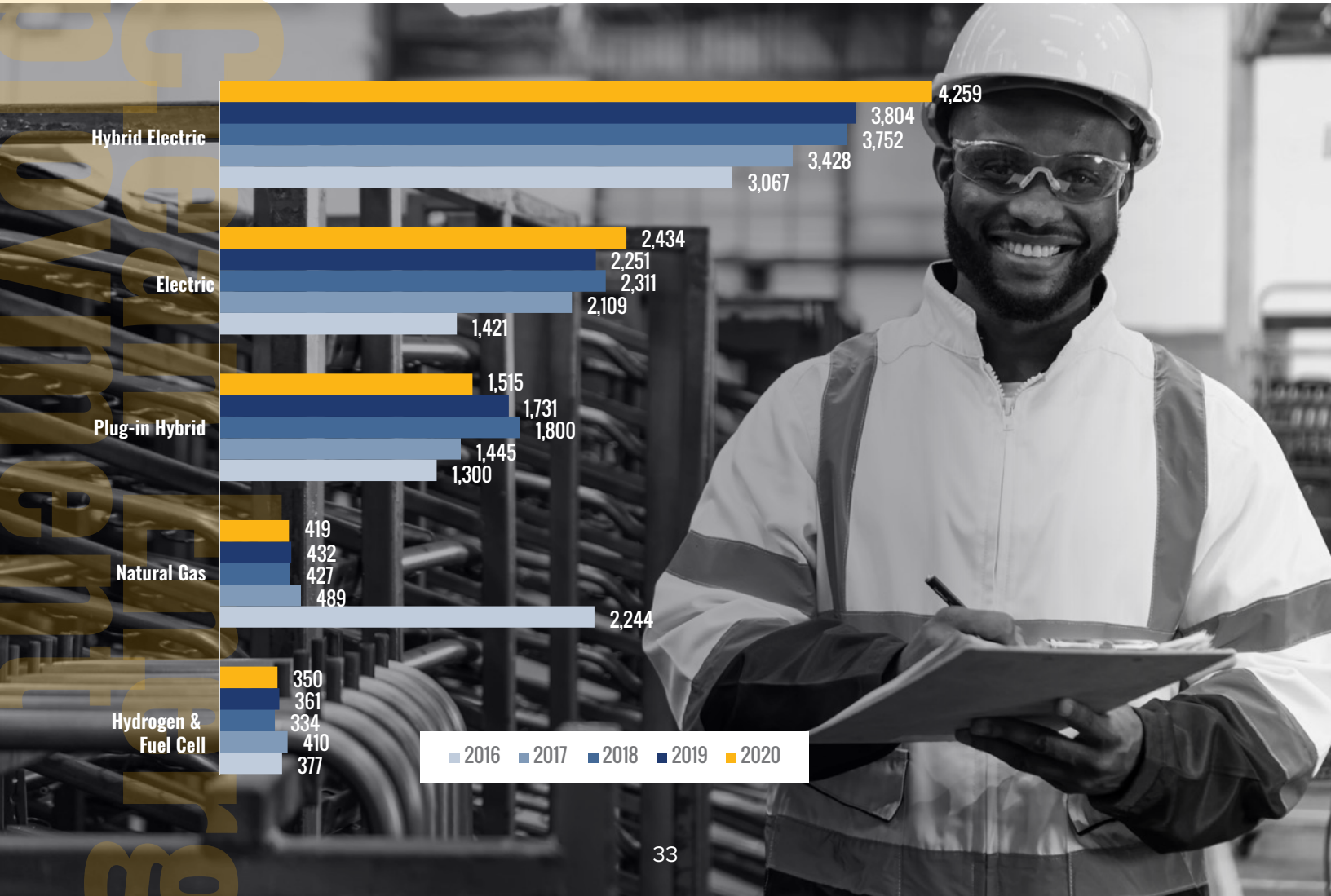
ALTERNATIVE TRANSPORTATION

The alternative transportation sector is comprised of workers that support the manufacture, sales, repair, and maintenance, and professional business support — such as legal, financial, engineering, or consulting services — of alternative vehicle technologies. Alternative transportation includes technologies like plug-in hybrid, hybrid electric, electric, natural gas, hydrogen, and fuel cell vehicles.

The alternative transportation sector remained strong throughout the pandemic, growing by almost 5% overall, or about 400 jobs. This job growth was driven largely by the hybrid electric and electric vehicle sub-technologies, which grew by a respective 12% and 8% between 2019 and 2020; this growth resulted in a collective addition of 640 jobs between the two sub-technologies. The remaining sub-technologies of plug-in hybrid, natural gas, and hydrogen and fuel cell vehicles all saw job losses between 2019 and 2020, which resulted in the net change of about 400 jobs for the overall sector.

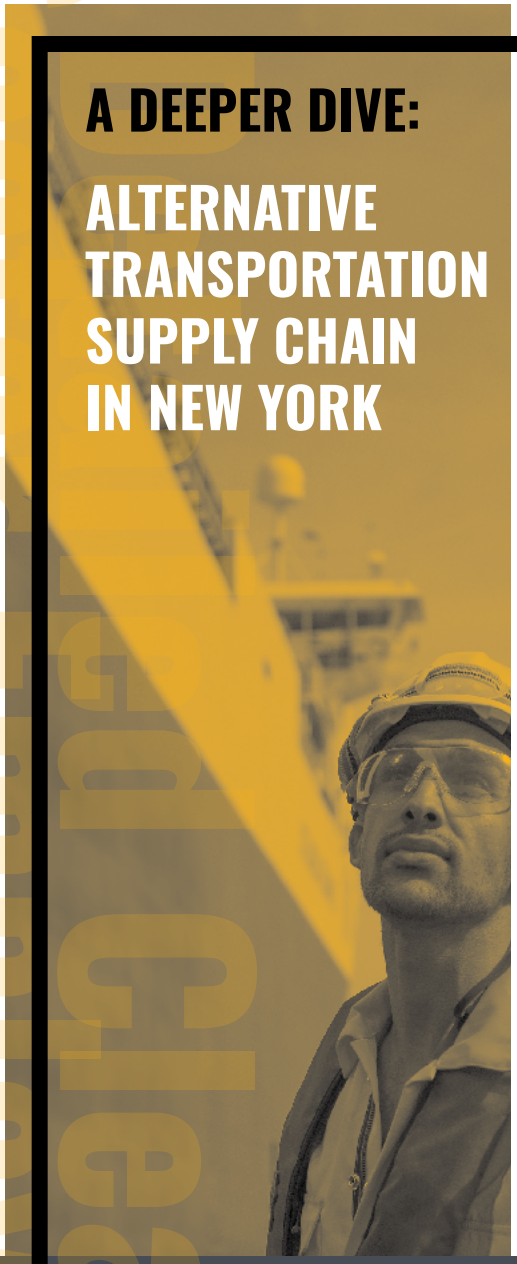
Plug-in hybrid vehicle jobs declined by 12%, a loss of 220 jobs, while natural gas and hydrogen and fuel cell jobs declined by about 3% each, or more than 20 jobs altogether.

FIGURE 18. ALTERNATIVE TRANSPORTATION EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2020



A DEEPER DIVE:

ALTERNATIVE TRANSPORTATION SUPPLY CHAIN IN NEW YORK



MANUFACTURING CAPACITY IN NEW YORK

This year's Clean Energy Industry Report includes a supplemental survey of manufacturing firms in New York. Only specific sectors of the manufacturing industry that are most likely able to support electric vehicle and related components manufacturing were surveyed in this outreach effort. These include the following industries: machinery manufacturing; computer and electronic product manufacturing; electrical equipment, appliance, and component manufacturing (including charging stations); and transportation equipment manufacturing. These industries can be considered the "potential universe" of manufacturers that could support the expansion and growth of alternative transportation supply chains and markets in New York.

It is important to note that manufacturing in general represents a small component of New York's economic activities. Overall, the manufacturing sector accounted for 2% of all business establishments in the State and 5% of total jobs in 2020. A smaller subset of the overall manufacturing sector, the alternative transportation sector's potential universe of manufacturers accounted for less than 1% of all establishments and 1% of total employment. As a proportion of total manufacturing in the State, alternative transportation-related manufacturing represents 16% of all manufacturing establishments and 30% of all manufacturing employment across the State.[30]

TABLE 3. MANUFACTURING CAPACITY IN NEW YORK, 2020[31]

	Establishments	Employment	% of Total Establishments	% of Total Employment
Manufacturing Overall	16,209	393,536	2%	5%
Machinery manufacturing	955	33,386	<1%	<1%
Computer and electronic product manufacturing	924	53,118	<1%	1%
Electrical equipment, appliance, and component manufacturing	332	12,216	<1%	<1%
Transportation equipment manufacturing	338	18,572	<1%	<1%
Total Alternative Transportation-Related Manufacturing (Potential Universe)	2,549	117,292	<1%	1%

A DEEPER DIVE: ALTERNATIVE TRANSPORTATION SUPPLY CHAIN IN NEW YORK

heavy concentrations of establishments and employment in 3 counties:

> Erie

> Monroe

> Suffolk

36% of employment

35% of business establishments

The maps featured in Figure 19 and Figure 20 illustrate the distribution of alternative transportation-related manufacturing capacity across New York. In general, the potential universe of alternative transportation supply chain industries has heavy concentration of establishments and employment across three counties — Erie, Monroe, and Suffolk. In total, 36% of employment and 35% of business establishments from the potential universe are located in these three counties.

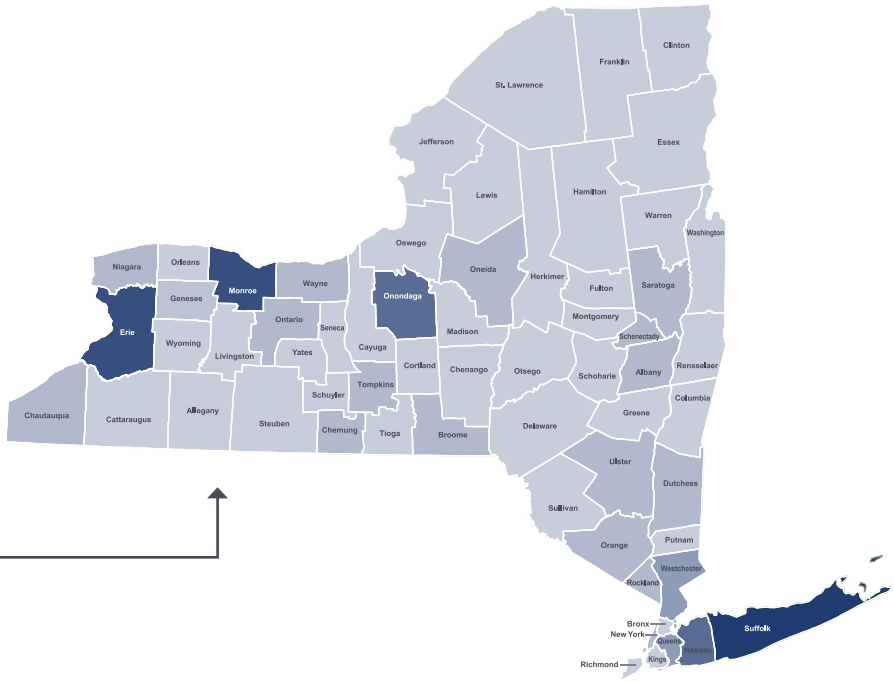


FIGURE 19. ALTERNATIVE TRANSPORTATION-RELATED MANUFACTURING (POTENTIAL UNIVERSE) **BUSINESS ESTABLISHMENTS** BY COUNTY, 2020

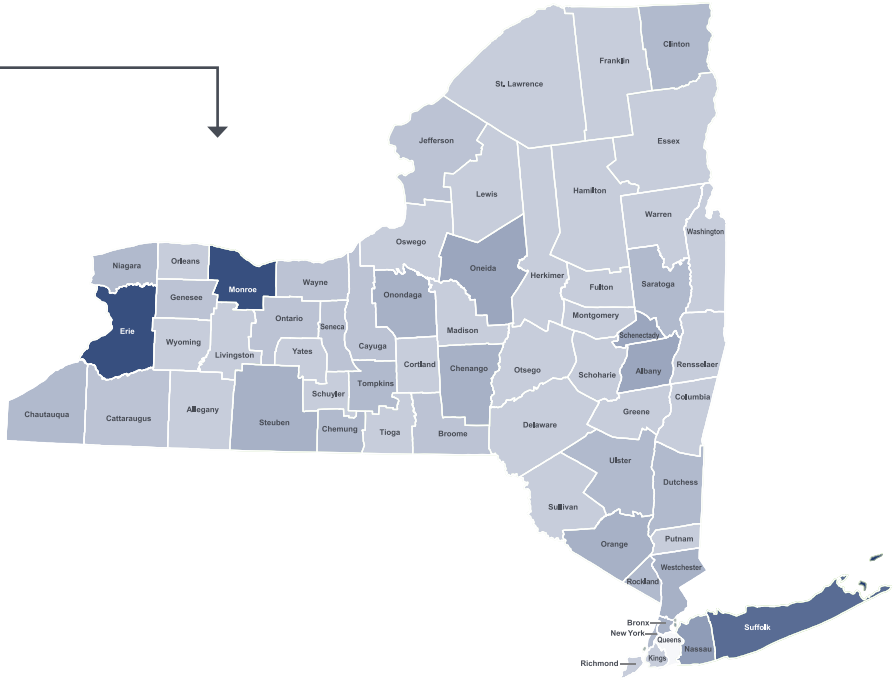
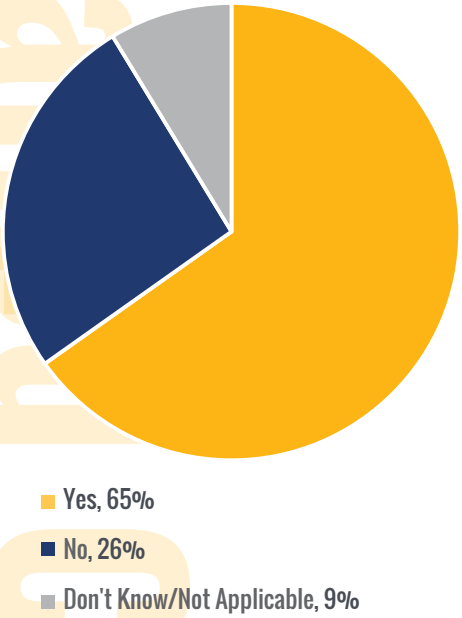


FIGURE 20. ALTERNATIVE TRANSPORTATION-RELATED MANUFACTURING (POTENTIAL UNIVERSE) **EMPLOYMENT** BY COUNTY, 2020

A DEEPER DIVE: ALTERNATIVE TRANSPORTATION SUPPLY CHAIN IN NEW YORK

FIGURE 21. NEW YORK MANUFACTURING FIRMS' EXCESS PRODUCTION CAPACITY



EMPLOYER SURVEY RESULTS

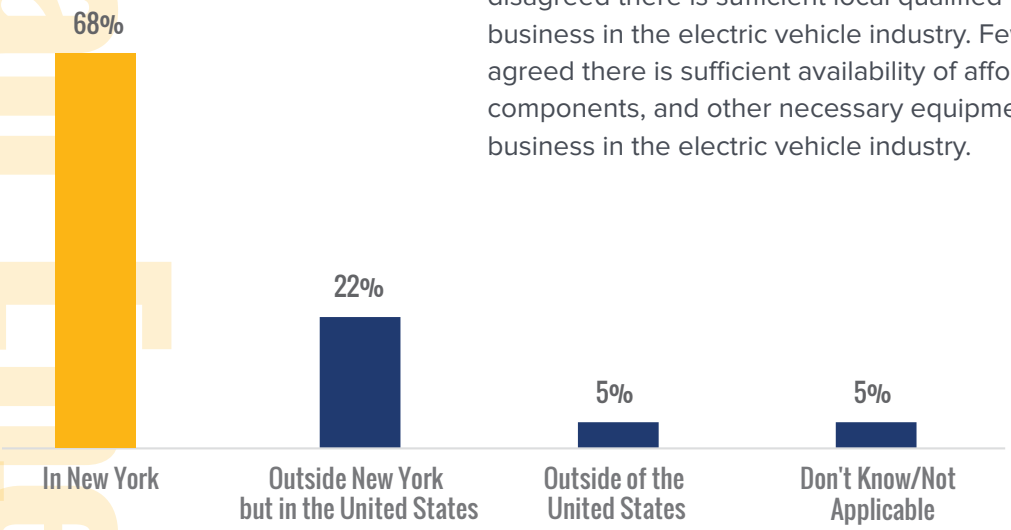
The following is a synopsis of findings from the employer survey of manufacturers in the potential universe across New York. The majority of surveyed manufacturers (65%) indicated their organization has excess production capacity, meaning they could produce more goods and components given additional investments of capital.

Most manufacturers reported their energy-related suppliers and vendors are within the State. Almost seven in ten (68%) indicated their suppliers and vendors are in New York; fewer than a quarter reported suppliers and vendors outside the State and less than 5% indicated sourcing from international suppliers.

Almost seven in ten (68%) surveyed manufacturers agreed that they are interested in the opportunity electric vehicles present for their business. Additionally, 63% reported their current offering of goods and services could be used by the electric vehicle industry, and 42% of firms agreed there is sufficient market demand to grow a profitable business in the electric vehicle industry.

However, the majority of surveyed manufacturers also indicated they would need to make significant capital investments to serve the electric vehicle industry (58%), while 47% agreed there are policy challenges inhibiting the growth of a profitable business in the electric vehicle industry. Firms also indicated concern over talent/workforce needs as well as component and equipment access and availability. Almost half (47%) of firms reported their staff would need additional training to serve the electric vehicle industry, while 53% of firms disagreed there is sufficient local qualified talent to grow a profitable business in the electric vehicle industry. Fewer than four in ten firms agreed there is sufficient availability of affordable raw materials, components, and other necessary equipment to grow a profitable business in the electric vehicle industry.

FIGURE 22. SUPPLIER AND VENDOR LOCATION



A DEEPER DIVE: ALTERNATIVE TRANSPORTATION SUPPLY CHAIN IN NEW YORK

TABLE 4. NEW YORK MANUFACTURING FIRMS' INTEREST IN ALTERNATIVE TRANSPORTATION MARKET*

	Strongly Agree	Somewhat Agree	Neither Agree or Disagree	Somewhat Disagree	Strongly Disagree
We are interested in the opportunity electric vehicles present for our business	37%	32%	5%	10%	16%
Our current offering of goods and/or services can be used by the electric vehicle industry	21%	42%	16%	10.5%	10.5%
Our company would need to make significant capital investments to serve the electric vehicle industry	26%	32%	37%	5%	0%
There are policy challenges inhibiting growth of a profitable business in the electric vehicle industry	16%	32%	32%	10%	10%
Our staff would need additional training to serve the electric vehicle industry	21%	26%	32%	11%	11%
There is sufficient market demand to grow a profitable business in the electric vehicle industry	16%	26%	37%	16%	5%
There is sufficient supply of affordable raw materials to grow a profitable business in the electric vehicle industry	5%	32%	42%	16%	5%
There is sufficient availability of necessary equipment to grow a profitable business in the electric vehicle industry	0%	36%	32%	32%	0%
There is sufficient local qualified talent to grow a profitable business in the electric vehicle industry	5%	26%	26%	26%	16%
There are permitting delays inhibiting growth of a profitable business in the electric vehicle industry	5%	21%	58%	5%	11%
There is sufficient supply of affordable component parts to grow a profitable business in the electric vehicle industry	0%	16%	47%	16%	21%

** Percentages may not sum to 100% due to rounding.*

clean storage

61% growth

700 new jobs

[2016-2019]

smart grid

69% growth

180 new jobs

[2016-2019]

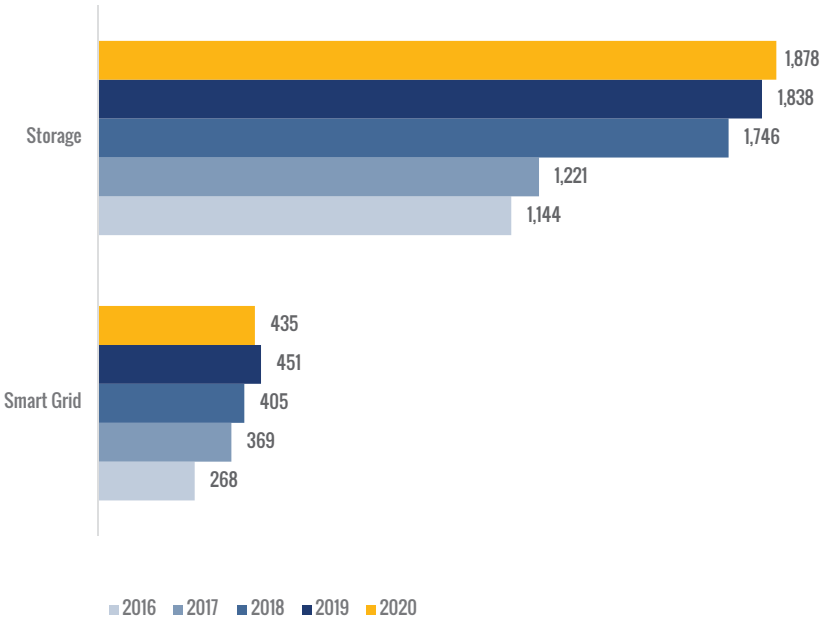
GRID MODERNIZATION

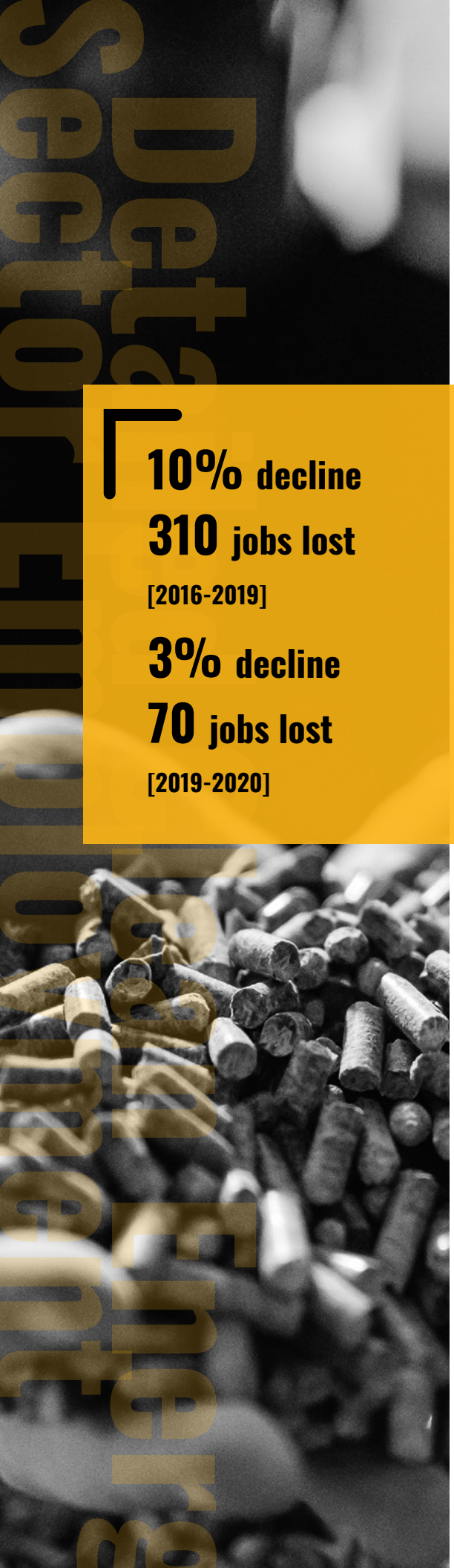
For the purposes of this report, clean grid and storage workers include any individual who supports the deployment (construction), manufacture, wholesale trade, or legal, financial, and engineering services of smart grid and energy storage technologies.

Clean storage — which includes pumped hydropower storage,[32] battery storage,[33] mechanical storage,[34] thermal storage,[35] biofuel storage (including ethanol and biodiesel), and nuclear fuel storage — accounted for about eight in ten jobs (81%). Between 2016 through 2019, these firms grew their workforce by 61%, or about 700 jobs. From 2019 through 2020, the storage sub-sector continued to grow by roughly 40 jobs, or 2%, in 12 months.

Between 2016 and 2019, smart grid[36] employment grew by 69% — an additional 180 clean energy jobs over three years. However, from 2019 through 2020, smart grid firms shed roughly 20 jobs for an almost 4% decline in 12 months.

FIGURE 23. GRID MODERNIZATION AND STORAGE EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2020





10% decline
310 jobs lost
[2016-2019]

3% decline
70 jobs lost
[2019-2020]

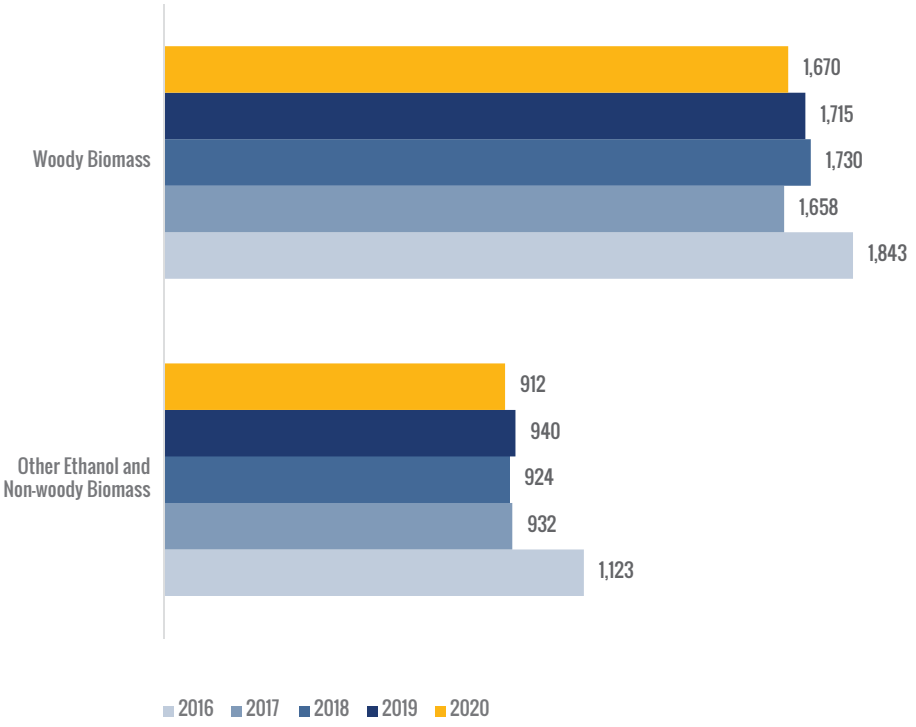
RENEWABLE FUELS

The clean fuels sector includes all workers involved in the production, distribution and sales, or professional and business service support for clean fuels and clean fuel technologies that use woody and non-woody biomass.

The declines in renewable fuels employment followed a steady trend dating back to 2016. From 2016 through 2019, the renewable fuels sector was the only sector of New York's clean energy economy that declined. Overall, jobs shrank by 10%, or 310 workers, between 2016 and 2019. From 2019 through 2020, the sector continued its downward trend, shedding just over 70 jobs — an additional decline of about 3% in 12 months.

The woody biomass sub-technology declined by almost 3%, or roughly 50 jobs, while the other ethanol and non-woody biomass sub-technology shed almost 30 jobs, for a decline of 3%.

FIGURE 24. RENEWABLE FUELS EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2020[37]



Clean Energy Hiring and COVID-19 Impacts

Of all clean energy employers surveyed, 77% indicated they have an adequate number of qualified clean energy workers to meet their current needs. Only 23% of businesses indicated they currently do not have an adequate number of workers. Of those, 86% reported currently searching for new employees to fill open positions.

About nine in ten (85%) of employers who were hiring in 2020 reported overall difficulty — the sum of very and somewhat difficult — between 2019 and 2020. It is important to note that responses to this question are based on the small sample of employers who reported seeking workers over the course of 2020.

It is possible that clean energy industry sectors are still experiencing difficulty attracting qualified workers, but more detailed research on clean energy employers' hiring experiences in 2020 may help to better understand the pandemic's effect on clean energy hiring in New York.

FIGURE 25. ADEQUATE WORKERS TO MEET CURRENT NEEDS, 2020

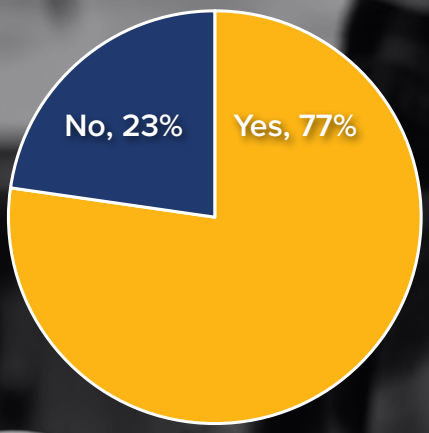


FIGURE 26. EMPLOYER-REPORTED HIRING DIFFICULTY, 2020

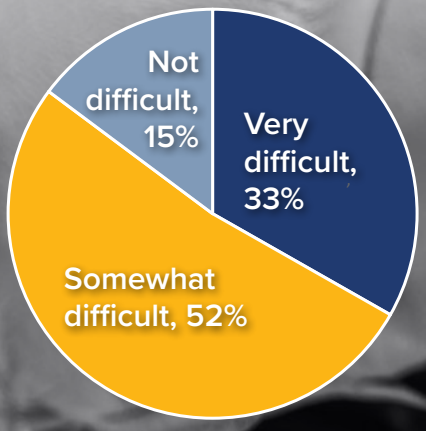
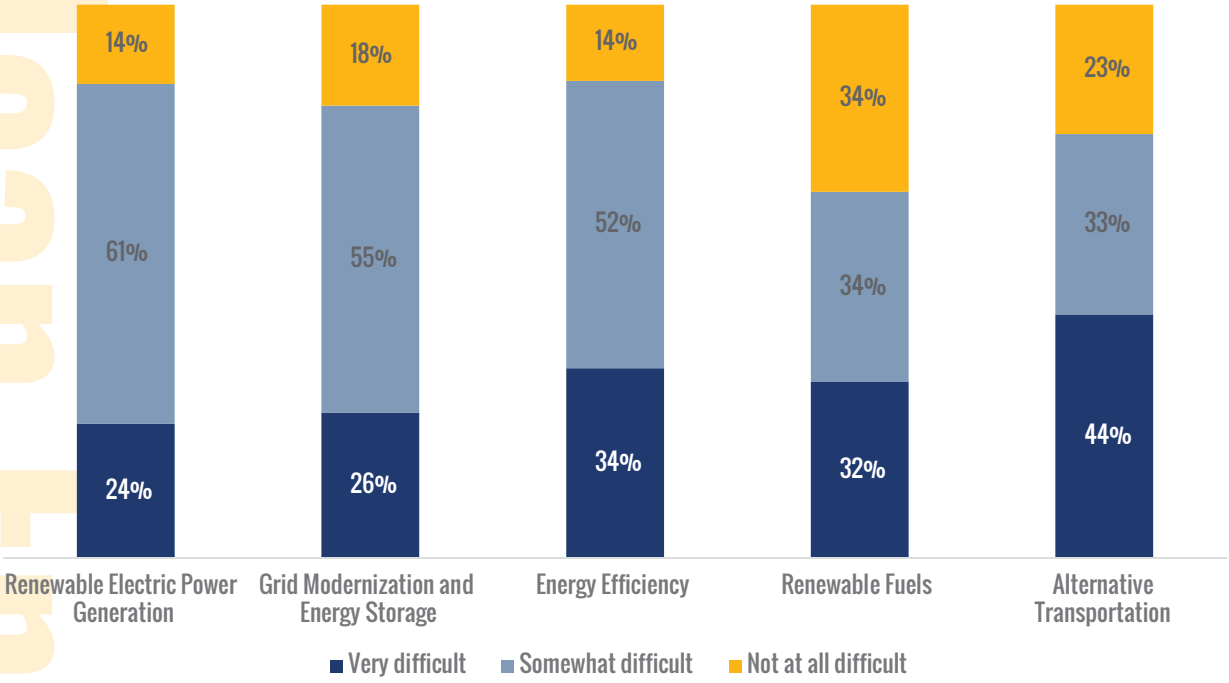


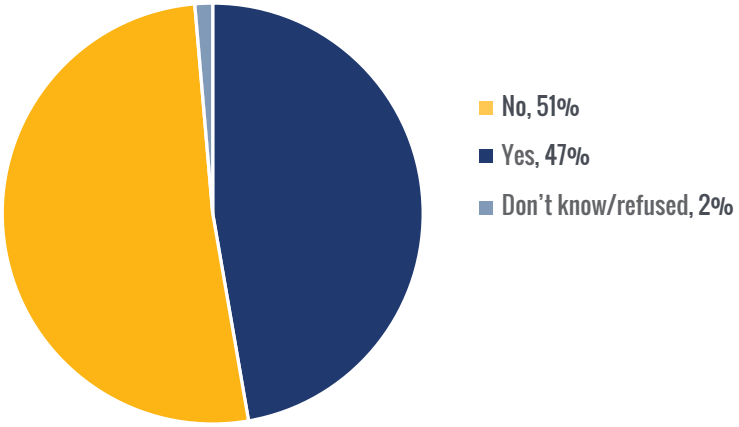
FIGURE 27. EMPLOYER-REPORTED HIRING DIFFICULTY **BY TECHNOLOGY**, 2020*



** Percentages may not sum to 100% due to rounding.*

The slight majority of firms in New York (51%) indicated they did not have to layoff, furlough, or reduce pay for their clean energy workers as a result of COVID-19 and related-stay-at-home orders.

FIGURE 28. COVID-19 WORKFORCE IMPACTS, 2020

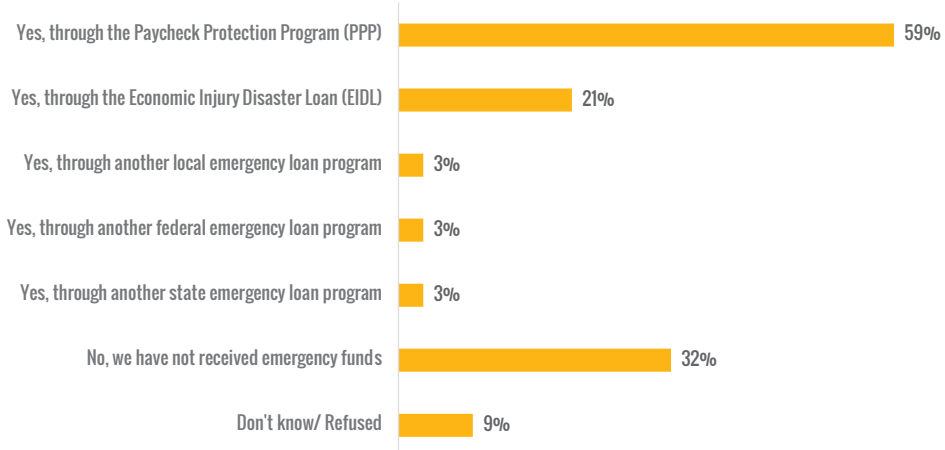


Of the 47% of firms that indicated their workforce had been impacted by COVID-19 restrictions:

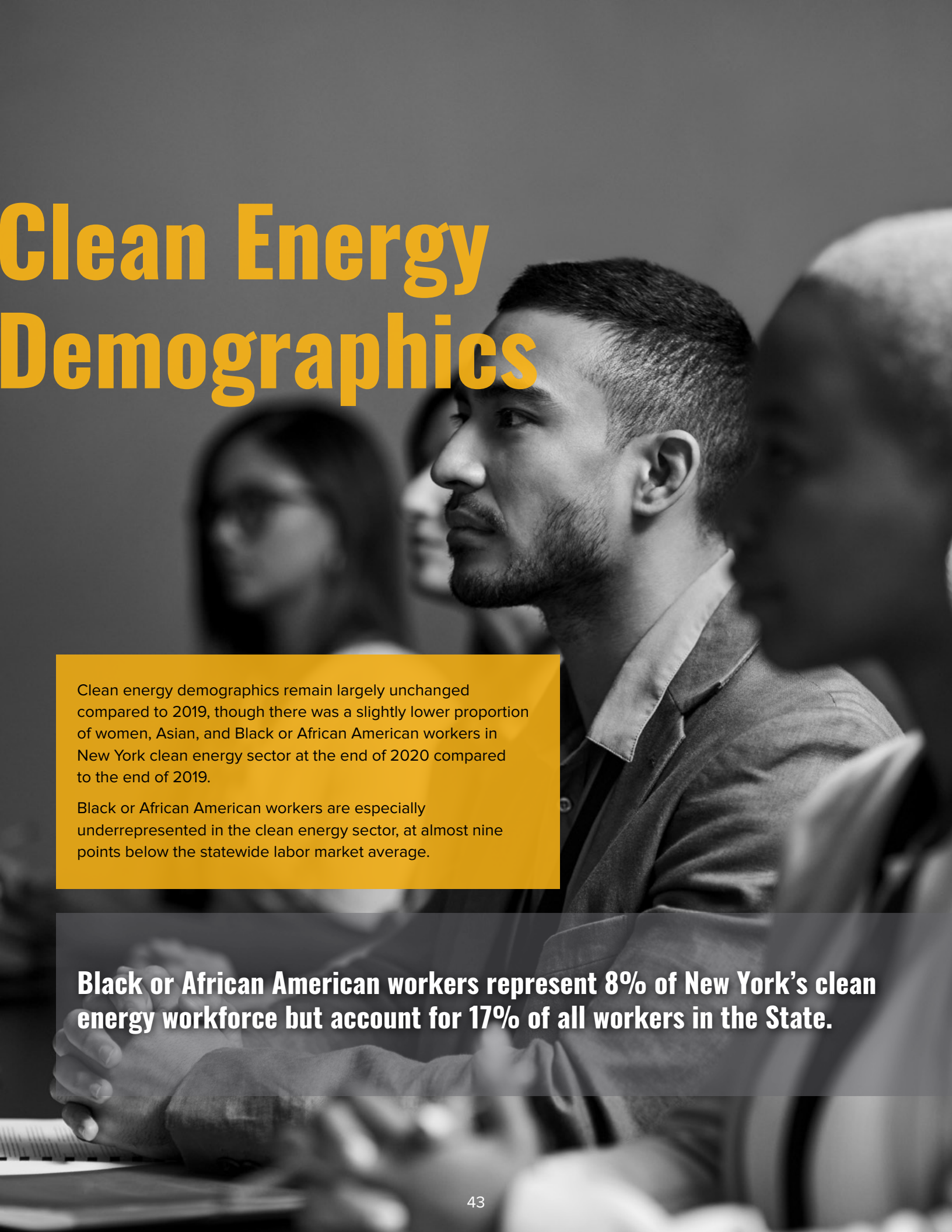
- 29% of the workforce was furloughed
- 23% were temporarily laid off
- 19% of workers suffered a reduction in hours
- 16% had reduced pay and/or benefits.
- 13% of firms reported that they had to permanently lay off clean energy staff.[38]

About six in ten (59%) clean energy businesses in New York reported receiving emergency financial relief through the Paycheck Protection Program. About one in five (21%) indicated receiving support through the Economic Injury Disaster Loan. About a third of clean energy businesses (32%) reported receiving no emergency funds over 2020.

FIGURE 29. COVID-19 RELIEF PROGRAMS AND ASSISTANCE, 2020[39]



Clean Energy Demographics



Clean energy demographics remain largely unchanged compared to 2019, though there was a slightly lower proportion of women, Asian, and Black or African American workers in New York clean energy sector at the end of 2020 compared to the end of 2019.

Black or African American workers are especially underrepresented in the clean energy sector, at almost nine points below the statewide labor market average.

Black or African American workers represent 8% of New York's clean energy workforce but account for 17% of all workers in the State.

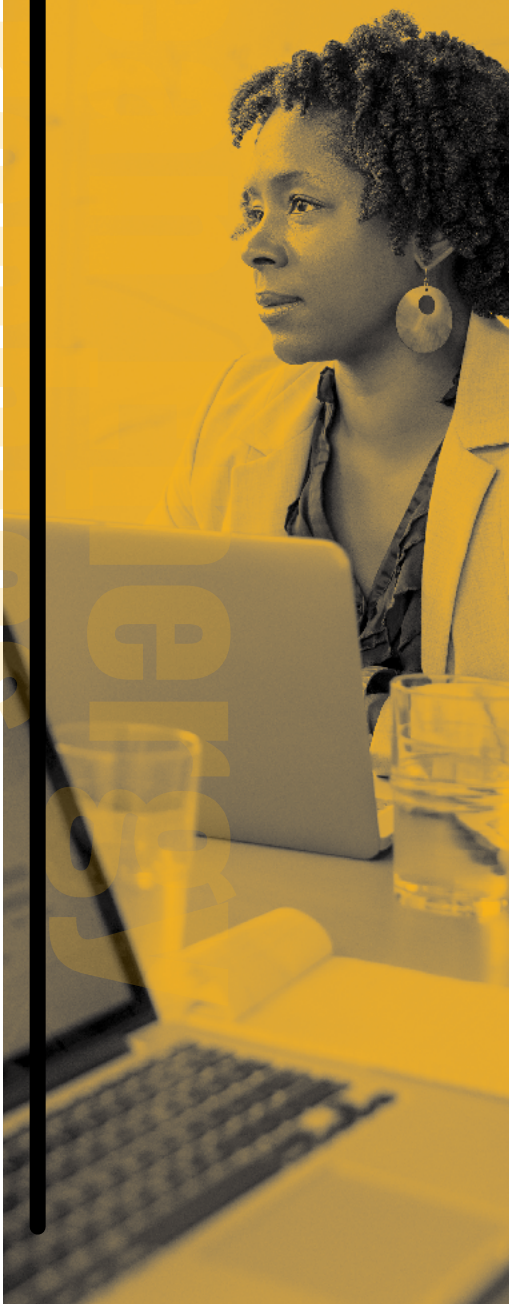
TABLE 5. CLEAN ENERGY DEMOGRAPHICS, 2020[40, *]

	NY CLEAN ENERGY INDUSTRY					
	Overall Clean Energy, 2019	Overall Clean Energy, 2020	Energy Efficiency, 2020	Renewable Electric Power Generation, 2020	NY Overall[41]	US Clean Energy[42]
Female	26%	25%	24%	29%	49%	27%
Male	74%	75%	76%	71%	51%	73%
White	72%	72%	73%	71%	71%	73%
Hispanic/ Latinx	15%	15%	14%	17%	16%	17%
Black	8%	8%	8%	9%	17%	8%
Asian	8%	6%	6%	9%	10%	8%
Native American	1%	1%	2%	1%	%	1%
Pacific Islander	1%	1%	1%	1%	<1%	1%

** Race categories will not sum to 100% because the individuals who selected "two or more races" are not featured in this table.*

A DEEPER DIVE:

PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR



Per NYSERDA's definition, priority populations include Veterans, Native Americans, individuals with disabilities, low-income individuals, incumbent or unemployed power plant workers, previously incarcerated individuals, young adults who are enrolled in or have completed a work preparedness training program, homeless individuals, and single parents.[43]

For clean energy training, on-the-job training, internships, and other workforce development programs offered by NYSERDA, preference is given to individuals who fall under one of these priority population segments or to individuals residing in a disadvantaged community.

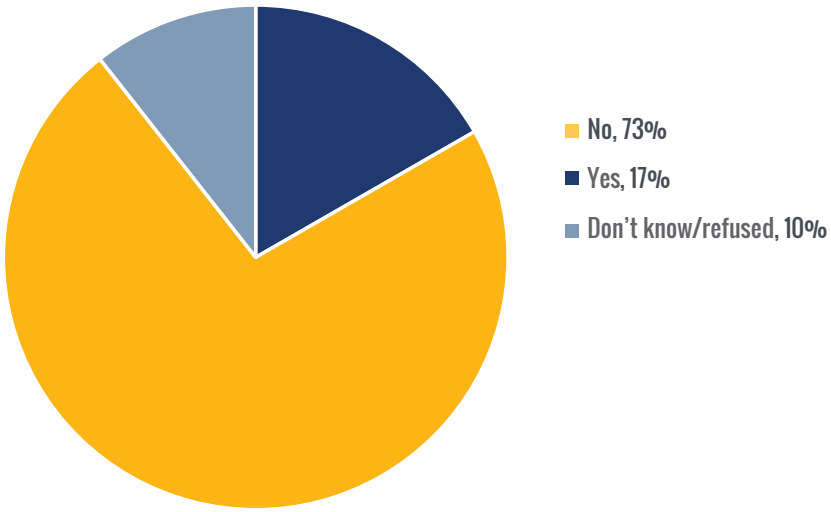
Due to the broad nature of groups included in NYSERDA's priority population definition, the research conducted for this supplemental analysis focuses specifically on Veteran status, race and ethnicity, previous incarceration, individuals with disabilities, and those who are unhoused.

EMPLOYER SURVEY RESULTS

Diversity, Equity, and Inclusion – Priorities, Programs, and Policies

Few surveyed clean energy employers reported tracking clean energy demographics. Only 17% of surveyed firms reported they track the demographics of their clean energy workforce.

FIGURE 30. CLEAN ENERGY BUSINESS DEMOGRAPHIC TRACKING



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

93% of surveyed employers reported

creating a work environment with equal access to employment opportunities is important

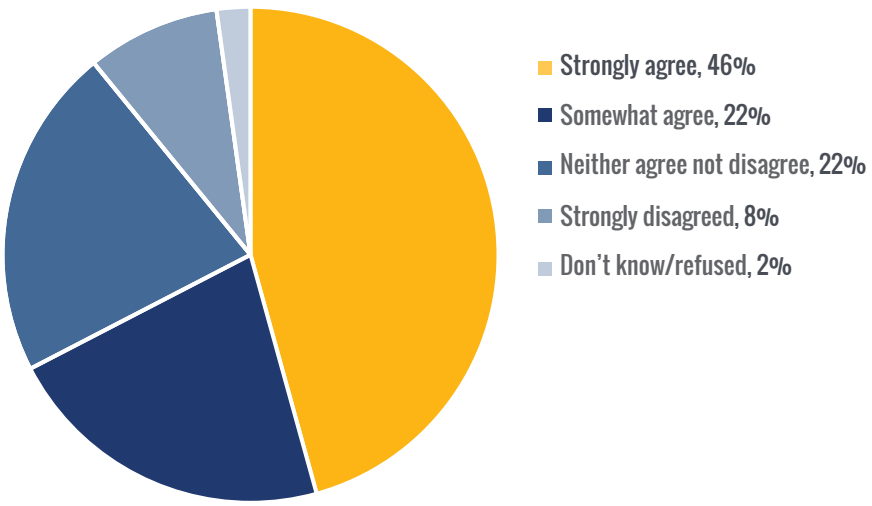
The majority of employers agree that equal opportunity and diverse/inclusive workplaces are important to company culture, innovation, and profitability. About nine in ten (93%) surveyed employers reported creating a work environment with equal access to employment opportunities is important. Though diversity, inclusion, and equal opportunities were reported to be important and very important by a majority of employers, lower on the list of priorities was the actual implementation of policies to support increased diversity. About seven in ten (72%) employers reported implementing policies and programs that promote a more diverse and inclusive workplace is important and very important to their firm. Additionally, only 65% of employers reported placing a high priority on a diverse workplace was important and very important.

TABLE 6. CLEAN ENERGY BUSINESSES' DEI PRIORITIES*

	Very Important	Important	Somewhat Important	Not Important	Don't Know/ Refused
Creating a work environment where everyone has equal access to	65%	28%	4%	0%	2%
Listening to and empowering our employees	63%	28%	2%	0%	7%
Ensuring equal opportunities for people of color	48%	33%	4%	9%	6%
Implementing policies and programs that promote a more diverse and inclusive workplace	33%	39%	11%	11%	6%
Placing a high priority on a diverse workplace	35%	30%	13%	15%	7%

** Percentages may not sum to 100% due to rounding.*

FIGURE 31. DIVERSITY, INNOVATION, AND PROFITABILITY



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

81% of surveyed employers reported

their companies offer employee diversity training or diversity awareness events

Almost eight in ten (88%) firms reported they have a company policy in place to respond to incidents of discrimination, and 81% of surveyed clean energy employers indicated their companies offer employee diversity training or diversity awareness events.

However, fewer than 40% of firms reported having any other policies, programs, or strategies in place to increase the number of female hires, ethnic and racial minorities, LGBTQ+ individuals, and Veterans, and only 15% of employers indicated they have plans to implement diversity policies or programs in the future.

Furthermore, fewer than 15% of firms reported mentorship programs or formal promotion policies for gender, racial, and ethnic minorities.

TABLE 7. CLEAN ENERGY BUSINESSES' DEI POLICIES OR PROGRAMS

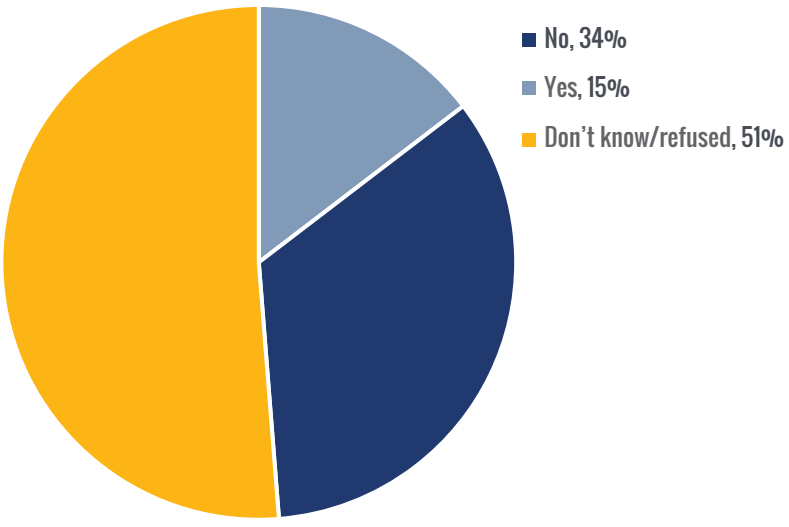
	Yes	No	Don't know/ refused
A company policy to respond to incidents of discrimination	79%	9%	12%
Employee diversity training or diversity awareness events	39%	42%	19%
Strategies, policies, or programs to increase the number of female hires	33%	49%	18%
Strategies, policies, or programs to increase the number of ethnic and racial minorities	28%	53%	19%
Strategies, policies, or programs to increase the number of LGBTQ+ individuals	21%	56%	23%
Strategies, policies, or programs to increase the number of Veterans	19%	60%	21%

A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

TABLE 8. CLEAN ENERGY BUSINESSES' MENTORSHIP OR PROMOTION POLICIES

	Yes	No	Don't know/ refused
Mentorship programs for women	14%	58%	28%
Promotion policies for women	14%	58%	28%
Promotion policies for ethnic and racial minorities	12%	60%	28%
Mentorship programs for Veterans	9%	63%	28%
Promotion policies for Veterans	9%	63%	28%
Mentorship programs for ethnic and racial minorities	9%	63%	28%
Mentorship programs for LGBTQ+ individuals	7%	63%	30%
Promotion policies for LGBTQ+ individuals	7%	63%	30%

FIGURE 32. FUTURE DEI POLICIES OR PROGRAMS



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

PRIORITY POPULATION RECRUITMENT STRATEGIES

About three-quarters (74%) of surveyed firms do not recruit either formerly incarcerated or homeless individuals. A small proportion — about one in ten (10%) firms reported they do actively recruit formerly incarcerated individuals, and 2% reported actively recruiting homeless individuals. Similarly, only 7% of clean energy firms reported they conduct formal recruitment of individuals with disabilities.

FIGURE 33. CLEAN ENERGY BUSINESSES – RECRUITMENT OF FORMERLY INCARCERATED AND HOMELESS INDIVIDUALS

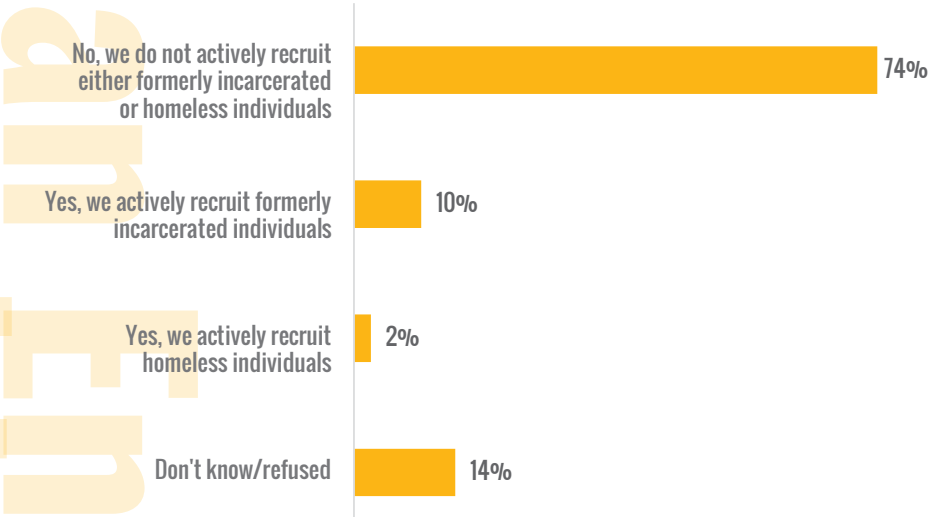
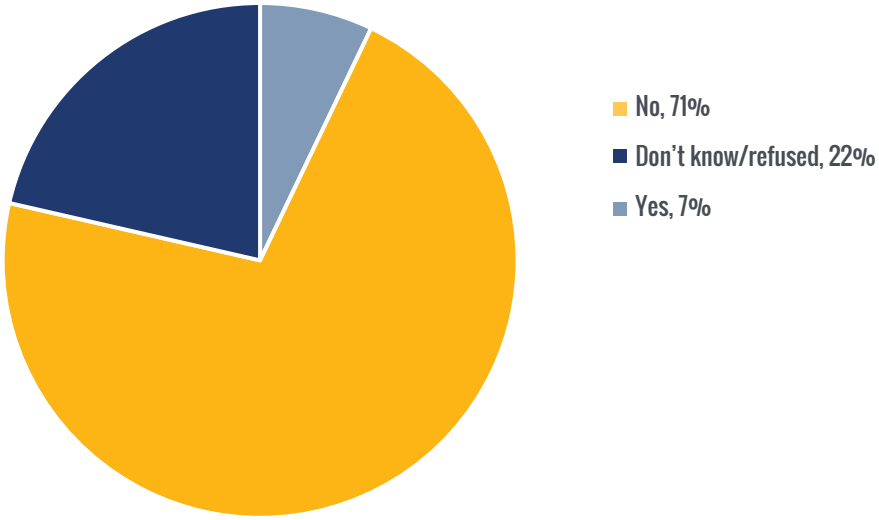


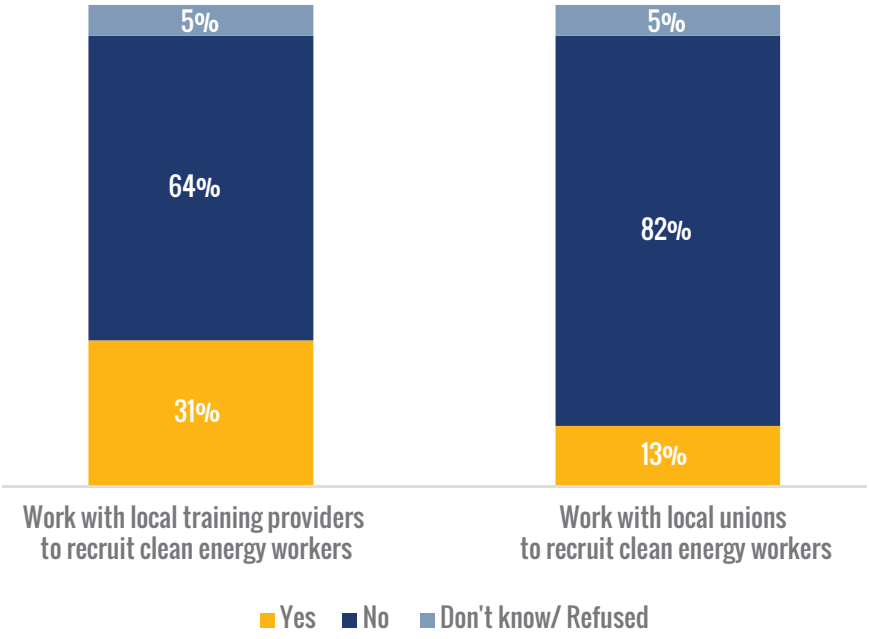
FIGURE 34. CLEAN ENERGY BUSINESSES – RECRUITMENT OF INDIVIDUALS WITH DISABILITIES



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

About three in ten (31%) of surveyed clean energy employers reported they work with local training providers to recruit qualified clean energy workers. Even fewer, 13% of firms indicated they work with local unions to find qualified clean energy workers.

FIGURE 35. RECRUITMENT PARTNERSHIPS – TRAINING PROVIDERS AND UNIONS

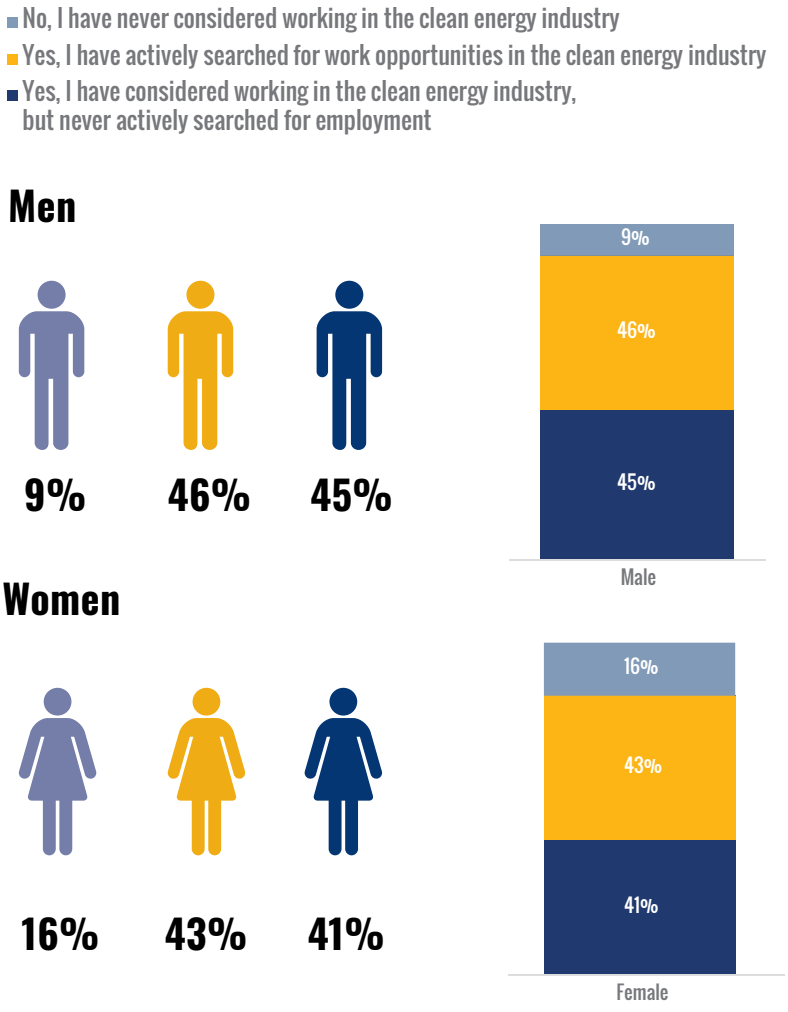


WORKER SURVEY RESULTS

CLEAN ENERGY CAREER INTEREST (NON-CLEAN ENERGY WORKERS)

Men were more likely to report they had either considered or actively searched for work opportunities in the clean energy industry compared to women. Roughly nine in ten (91%) men indicated they have either considered or actively searched for clean energy employment opportunities — 6.5 points higher compared to female survey respondents.

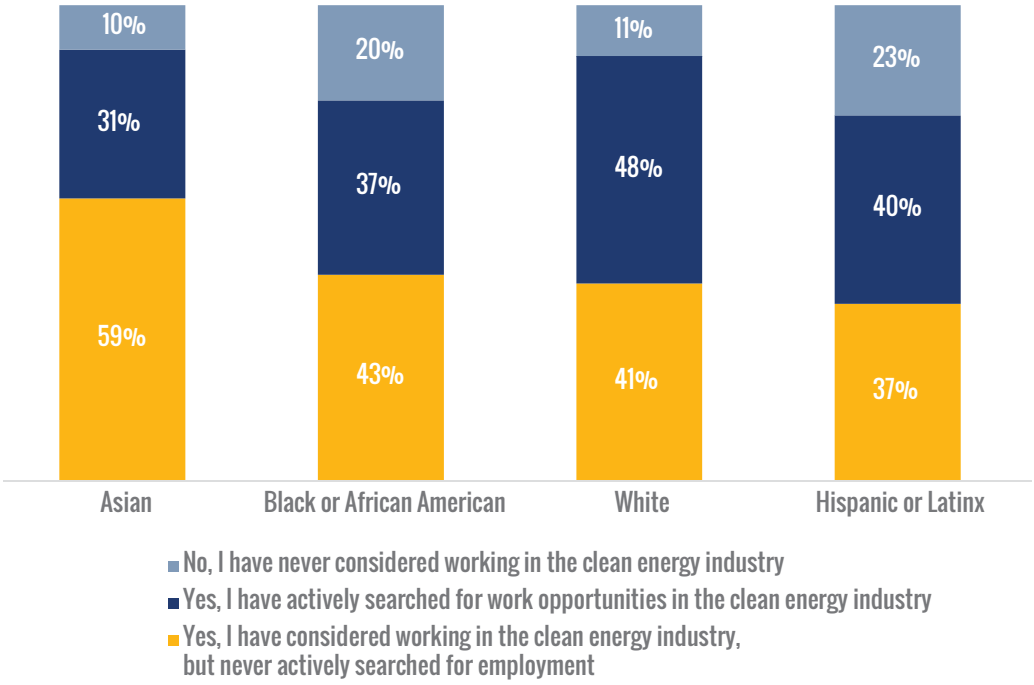
FIGURE 36. PERCENTAGE OF INDIVIDUALS CONSIDERED WORKING IN CLEAN ENERGY INDUSTRY **BY GENDER**



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

Ethnic and racial minorities were most likely to indicate they had not considered a career in clean energy. About a quarter of Hispanic or Latinx respondents (23%) and one in five Black or African American respondents (20%) reported they have never considered working in the clean energy industry, compared to only 10% of Asian respondents and 11% of White respondents.

FIGURE 37. PERCENTAGE OF INDIVIDUALS CONSIDERED WORKING IN CLEAN ENERGY INDUSTRY **BY RACE/ETHNICITY**

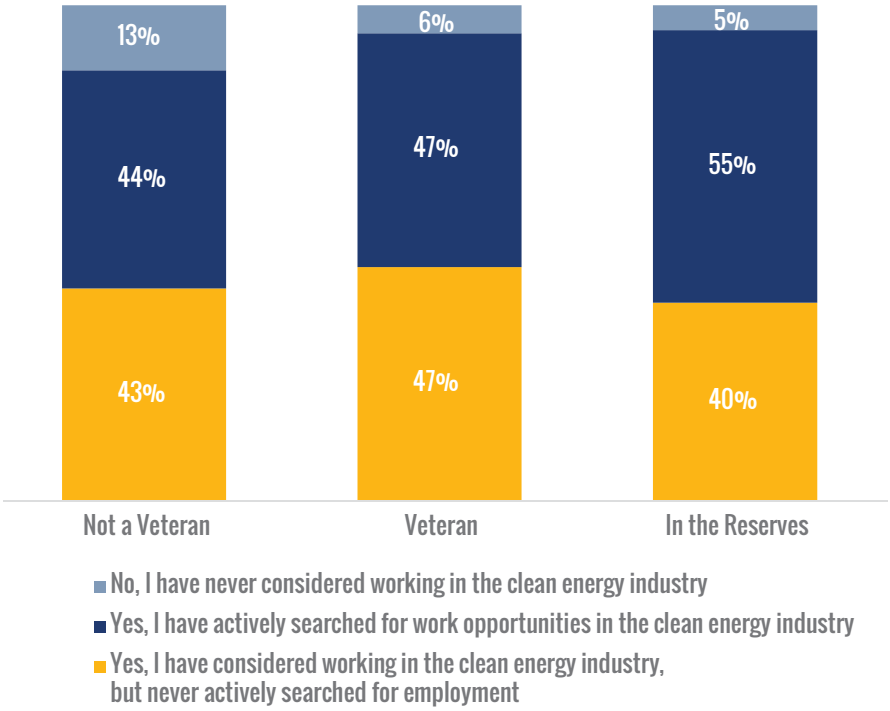


A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

Individuals who indicated they are Veterans or in the Reserves were more likely to have considered a career in the clean energy industry compared to non-Veteran respondents. Only about 5–6% of Veterans or respondents in the Reserves indicated they have never considered working in the clean energy industry, compared to 13% of non-Veterans.

There were no statistically significant differences for clean energy career interest amongst those who were previously incarcerated or respondents indicated they have a disability that requires accommodation.

FIGURE 38. PERCENTAGE OF INDIVIDUALS CONSIDERED WORKING IN CLEAN ENERGY INDUSTRY **BY VETERAN STATUS**

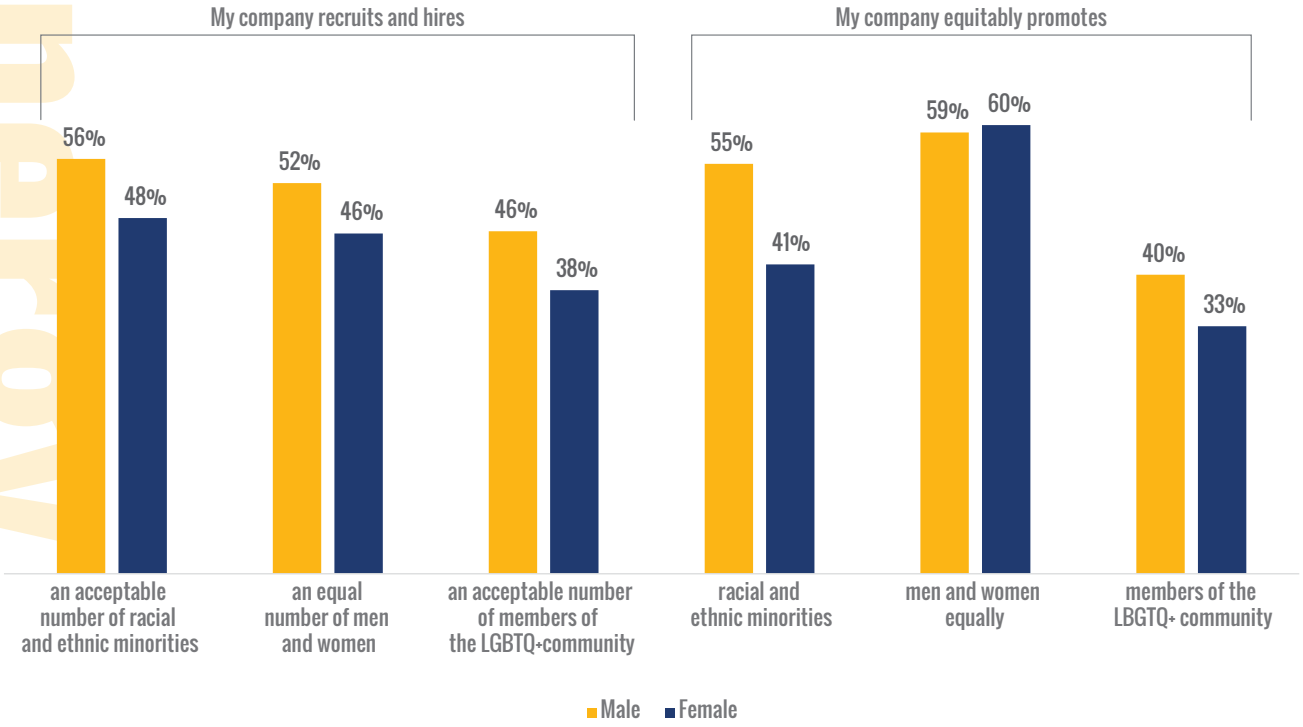


WORKPLACE EQUITY, INCLUSION, AND SUPPORT (CURRENT CLEAN ENERGY WORKERS)

Male respondents were more likely to strongly agree their clean energy company has diverse and equitable recruitment and promotion policies compared to female respondents. About half or more of male survey respondents reported their company recruits, hires, and promotes an acceptable number of racial and ethnic minorities, men and women, and members of the LGBTQ+ community. By comparison, less than half of women reported their clean energy firm has equitable recruitment, hiring, and promotion practices for racial and ethnic minorities, men and women, and members of the LGBTQ+ community.

Across the board, Asian and Black or African American respondents were least likely to feel their clean energy firm had equitable recruitment, hiring, and promotion policies. White and Hispanic or Latinx clean energy workers were more likely to feel there is diversity in recruitment and hiring at their firm. Veterans and members of the reserves were also more likely to strongly agree their clean energy company has diverse recruitment and promotion practices.

FIGURE 39. PERCEPTIONS OF DIVERSITY IN RECRUITMENT AND PROMOTION **BY GENDER** – "STRONGLY AGREE"



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

FIGURE 40. PERCEPTIONS OF DIVERSITY IN RECRUITMENT AND PROMOTION **BY RACE/ETHNICITY** – "STRONGLY AGREE"

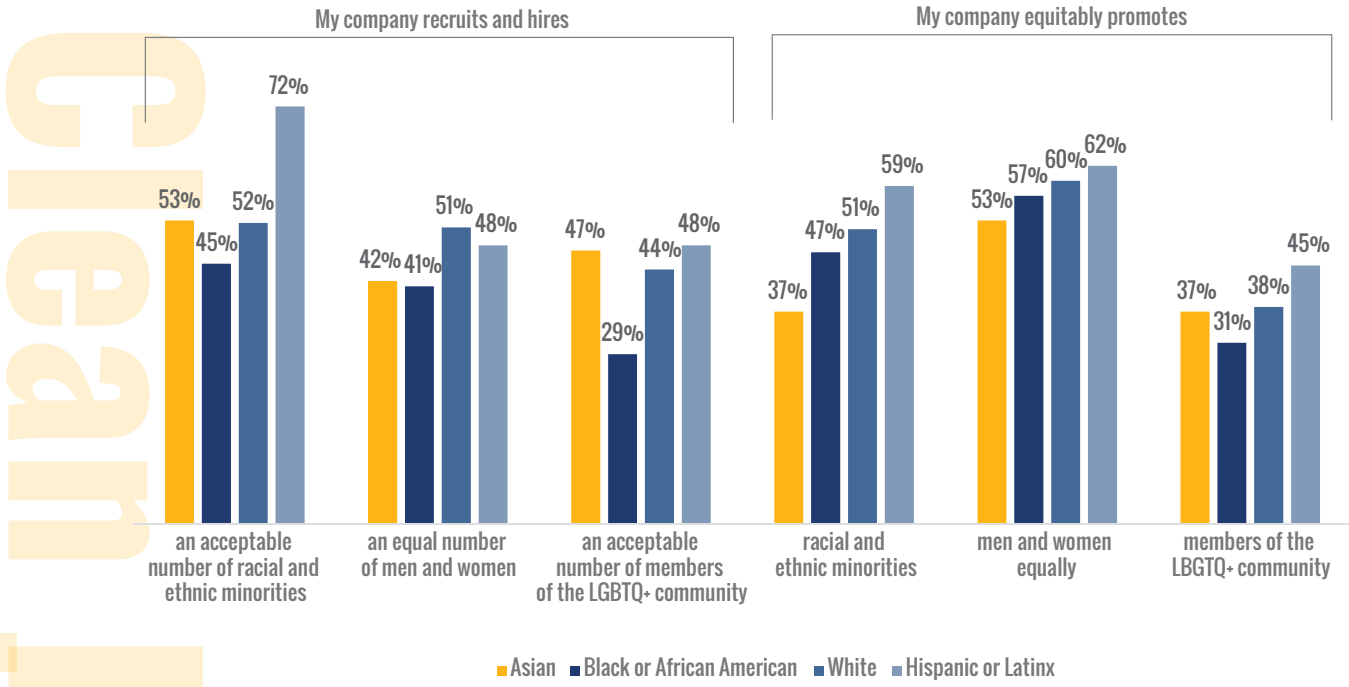
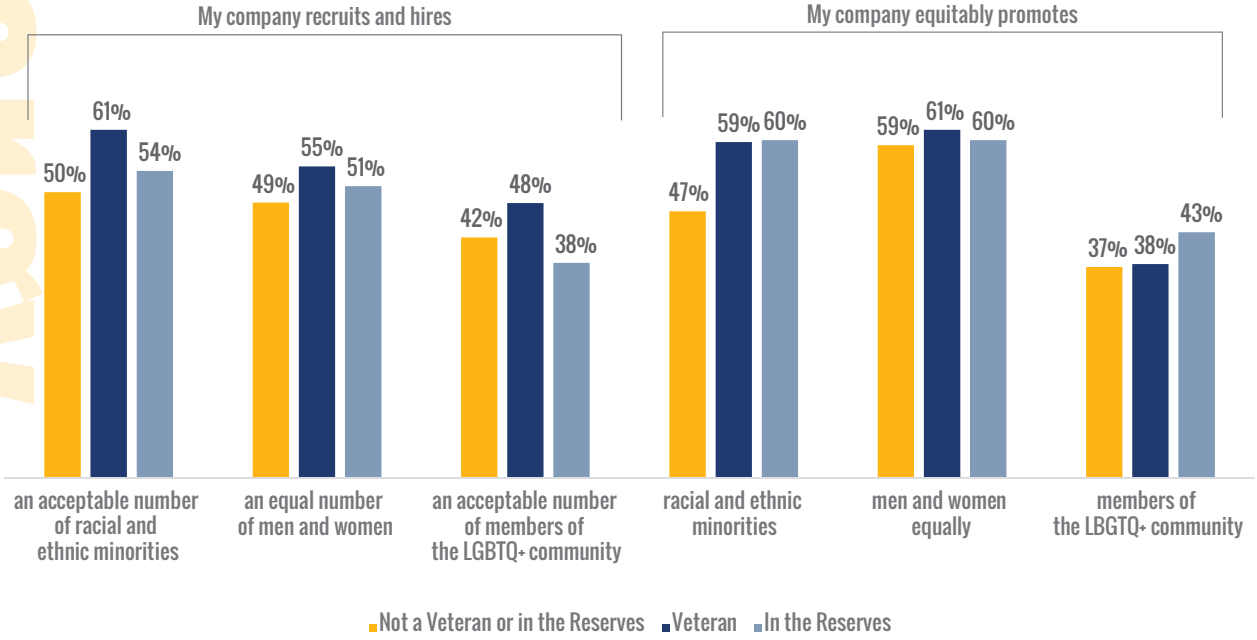


FIGURE 41. PERCEPTIONS OF DIVERSITY IN RECRUITMENT AND PROMOTION **BY VETERAN STATUS** – "STRONGLY AGREE"



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

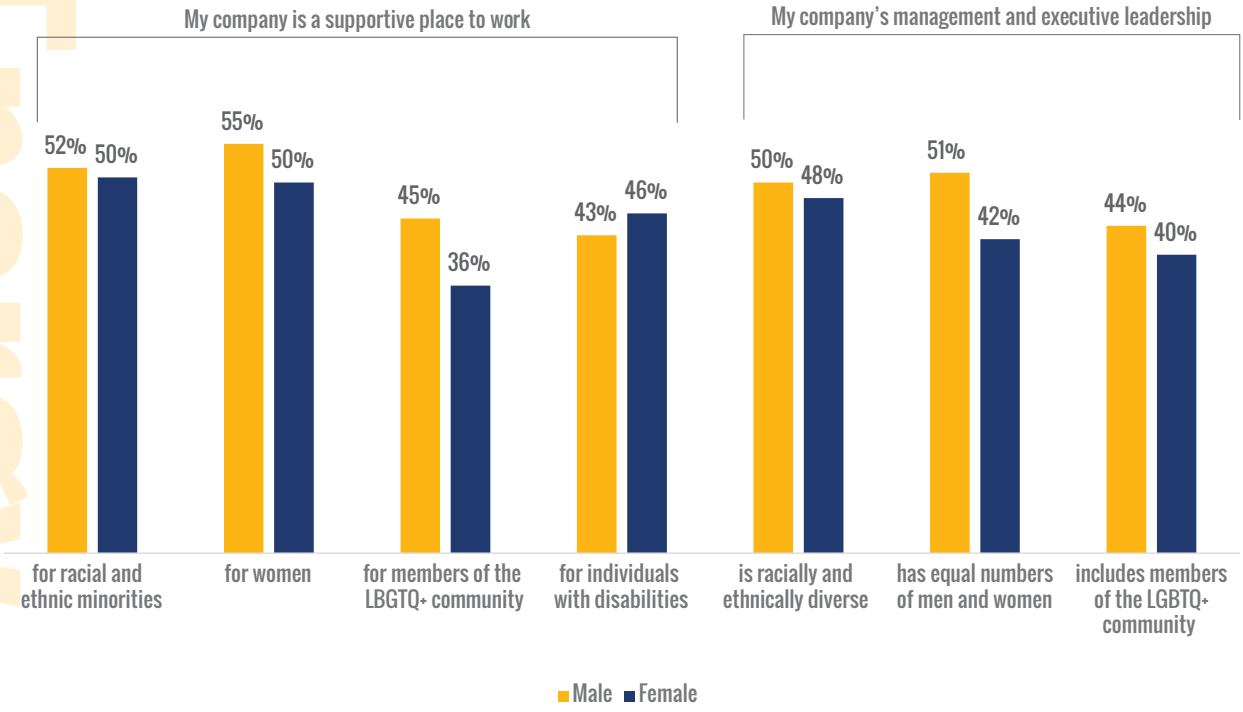
Men were more likely to feel their clean energy company's management and executive leadership has equal numbers of men and women. More than half (51%) of male respondents indicated that they strongly agree with this sentiment, compared to only 42% of women.

White and Hispanic or Latinx clean energy workers were more likely to strongly agree their company is a supportive place to work for racial and ethnic minorities compared to Asian and Black or African American respondents.

In general, White and Hispanic or Latinx clean energy workers tended to feel more positively about company support for disadvantaged populations as well as diversity in leadership positions for racial and ethnic minorities, men and women, individuals with disabilities, and members of the LGBTQ+ community.

Clean energy workers who are Veterans and members of the Reserves were also more likely to the feel their company is supportive of underrepresented communities.

FIGURE 42. COMPANY SUPPORT AND DIVERSITY IN LEADERSHIP **BY GENDER** – "STRONGLY AGREE"



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

FIGURE 43. COMPANY SUPPORT AND DIVERSITY IN LEADERSHIP
BY RACE/ETHNICITY – "STRONGLY AGREE"

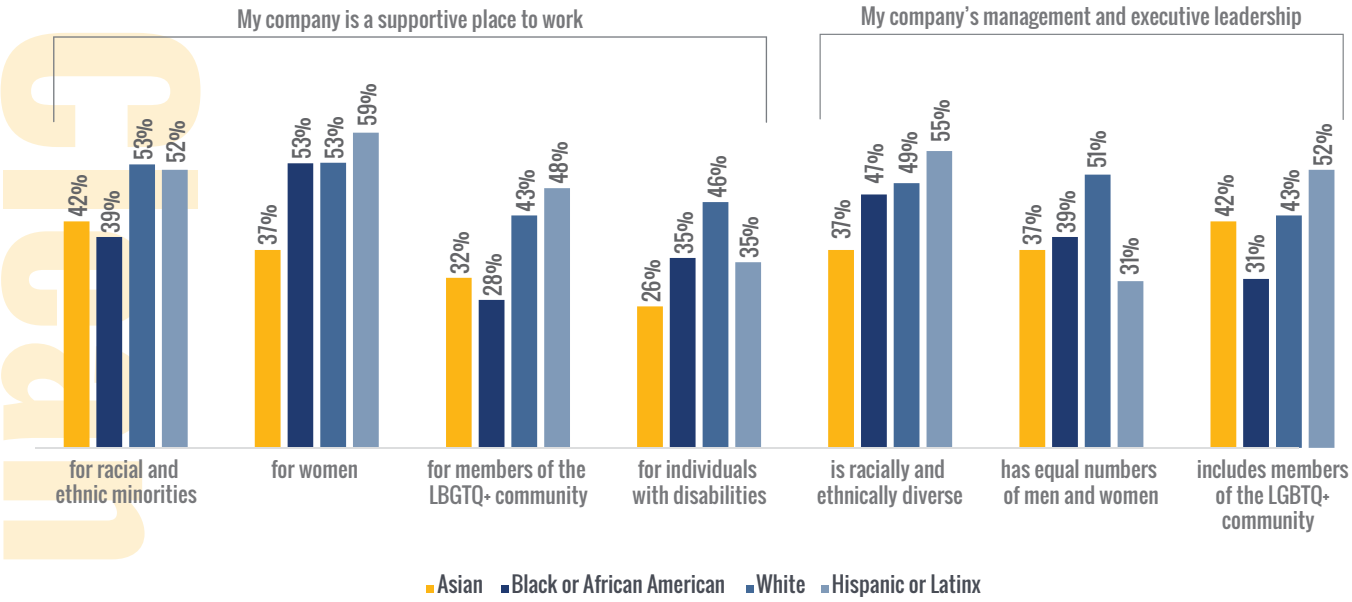


FIGURE 44. COMPANY SUPPORT AND DIVERSITY IN LEADERSHIP
BY VETERAN STATUS – "STRONGLY AGREE"

A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

Male clean energy respondents were significantly more likely to feel their company is for people like them; more than half of male respondents strongly agreed with this statement compared to only four in ten female clean energy workers.

In general, male respondents were more likely to report a higher sense of inclusion and belonging in their workplace compared to women.

Similarly, White and Hispanic or Latinx clean energy workers were more likely to feel like they are valued and accepted at their company compared to Asian and Black or African American respondents, while Veterans were most likely to feel this way compared to individuals in the Reserves or non-Veterans.

FIGURE 45. PERCEPTIONS OF INCLUSION AND BELONGING **BY GENDER** – "STRONGLY AGREE"

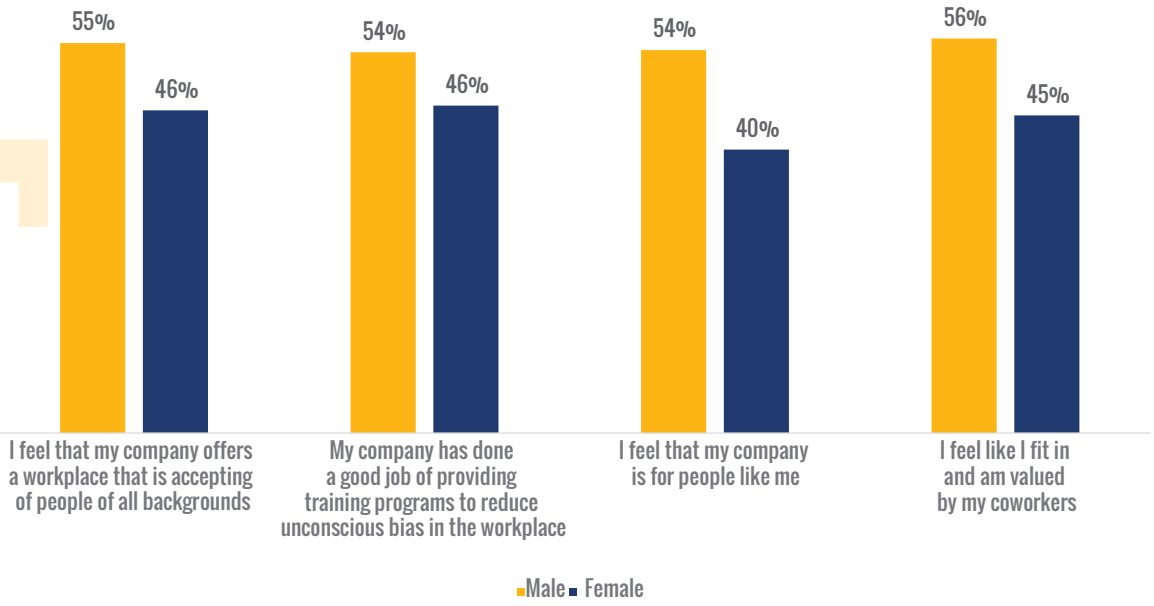


FIGURE 46. PERCEPTIONS OF INCLUSION AND BELONGING
BY RACE/ETHNICITY – "STRONGLY AGREE"

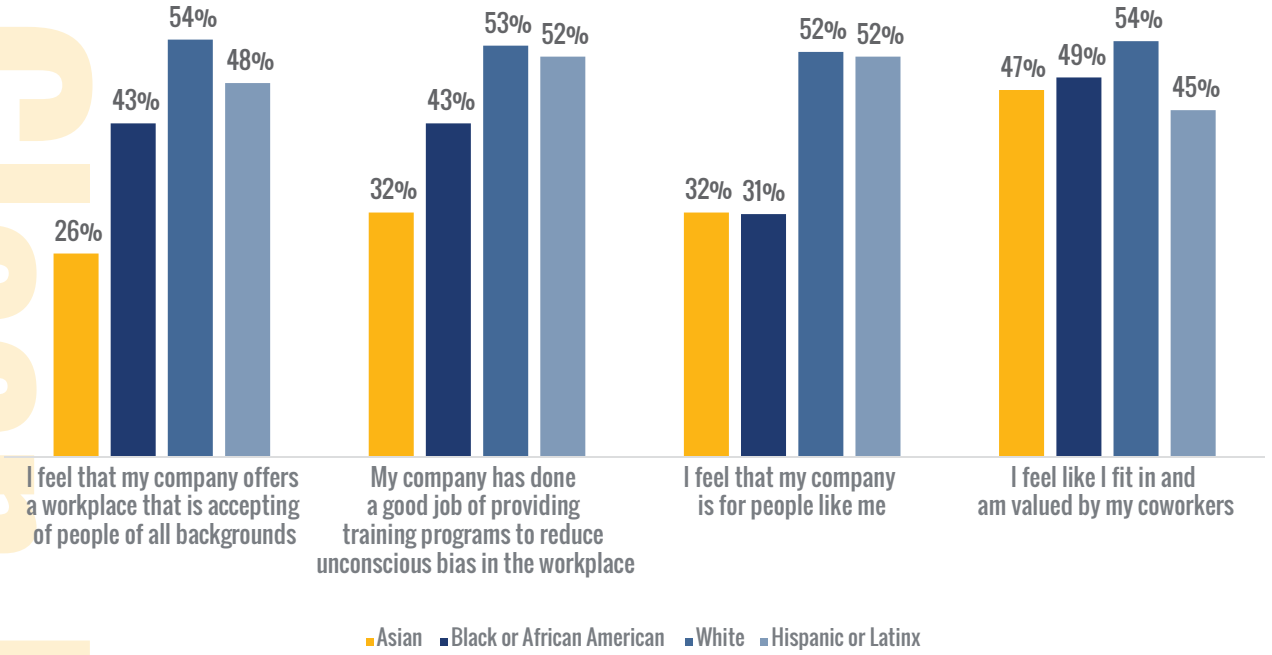
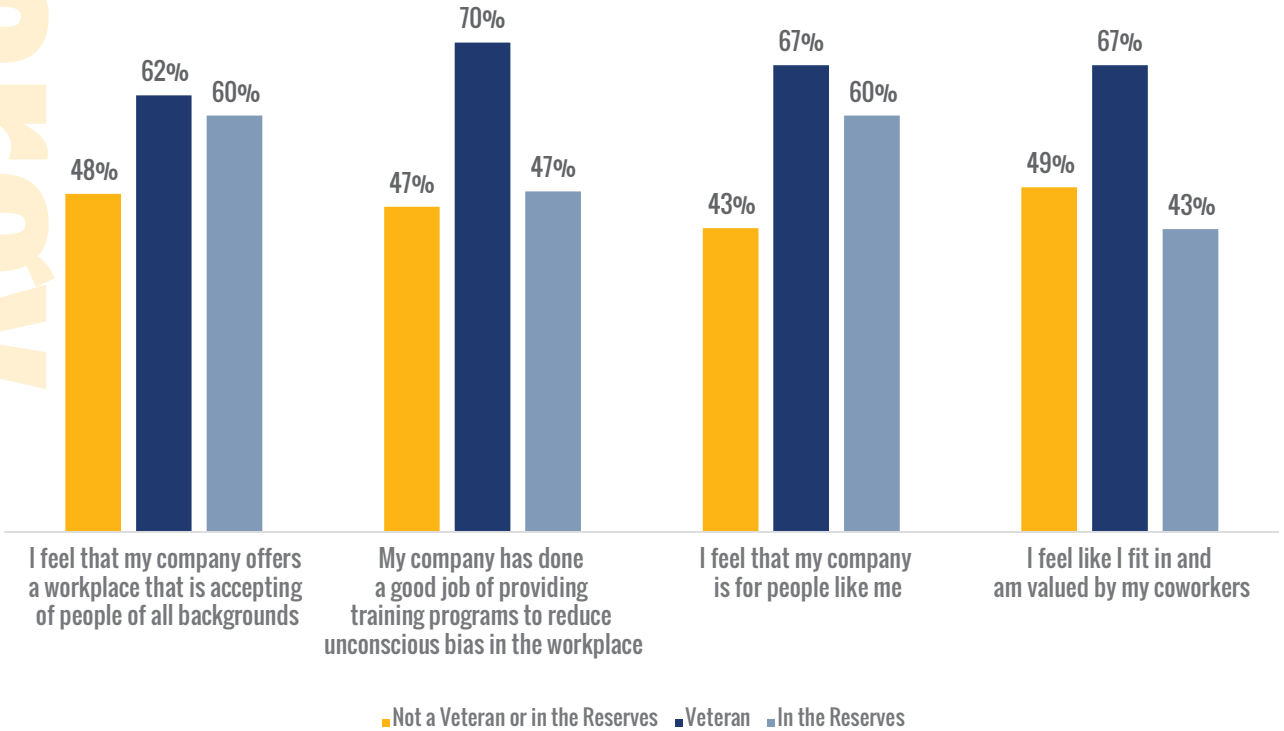


FIGURE 47. PERCEPTIONS OF INCLUSION AND BELONGING
BY VETERAN STATUS – "STRONGLY AGREE"



CAREER ADVANCEMENT OBSTACLES (CURRENT CLEAN ENERGY WORKERS)

Compared to male respondents, female clean energy workers were more likely to indicate that lacking basic information about clean energy careers early in their education and developing the necessary technical skills and expertise were obstacles to advancing their clean energy career.

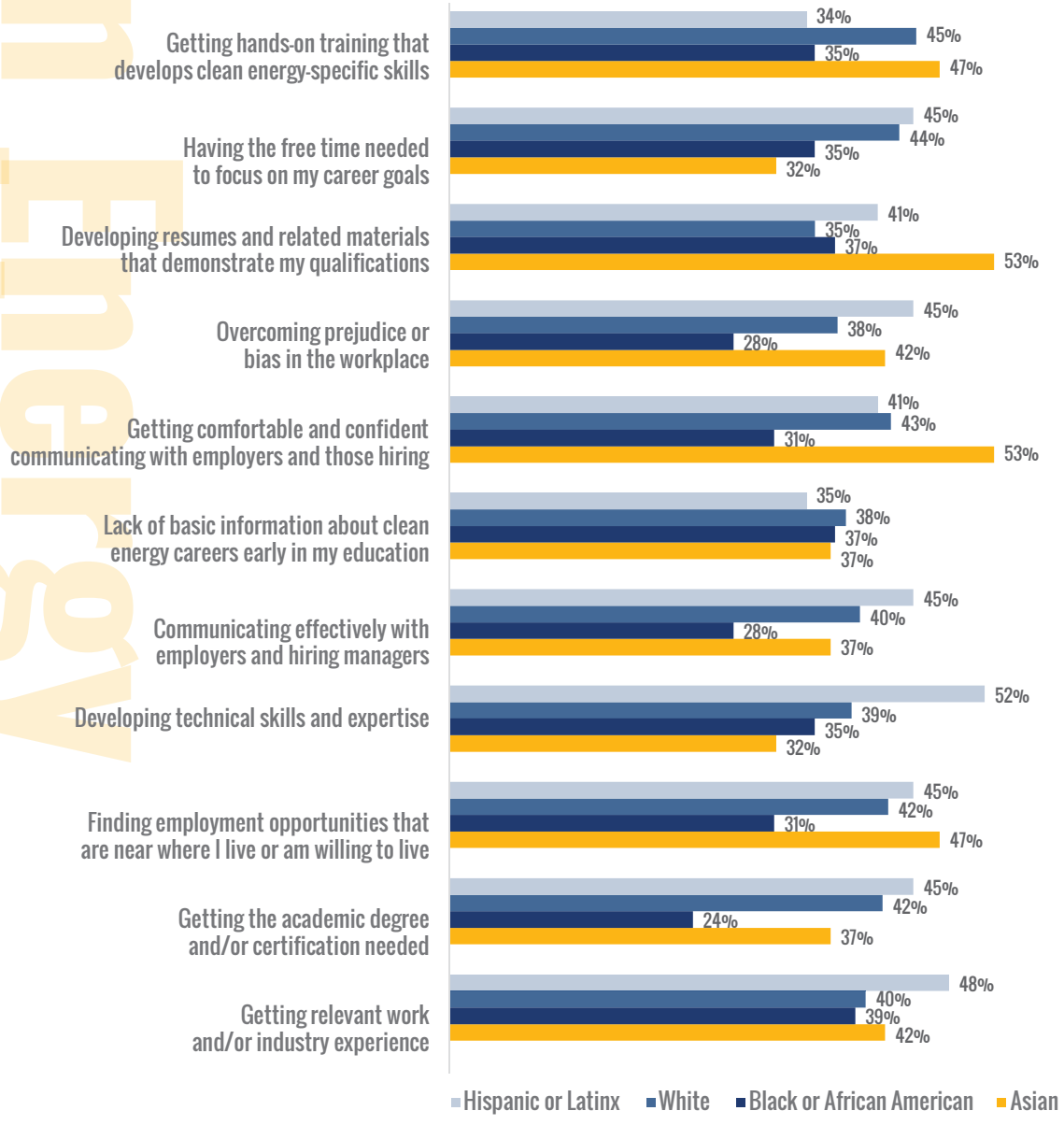
Across other tested obstacles, including getting hands-on training, having free time, getting the needed academic degrees and certifications, and finding geographically-desirable employment opportunities, men were more likely to rate these as a considerable challenge compared to female respondents.

FIGURE 48. OBSTACLES TO CLEAN ENERGY CAREER ADVANCEMENT **BY GENDER** – "CONSIDERABLE CHALLENGE"

A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

In general, Black or African American clean energy workers were least likely to rate the tested obstacles to clean energy career advancement as a considerable challenge compared to White, Asian, and Hispanic or Latinx survey respondents. Hispanic or Latinx clean energy workers were most likely to indicate that getting the relevant work and/or industry experience and developing technical skills and expertise were considerable challenges to advancing their clean energy career, while Asian clean energy workers were most likely to indicate getting comfortable and confident communicating with employers as well as developing resumes and related materials were considerable challenges. Asian and Hispanic or Latinx workers were also more likely to indicate overcoming prejudice or bias in the workplace was a considerable challenge to advancing their clean energy career.

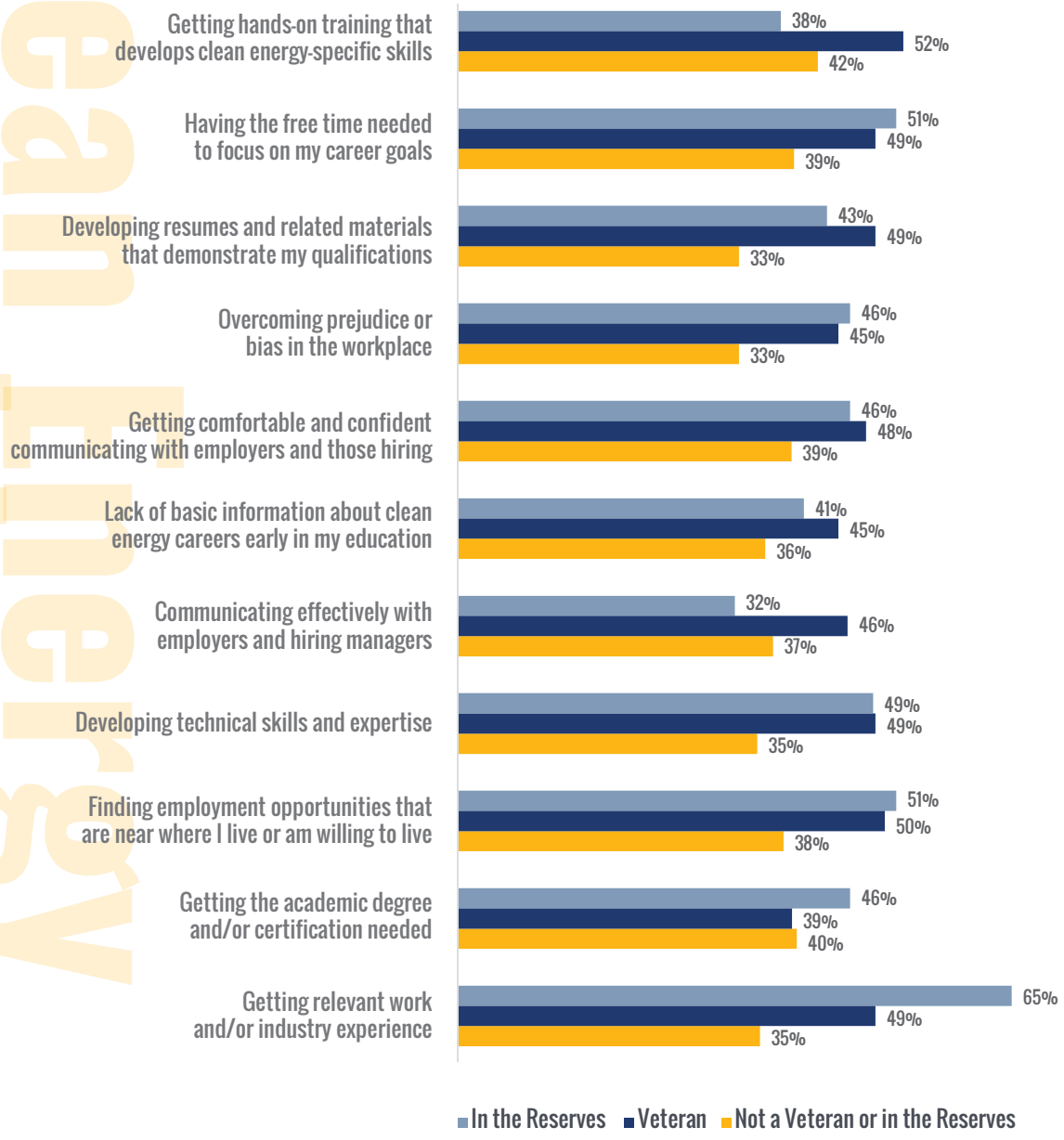
FIGURE 49. OBSTACLES TO CLEAN ENERGY CAREER ADVANCEMENT **BY RACE/ETHNICITY** – "CONSIDERABLE CHALLENGE"



A DEEPER DIVE: PRIORITY POPULATIONS AND NEW YORK'S CLEAN ENERGY SECTOR

Overall, clean energy workers who are Veterans or in the Reserves indicated greater challenges to advancing their clean energy career compared to non-Veterans. Getting relevant work and/or industry experience was rated a considerable challenge by at least half of Veterans and 65% of clean energy workers who reported they are currently in the Reserves.

FIGURE 50. OBSTACLES TO CLEAN ENERGY CAREER ADVANCEMENT **BY VETERAN STATUS** – "CONSIDERABLE CHALLENGE"



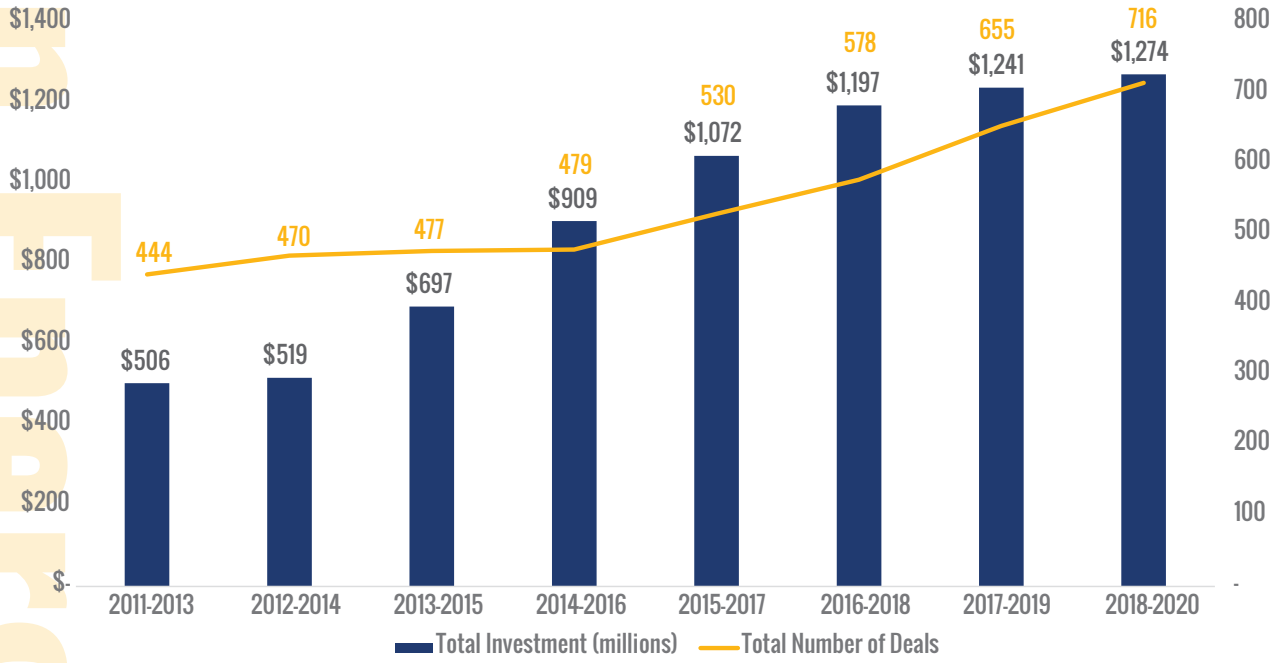
Clean Energy Investments

The following section draws on investment and expenditure data from a variety of sources, including the Department of Energy's Sunshot Initiative, the Advanced Research Projects Agency-Energy (ARPA-E); the Small Business Innovation Research (SBIR) and Small Business Technology Transfer (STTR) program; the Office of Science; NYSERDA expenditures; and Crunchbase, a proprietary dataset and platform that collects investments and funding information for public and private companies.

TOTAL INVESTMENTS

Clean energy investments in New York have been steadily on the rise since 2011. Between the first and last three-year rolling averages from 2011 through 2020, total investments increased by 152% while the number of deals across these three-year rolling averages increased by 61%. Overall, clean energy firms saw a total of $9.13 billion in investments across 5,519 deals between 2011 and 2020.

FIGURE 51. TOTAL CLEAN ENERGY INVESTMENTS (MILLIONS), 2011-2020 THREE-YEAR ROLLING AVERAGES



626% increase

in alternative transportation investments

[across three-year rolling averages]

By technology sector, the renewable electric power generation segment accounted for the majority of all investments from 2011 through 2020, representing 56% of all investment dollars flowing to the clean energy economy during these years.

Across the three-year rolling averages, investments in alternative transportation saw the greatest increase — 626% — followed by renewable electric power generation, renewable fuels, and grid modernization and storage. The energy efficiency sector actually saw an overall decline in investments by almost 11% between the three-year rolling averages of 2011 to 2013 and 2018 to 2020.

The majority of investments in New York's clean energy industry from 2011 through 2020 (80%) came from the public sector. Public expenditures in the State's clean energy businesses grew continually from 2011 through 2020 — by cumulative 114% across the three-year rolling averages. Though a smaller proportion of total investments, private investments saw significant growth as well, increasing by 473% over the same time.

The sharp increase in private investments is due to relatively small private investment dollars from 2011 through 2014. From 2011 through 2020, private investments totaled to $1.80 billion across 72 deals while public investments totaled to $6.96 billion across 5,369 deals.

FIGURE 52. TOTAL CLEAN ENERGY INVESTMENTS BY TECHNOLOGY (MILLIONS), 2011-2020 THREE-YEAR ROLLING AVERAGES[44]

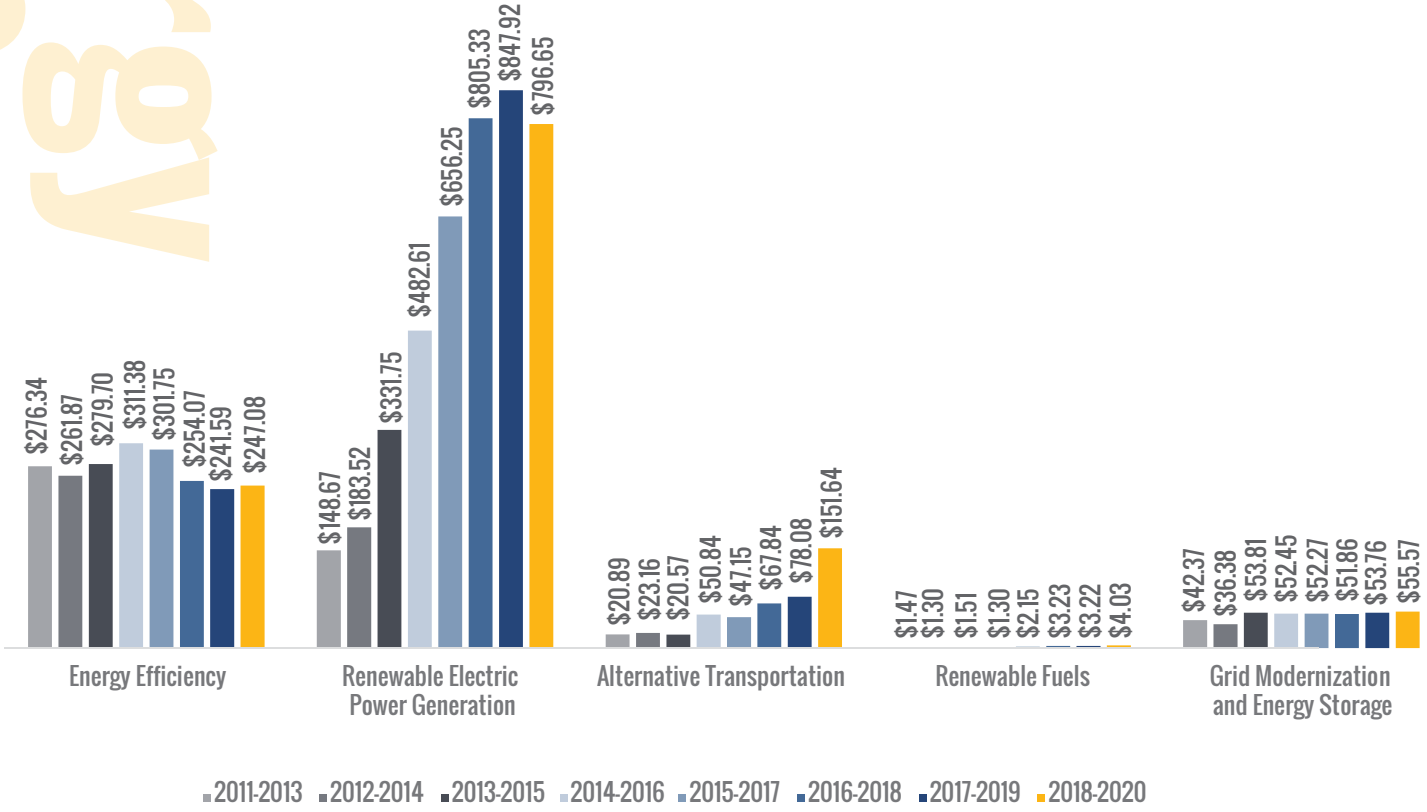


FIGURE 53. TOTAL PRIVATE CLEAN ENERGY FUNDING (MILLIONS), 2011-2020 THREE-YEAR ROLLING AVERAGES[45]

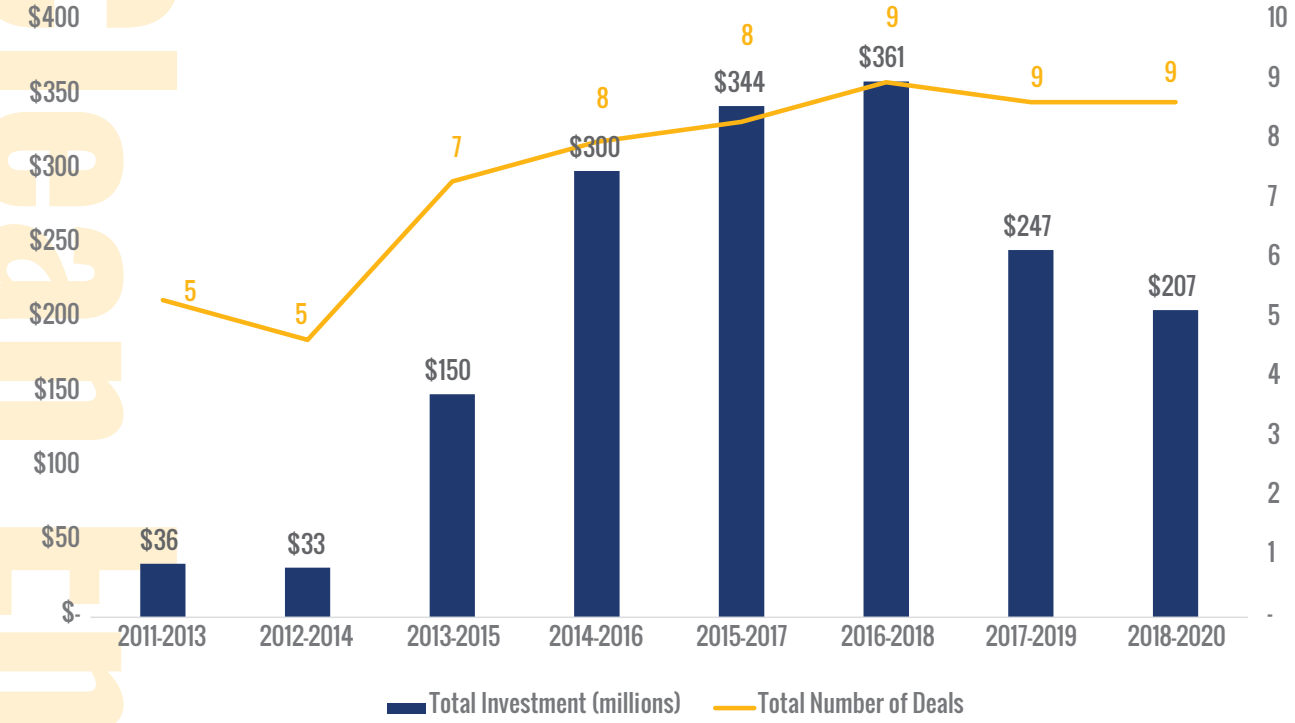


FIGURE 54. TOTAL PUBLIC CLEAN ENERGY FUNDING (MILLIONS), 2011-2020 THREE-YEAR ROLLING AVERAGES[46]

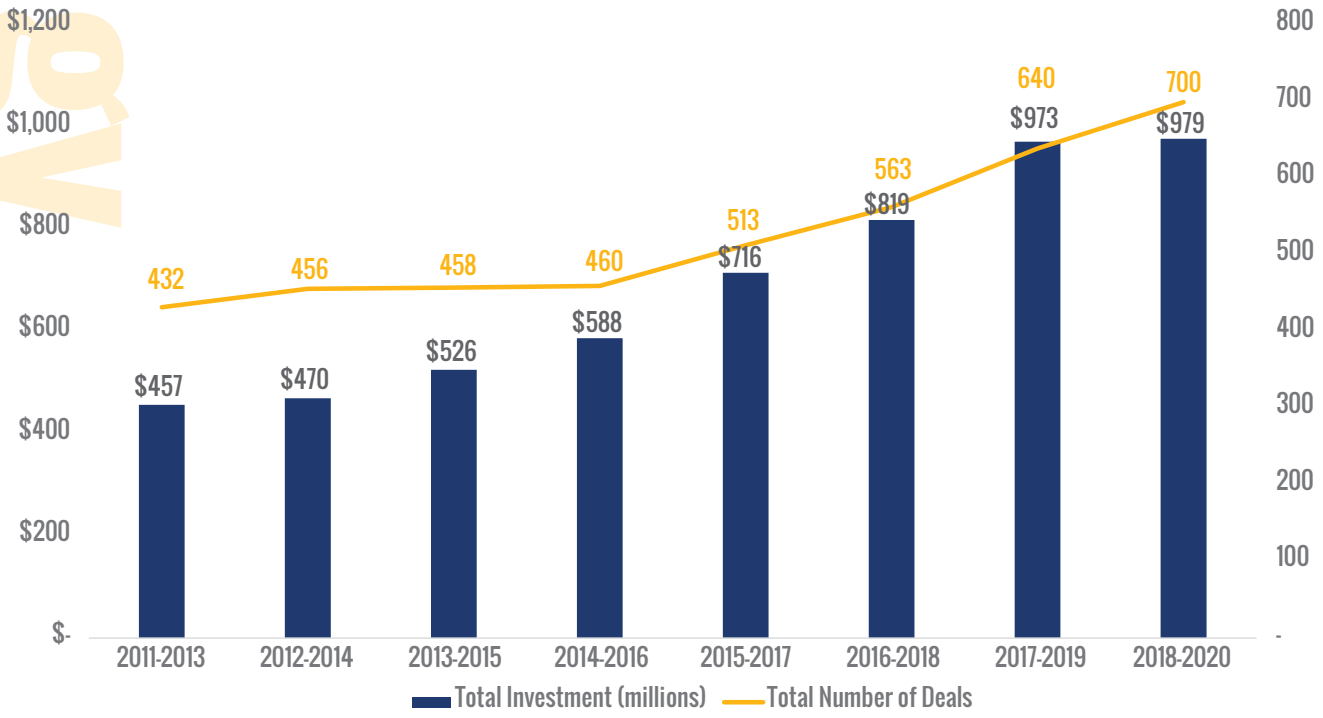


FIGURE 55. THE STAGES OF INNOVATION

Phase I: Research and Prototyping

- > Ideation
- > Theoretical research
- > Prototype development
- > Lab testing

Phase II: Demonstration and Acceleration

- > Product testing
- > System evaluation
- > Market research

Phase III: Commercialization and Growth

- > Expand manufacturing capacity
- > Identify early customers

INVESTMENTS BY INNOVATION PHASE

The following section provides a break-out of investment data by each of the three stages of innovation funding. It should be noted that not all investments and expenditures are able to be categorized into a distinct innovation phase due to lack of data availability regarding a specific abstract, project, or investment deal. As such, the sum of totals presented by innovation phase will not sum to the total values provided in Figure 35. The following is a brief description of each phase of innovation:

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 activity.

Phase II: Demonstration and Acceleration

Innovation in this stage often involves startup firms' refinement of their technology and expansion of 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 aiming for 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.

Phase III: Commercialization and Growth

In this final stage of innovation, companies bring fully-developed products to wide commercial availability. Useful metrics for this phase include quantities of venture capital and project finance, as well as economic development grant funding and tax incentives.

Total investments for Phase I reached $325 million across 190 deals from 2011 through 2020. Phase I investments accounted for 4% of all investments during this time and saw a cumulative growth of 60% over the first and last three-year rolling averages. Phase II investments accounted for 6% of all investments and totaled $510 million across 443 total deals. Between the 2011 to 2013 and 2018 to 2020 rolling averages, Phase II saw investment dollars grow by a cumulative 83%.

FIGURE 55. PHASE I INVESTMENTS (MILLION), 2011-2020
THREE-YEAR ROLLING AVERAGES

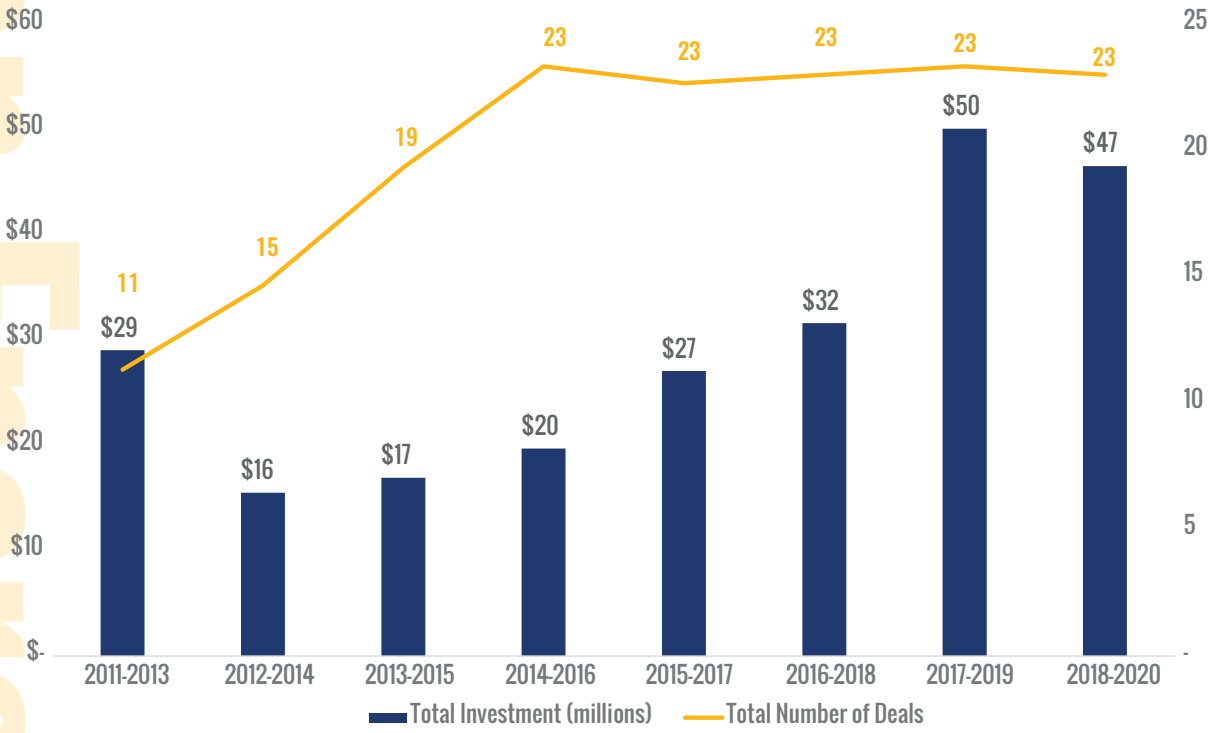
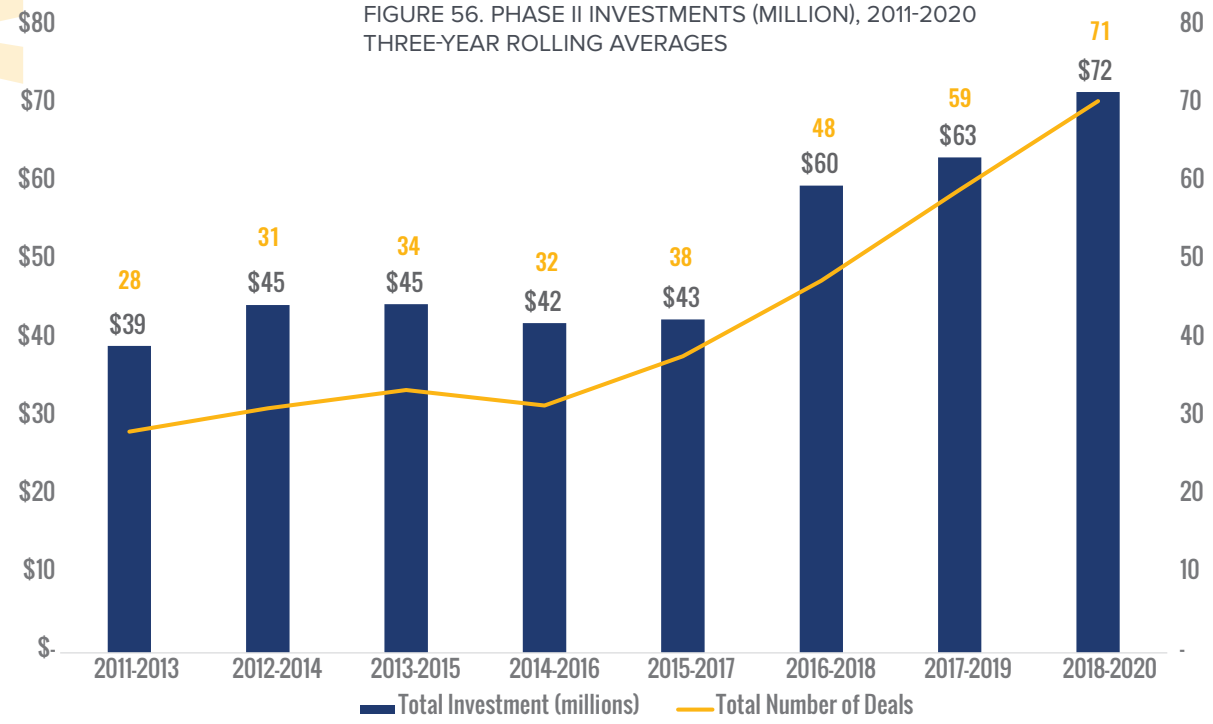


FIGURE 56. PHASE II INVESTMENTS (MILLION), 2011-2020
THREE-YEAR ROLLING AVERAGES



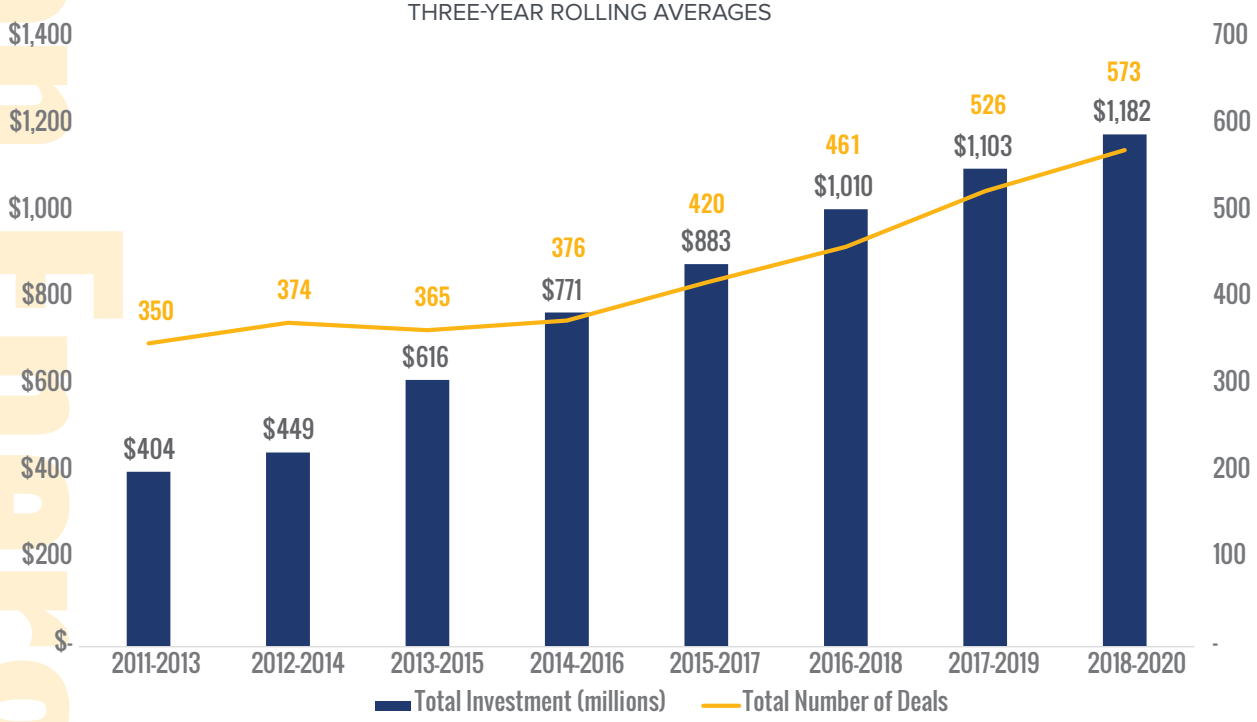
It is important to note that much of Phase III expenditures and investment dollars can be attributed to spending by NYSERDA

Phase III accounted for the largest share of all total investment dollars by innovation phase, representing almost 91% of all expenditures.

From 2011 through 2020, Phase III investments amounted to $7.93 billion across 4,394 deals.

Innovation investments directed toward commercialization and growth saw continual growth, resulting in a cumulative growth rate of 193% between the first and last three-year rolling averages.

FIGURE 57. PHASE III INVESTMENTS (MILLION), 2011-2020
THREE-YEAR ROLLING AVERAGES



Appendices

Appendix A: Clean Energy Technology List

A clean energy job is defined as any worker who is directly involved with the research, development, production, manufacture, distribution, sales, implementation, installation, or repair of components, goods, or services related to the following sectors of Clean Energy Generation, Clean Grid and Storage, Energy Efficiency, Clean Fuels, and Alternative Transportation. These jobs also include supporting services such as consulting, finance, tax, and legal services related to energy.

RENEWABLE ELECTRIC POWER GENERATION

- Solar Photovoltaic Electric Generation
- Concentrated Solar Electric Generation
- Wind Generation
- Geothermal Generation
- Bioenergy/Biomass Generation, including Combined Heat and Power
- Low-Impact Hydroelectric Generation, including wave/kinetic generation
- Traditional Hydroelectric Generation

GRID MODERNIZATION AND ENERGY STORAGE

Electric Power Transmission and Distribution

- Smart Grid

Storage

- Pumped Hydropower Storage
- Battery Storage, including battery storage for solar generation
  - > Lithium Batteries
  - > Lead-Based Batteries
  - > Other Solid-Electrode Batteries
  - > Vanadium Redox Flow Batteries
  - > Other Flow Batteries
- Mechanical Storage, including flywheels, compressed air energy storage, etc.
- Thermal Storage

Energy Efficiency

- Traditional HVAC goods, control systems, and services
- High Efficiency HVAC and Renewable Heating and Cooling
  - > Solar Thermal Water Heating and Cooling
  - > ENERGY STAR-Certified Heating Ventilation and Air Conditioning (HVAC), including boilers and furnaces with an AFUE rating of 90 or greater and air and central air conditioning units of 15 SEER or greater
  - > Other Renewable Heating and Cooling (geothermal, biomass, heat pumps, etc.)
- ENERGY STAR® and Efficient Lighting
  - > ENERGY STAR-Certified Appliances, excluding HVAC
  - > ENERGY STAR-Certified Electronics (TVs, Telephones, Audio/Video, etc.)
  - > ENERGY STAR-Certified Windows and Doors
  - > ENERGY STAR-Certified Roofing
  - > ENERGY STAR-Certified Seal and Insulation
  - > ENERGY STAR-Certified Commercial Food Service Equipment
  - > ENERGY STAR-Certified Data Center Equipment
  - > ENERGY STAR-Certified LED Lighting
  - > Other LED, CFL, and Efficient Lighting
- Advanced Building Materials/ Insulation
- Other Energy Efficiency
  - > Recycled Building Materials
  - > Reduced Water Consumption Products and Appliances

Renewable Fuels

- Woody Biomass
- Other Ethanol and Non-Woody Biomass, including biodiesel

Alternative Transportation

- Plug-In Hybrid Vehicles
- Electric Vehicles
- Hybrid Electric Vehicles
- Natural Gas Vehicles
- Hydrogen and Fuel Cell Vehicles

Appendix B: Research Methodology

EMPLOYMENT DATA

Data for the 2021 New York Clean Energy Industry Report is taken from data collection for the U.S. Energy and Employment Report (USEER). The survey was administered by phone and web. The phone survey was conducted by ReconMR, and the web instrument was programmed internally. Each respondent was required to use a unique ID in order to prevent duplication.

The 2021 USEER survey in New York resulted in more than 25,600 calls and more than 4,700 emails to potential respondents. More than 2,100 business establishments participated in the survey. These responses were used to develop incidence rates among industries as well as to apportion employment across various industry categories in ways currently not provided by State and federal labor market information agencies. The margin of error is +/- 2.08% at a 95% confidence level.

INTENSITY-ADJUSTED CLEAN ENERGY EMPLOYMENT

Intensity-adjusted clean energy employment was extrapolated using State employment thresholds by technology weighted on census division and previous year's data. Employment thresholds are survey data from questions asking what percentage of a firm's employment spends at least 50% of their time working on energy-related activities and what percent spends all of their time. Using the adjusted thresholds, employment by State is then split into three groups, those that spend all (100%) of their time on energy-related activities, those that spend a majority (50% to 99%) of their time, and those that spend less than a majority (0% to 49%) of their time. These employment groups are weighted 0.25 on the less than a majority group, 0.75 on the majority group, and 1 on the 100% group. Intensity-adjusted employment estimates are sum of these products.

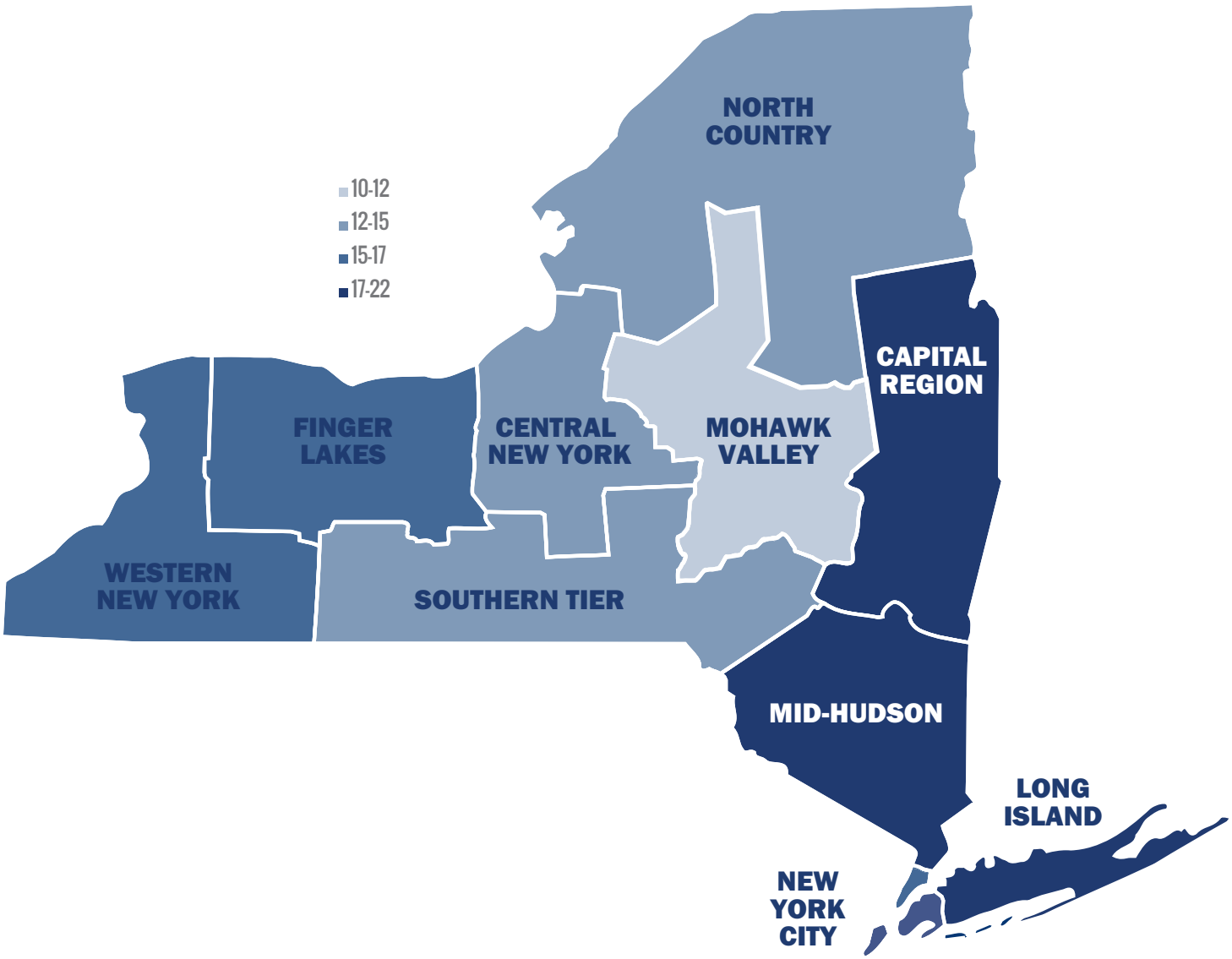
Appendix C: Regional Clean Energy Employment

The following table provides clean energy employment data by county for total clean energy jobs, renewable electric power generation jobs, and energy efficiency jobs in Q4 2020.

County Name	Clean Energy Jobs	Renewable Electric Power Generation Jobs	Energy Efficiency Jobs
Albany	3,752	659	2,829
Allegany	186	27	136
Bronx	2,955	426	2,051
Broome	1,198	173	934
Cattaraugus	230	33	172
Cayuga	474	68	296
Chautauqua	726	105	545
Chemung	554	80	418
Chenango	189	27	124
Clinton	460	66	305
Columbia	324	47	233
Cortland	175	25	131
Delaware	136	20	95
Dutchess	1,841	265	1,467
Erie	8,684	1,252	5,284
Essex	131	19	104
Franklin	159	23	128
Fulton	119	17	91
Genesee	302	44	212
Greene	160	23	123
Hamilton	16	2	13
Herkimer	166	24	131
Jefferson	468	67	373
Kings	7,914	1,141	6,323
Lewis	125	18	74
Livingston	296	43	178
Madison	216	31	163
Monroe	5,583	805	4,366
Montgomery	241	35	132
Nassau	12,343	1,780	9,223
New York	45,767	6,599	38,443
Niagara	1,181	170	823
Oneida	1,030	149	739
Onondaga	3,751	541	2,946

County Name	Clean Energy Jobs	Renewable Electric Power Generation Jobs	Energy Efficiency Jobs
Ontario	776	112	618
Orange	2,205	318	1,441
Orleans	167	24	74
Oswego	467	67	267
Otsego	181	26	115
Putnam	618	89	494
Queens	11,261	1,624	9,429
Rensselaer	1,111	160	685
Richmond	2,159	311	1,810
Rockland	2,169	313	1,395
St. Lawrence	353	51	282
Saratoga	2,074	299	1,650
Schenectady	1,536	222	917
Schoharie	150	22	81
Schuyler	60	9	48
Seneca	54	8	38
Steuben	623	90	442
Suffolk	14,138	2,039	10,440
Sullivan	271	39	207
Tioga	85	12	59
Tompkins	806	116	396
Ulster	906	131	649
Warren	953	137	365
Washington	163	24	112
Wayne	814	117	237
Westchester	8,622	1,243	6,571
Wyoming	174	25	96
Yates	89	13	50
N/A	2,844	410	2,379

FIGURE 58. CLEAN ENERGY EMPLOYMENT **BY REDC** (PER 1,000 TOTAL JOBS), 2020



Appendix D: New York Offshore Wind Occupational Data

The following table includes all occupations identified as participatory in the life cycle of an offshore wind project. The table presents the total number of jobs in New York for each occupation, not only clean energy jobs, to demonstrate workforce availability for offshore wind projects. Data is organized by location quotient.

SOC	Occupation	LQ, 2020	Total Jobs, 2020	Percent Change, 2015-2020
47-4021	Elevator and Escalator Installers and Repairers	2.82	4,350	15%
51-8021	Stationary Engineers and Boiler Operators	2.23	4,120	1%
13-2098	Financial and Investment Analysts, Financial Risk Specialists, and Financial Specialists, All Other	2.15	61,920	11%
23-1011	Lawyers	1.86	76,660	6%
27-3031	Public Relations Specialists	1.77	27,120	4%
13-1161	Market Research Analysts and Marketing Specialists	1.64	70,770	39%
13-2011	Accountants and Auditors	1.41	112,360	10%
49-9071	Maintenance and Repair Workers, General	1.37	116,330	19%
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	1.32	152,130	-23%
23-2011	Paralegals and Legal Assistants	1.32	27,540	29%
25-1032	Engineering Teachers, Postsecondary	1.26	3,030	-7%
43-4161	Human Resources Assistants, Except Payroll and Timekeeping	1.23	8,340	-18%
13-1151	Training and Development Specialists	1.13	22,540	32%
11-3131	Training and Development Managers	1.13	2,730	2%
13-2053	Insurance Underwriters	1.12	7,100	-1%
11-3031	Financial Managers	1.11	45,390	13%
11-3121	Human Resources Managers	1.10	10,800	8%
15-2031	Operations Research Analysts	1.10	6,600	17%
13-1041	Compliance Officers	1.09	22,280	12%
11-1021	General and Operations Managers	1.08	158,110	1%
17-2081	Environmental Engineers	1.07	3,350	10%
13-1020	Buyers and Purchasing Agents	1.04	27,380	9%
17-2111	Health and Safety Engineers, Except Mining Safety Engineers and Inspectors	1.04	1,550	-11%
43-3031	Bookkeeping, Accounting, and Auditing Clerks	1.03	92,810	-22%
53-5031	Ship Engineers	1.03	480	-31%
11-3021	Computer and Information Systems Managers	1.02	29,050	12%
11-3061	Purchasing Managers	0.99	4,400	4%
13-1071	Human Resources Specialists	0.98	39,720	32%
43-9061	Office Clerks, General	0.96	167,640	-16%
47-2061	Construction Laborers	0.96	58,380	-1%

SOC	Occupation	LQ, 2020	Total Jobs, 2020	Percent Change, 2015-2020
13-2031	Budget Analysts	0.96	2,960	-9%
51-8013	Power Plant Operators	0.96	1,980	11%
11-2022	Sales Managers	0.95	23,230	20%
15-1299	Computer Occupations, All Other	0.93	21,052	8%
11-3010	Administrative Services and Facilities Managers	0.92	17,670	-14%
47-2111	Electricians	0.89	36,310	-10%
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	0.89	26,550	5%
47-2221	Structural Iron and Steel Workers	0.87	3,880	-20%
53-5021	Captains, Mates, and Pilots of Water Vessels	0.86	1,480	-16%
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	0.81	14,570	-2%
53-5011	Sailors and Marine Oilers	0.81	1,290	-19%
49-9098	Helpers--Installation, Maintenance, and Repair Workers	0.79	4,490	-21%
49-9092	Commercial Divers	0.79	170	183%
17-2051	Civil Engineers	0.78	14,670	-1%
47-2171	Reinforcing Iron and Rebar Workers	0.78	910	-37%
53-7065	Stockers and Order Fillers	0.77	105,740	-8%
19-4042	Environmental Science and Protection Technicians, Including Health	0.74	1,470	-12%
49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	0.73	11,540	-13%
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	0.72	126,480	20%
17-2071	Electrical Engineers	0.71	8,170	-26%
51-9021	Crushing, Grinding, and Polishing Machine Setters, Operators, and Tenders	0.71	1,440	19%
51-2028	Electrical, Electronic, and Electromechanical Assemblers, Except Coil Winders, Tapers, and Finishers	0.70	12,390	-2%
17-3023	Electrical and Electronic Engineering Technologists and Technicians	0.70	5,010	-12%
19-2041	Environmental Scientists and Specialists, Including Health	0.70	3,700	8%
17-3013	Mechanical Drafters	0.70	2,260	-40%
53-6098	Aircraft Service Attendants and Transportation Workers, All Other	0.70	1,460	-29%
13-1051	Cost Estimators	0.69	8,640	-10%
19-5011	Occupational Health and Safety Specialists	0.68	4,050	8%
49-9051	Electrical Power-Line Installers and Repairers	0.66	4,770	~-1%
41-9031	Sales Engineers	0.66	2,630	-2%
17-2112	Industrial Engineers	0.64	11,580	25%
51-9012	Separating, Filtering, Clarifying, Precipitating, and Still Machine Setters, Operators, and Tenders	0.63	1,880	1%
51-9011	Chemical Equipment Operators and Tenders	0.62	3,620	82%
43-5071	Shipping, Receiving, and Inventory Clerks	0.61	27,880	-23%

SOC	Occupation	LQ, 2020	Total Jobs, 2020	Percent Change, 2015-2020
51-9061	Inspectors, Testers, Sorters, Samplers, and Weighers	0.61	20,950	1%
51-2099	Assemblers and Fabricators, All Other	0.60	8,044	31%
51-4051	Metal-Refining Furnace Operators and Tenders	0.60	570	-7%
51-1011	First-Line Supervisors of Production and Operating Workers	0.59	22,230	-13%
17-3027	Mechanical Engineering Technologists and Technicians	0.59	1,480	-21%
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	0.58	22,430	-1%
11-9041	Architectural and Engineering Managers	0.58	7,130	-0.3%
17-3019	Drafters, All Other	0.58	500	-41%
51-4041	Machinists	0.57	12,750	-5%
53-7199	Material Moving Workers, All Other	0.55	910	72%
49-9096	Riggers	0.55	750	241%
19-2021	Atmospheric and Space Scientists	0.55	350	-27%
11-9198	Personal Service Managers, All Other; Entertainment and Recreation Managers, Except Gambling; and Managers, All Other	0.54	15,700	17%
17-2141	Mechanical Engineers	0.54	9,920	-9%
51-2031	Engine and Other Machine Assemblers	0.54	1,390	216%
51-9162	Computer Numerically Controlled Tool Programmers	0.54	860	8%
53-3032	Heavy and Tractor-Trailer Truck Drivers	0.52	58,280	5%
47-2073	Operating Engineers and Other Construction Equipment Operators	0.51	12,960	2%
17-2131	Materials Engineers	0.51	790	-51%
53-7041	Hoist and Winch Operators	0.50	140	0%
51-2092	Team Assemblers	0.49	33,096	-14%
11-3071	Transportation, Storage, and Distribution Managers	0.49	4,010	18%
51-2041	Structural Metal Fabricators and Fitters	0.49	2,130	2%
11-9021	Construction Managers	0.48	8,580	-3%
47-5022	Excavating and Loading Machine and Dragline Operators, Surface Mining	0.48	1,210	-3%
11-3051	Industrial Production Managers	0.47	5,310	9%
17-2072	Electronics Engineers, Except Computer	0.47	3,560	-15%
53-7021	Crane and Tower Operators	0.46	1,260	-27%
49-9041	Industrial Machinery Mechanics	0.44	10,730	6%
17-2199	Engineers, All Other	0.44	4,180	60%
47-2051	Cement Masons and Concrete Finishers	0.42	5,100	-19%
17-3031	Surveying and Mapping Technicians	0.42	1,400	-23%
17-2121	Marine Engineers and Naval Architects	0.42	230	92%
53-7051	Industrial Truck and Tractor Operators	0.41	16,240	15%
19-2042	Geoscientists, Except Hydrologists and Geographers	0.41	710	-21%

SOC	Occupation	LQ, 2020	Total Jobs, 2020	Percent Change, 2015-2020
17-3098	Calibration Technologists and Technicians and Engineering Technologists and Technicians, Except Drafters, All Other	0.40	2,290	-8%
51-4193	Plating Machine Setters, Operators, and Tenders, Metal and Plastic	0.40	950	-9%
53-2012	Commercial Pilots	0.40	930	-18%
51-4121	Welders, Cutters, Solderers, and Brazers	0.38	9,460	11%
13-1081	Logisticians	0.38	4,360	59%
51-4072	Molding, Coremaking, and Casting Machine Setters, Operators, and Tenders, Metal and Plastic	0.37	3,630	3%
51-9199	Production Workers, All Other	0.35	4,190	29%
51-9124	Coating, Painting, and Spraying Machine Setters, Operators, and Tenders	0.35	3,000	-30%
51-4031	Cutting, Punching, and Press Machine Setters, Operators, and Tenders, Metal and Plastic	0.34	3,860	-13%
49-9081	Wind Turbine Service Technicians	0.33	120	-12%
19-1023	Zoologists and Wildlife Biologists	0.32	340	-19%
11-9121	Natural Sciences Managers	0.30	1,440	-30%
47-5041	Continuous Mining Machine Operators	0.21	193	7%
51-4199	Metal Workers and Plastic Workers, All Other	0.18	240	41%
19-3091	Anthropologists and Archeologists	0.18	80	-39%
51-8099	Plant and System Operators, All Other	0.17	160	60%
51-4032	Drilling and Boring Machine Tool Setters, Operators, and Tenders, Metal and Plastic	0.16	90	-79%
17-2151	Mining and Geological Engineers, Including Mining Safety Engineers	0.13	50	-44%
17-2011	Aerospace Engineers	0.08	300	-49%

Appendix E: Offshore Wind Literature Review

The following list captures the reports whose findings directly informed the background information and literature review for this research. Importantly, this review helped develop the database of relevant occupations key to developing a healthy, domestic offshore wind industry. This database is the foundation of all occupational analyses.

- New York State Energy Research and Development Authority, 2019 OSW Jobs Fact Sheet
- New York State Energy Research and Development Authority, The Workforce Opportunity of Offshore Wind in New York (2017)
- Offshore Wind Industry Council, The U.K. Offshore Wind Industry: Supply Chain Review January 2019
- Pereira, Sydney. What New York's Offshore Wind Expansion Could Mean for Your Electricity Bill, Curbing Emissions, and Your Health (2021)
- Topham and McMillan. Renewable Energy Journal, Sustainable Decommissioning of an Offshore Wind Farm (2016)
- Wood Mackenzie, Economic Impact of New Offshore Wind Lease Auctions by BOEM (2021)
- Workforce Development Institute, New York State and the Jobs of Offshore Wind Energy (2017)

Appendix D: New York Investment Factors

MODEL DEVELOPMENT

As part of the 2020 New York Clean Energy Industry Report (NYCEIR), a supplemental effort to model the labor hours and costs associated with energy efficiency projects or upgrades, solar electricity generation projects, onshore and offshore wind electricity generation projects, and battery storage projects was conducted. BW Research worked with NYSERDA to identify specific work tasks associated with each of the project types.

PRIMARY DATA COLLECTION

Using the tasks identified in the previous step, BW Research drafted a questionnaire that was distributed to employers in the United States, with an oversample in New York. The survey asked energy efficiency, solar, wind, and battery storage installers to record labor hours associated with each specific task (for energy efficiency, labor hours were assigned on a per unit, per building, or per 1,000 square ft. basis). Approximately 800 total businesses participated in the full survey effort during the fourth quarter of 2020. As a follow-up, several large installation and development firms were asked to review labor hour estimates for accuracy via executive interviews. Labor hour estimates were then adjusted and revised as necessary.

SECONDARY DATA COLLECTION

Energy Efficiency

Current estimates for unit and installed costs by task were provided by Energy + Environmental Economics (E3) for New York specifically and by the U.S. Energy Information Administration (EIA) for U.S. based costs which were adjusted based on New York locational factors. Unit and installed costs are presented in a range similar to EIA data, and represent low-end, midpoint (in some cases representing ENERGY STAR® product lines), and high-end monetary values. These costs are assigned to each of the 103 specific tasks.

Solar

Residential, commercial, and utility price per watt installed was provided through research conducted by the Solar Energy Industries Association (SEIA). This data is publicly available on a yearly basis and is included in the Solar Market Insights report.

Wind

Onshore

Primary data was supplemented and verified using publicly available job year data from the National Renewable Energy Laboratory (NREL). Labor hour estimates were converted to job years and adjusted/ revised as necessary.

Offshore

BW Research conducted a comprehensive review and compilation of existing offshore wind workforce estimates.*

Battery Storage

BW Research conducted a comprehensive review and compilation of existing battery storage documents.**

** Full list included in standalone wind investment factor memo.*

*** Full list included in standalone battery storage investment factor memo.*

MODEL OUTPUTS

The following table displays job year and CEIR equivalent job outputs for solar, wind, and battery storage per $1,000,000 spent.

Technology	Project Type	Job Years	CEIR Jobs	MW Installed
Solar	Residential	1.68	2.07	0.35
	Commercial/ Industrial	2.49	3.07	0.73
	Community	2.51	3.09	0.73
	Utility	1.48	1.82	1.15
Wind	Onshore	0.58	0.70	0.71
	Offshore	0.73	0.89	0.32
Battery Storage	Utility	0.80	1.00	0.35
	Distributed	2.26	2.84	0.34

The table below displays job years, CEIR equivalent job years, units covered, buildings covered, and square feet covered by task groupings for a $1,000,000 investment.

Energy Efficiency Combined Tasks	Job Years	CEIR Job Years	Units	Buildings	Square Feet
SINGLE FAMILY RESIDENTIAL					
Appliances	1.4	1.9	126	126	123,337
Building Shell	2.1	3.0	39	39	38,796
Domestic Hot Water	2.8	4.0	98	98	98,148
HVAC*	1.4	2.0	21	21	21,314
HVAC HP	0.9	1.3	19	19	19,198
MULTI-FAMILY RESIDENTIAL					
Appliances	1.0	1.4	100	10	119,978
Building Shell	2.1	3.0	32	3	38,710
Domestic Hot Water	2.6	3.7	142	14	170,591
HVAC*	0.8	1.1	30	3	36,467
HVAC HP	0.9	1.3	19	2	23,005
COMMERCIAL & INDUSTRIAL					
Appliances	1.4	2.0	33	33	165,431
Building Shell	2.0	2.9	7	7	33,681
Domestic Hot Water	2.4	3.5	152	152	760,820
HVAC*	0.3	0.4	2	2	10,375
HVAC HP	0.9	1.3	18	18	91,162

**Does not include installation of boiler economizer*

MODEL UPDATES

The models are fully customizable and allow for updates to labor hours per task whether through primary data collection or the inclusion of a labor efficiency factor. Costs can also be updated in the data tab to reflect changes on a yearly basis

1. ENERGY EFFICIENCY MODELING

MODEL DEVELOPMENT

As part of the 2020 New York Clean Energy Industry Report (NYCEIR), a supplemental effort to model the labor hours and costs associated with single family residential, multifamily residential, and commercial & industrial energy efficiency projects or upgrades was conducted. BW Research worked with NYSERDA to identify 103 specific tasks (see list of tasks in Appendix A) in the following categories:*

- Appliances
- Appliances – Control
- Building Shell
- Compressed Air
- Domestic Hot Water
- Domestic Hot Water - Control
- Energy Management
- HVAC
- HVAC – Control
- HVAC Heat Pump
- Lighting
- Lighting – Control
- Motors and Drives

PRIMARY DATA COLLECTION

Using the energy efficiency tasks identified in the previous step, BW Research drafted a questionnaire that was distributed to energy efficiency employers in the United States, with an oversample in New York. The survey asked energy efficiency installers to record labor hours associated with each specific task and to assign labor hours on a per unit, per building, or per 1,000 square ft. (depending on the task). Approximately 650 businesses participated in the survey effort during the fourth quarter of 2020.

As a follow-up, several large energy efficiency installation firms were asked to review labor hour estimates for accuracy via executive interviews. Labor hour estimates were then adjusted and revised as necessary.

SECONDARY DATA COLLECTION

Current estimates for unit and installed costs by task were provided by Energy + Environmental Economics (E3) for New York specifically and by the U.S. Energy Information Administration (EIA) for U.S. based costs which were adjusted based on New York locational factors. Unit and installed costs are presented in a range similar to EIA data, and represent low-end, midpoint (in some cases representing ENERGY STAR® product lines), and high-end monetary values. These costs are assigned to each of the 103 specific tasks.

MODEL INPUTS

Each model (single family, multifamily, and commercial & industrial) includes radio buttons for precise project selection. The model calculates output based on selected tasks and user inputs.

The labor tool component includes three model input values:

- Units (same as buildings for single-family residential and commercial & industrial)
- Buildings
- Square Feet

MODEL OUTPUTS

Each model provides the following labor hour outputs based on user inputs:

- Labor Hours
- Job Years

In addition, outputs for total low-end, midpoint, and high-end unit and installed costs are provided.

Additional Cost Input Model

In addition to the labor hour tool, a simple cost input model is included. The user has the ability to input total budget in the input field and the output includes total potential units and units installed for each task as well as total labor hours associated with unit and dollar amounts.

MODEL UPDATES

The model is fully customizable and allows for updates to labor hours per task whether through primary data collection or the inclusion of a labor efficiency factor. Costs can also be updated in the data tab to reflect changes on a yearly basis.

2. SOLAR ENERGY MODELING

MODEL DEVELOPMENT

As part of the 2020 New York Clean Energy Industry Report (NYCEIR), a supplemental effort to model the labor hours and costs associated with residential, commercial/industrial, community, and utility solar photovoltaic projects was conducted. BW Research worked with NYSERDA to identify 32 specific tasks (see list of tasks in Appendix A) in the following categories:

- Project development (including design, financing, permitting, procurement, and other professional services)
- Construction/installation

PRIMARY DATA COLLECTION

Using the solar energy tasks identified in the previous step, BW Research drafted a questionnaire that was distributed to solar installers and developers in the United States, with an oversample in New York. The survey asked solar installers and developers to record labor hours associated with each specific task. Approximately 100 businesses participated in the survey effort during the fourth quarter of 2020.

As a follow-up, several solar installation and developer firms were asked to review labor hour estimates and project costs for accuracy via executive interviews. Labor hour estimates and costs were then adjusted and revised as necessary.

SECONDARY DATA COLLECTION

Residential, commercial, and utility price per watt installed was provided through research conducted by the Solar Energy Industries Association (SEIA). This data is publicly available on a yearly basis and is included in the Solar Market Insights report.

MODEL INPUTS

The model calculates output based on selected project type and a simple user input. Radio buttons are provided for project type selection.

The labor tool component includes a single input value:

- Project kilowatts (kW)

MODEL OUTPUTS

Each model provides the following labor hour outputs based on user inputs:

- Labor Hours
- Job Years

In addition, output for total cost of the project is included.

SOLAR JOB OUTPUTS EXAMPLE

According to Wood Mackenzie, 473MW of solar was installed in New York in 2019. The solar model is able to estimate direct installation job years, intensity adjusted direct installation jobs, and CEIR continuation installation jobs. Model outputs for 473MW are as follows:

- Direct installation job years: 2,259
- Intensity adjusted for CEIR direct installation job years: 2,778
- CEIR total continuation installation jobs: 9,015

Solar jobs from the 2021 CEIR are listed below:

- TOTAL CEIR Solar Jobs: 12,314
- TOTAL CEIR Solar Installation Jobs: ~8,900

The solar job model estimates 9,015 continuation jobs, within two percent of the CEIR reported solar installation jobs for 2021.

MODEL UPDATES

The model is fully customizable and allows for updates to labor hours per task whether through primary data collection or the inclusion of a labor efficiency factor. Costs can also be updated in the data tab to reflect changes on a yearly basis.

3. WIND ENERGY MODELING

MODEL DEVELOPMENT

As part of the 2020 New York Clean Energy Industry Report (NYCEIR), a supplemental effort to model the labor hours and costs associated with land-based and offshore wind projects was conducted.

Due to the youth of the offshore wind industry, two different development approaches were undertaken for each type of wind project.

LAND-BASED WIND

BW Research worked with NYSERDA to identify 40 specific tasks (see list of tasks in Appendix A) in the following categories:

- Project development (including design, financing, permitting, procurement, and other professional services)
- Construction/installation
- Operations and maintenance (including asset management)

Using the wind energy tasks identified in the previous step, BW Research interviewed wind installers and developers in the United States. The interview asked wind installers and developers to estimate labor hours associated with each specific task. Eighteen businesses were interviewed during the third and fourth quarters of 2020.

The data was supplemented and verified using publicly available job year data from the National Renewable Energy Laboratory (NREL). Labor hour estimates were converted to job years and adjusted/revised as necessary.

OFFSHORE WIND

BW Research conducted a comprehensive review and compilation of existing offshore wind workforce estimates, including the following documents:

- BVG Associates, The Virginia advantage: The roadmap for the offshore wind supply chain in Virginia (2018)
- Environmental Entrepreneurs, Offshore Wind - Generating Economic Benefits on the East Coast (2018)
- International Economic Development Council, Analysis of the Offshore Wind Energy Industry (2013)
- Massachusetts Clean Energy Center, 2018 Massachusetts Offshore Wind Workforce Assessment
- Natural Resources Defense Council, American Wind Farms: Breaking Down the Benefits from Planning to Production (2016)
- National Renewable Energy Laboratory, 2017 State of Wind Development in the United States by Region (April 2018)
- National Renewable Energy Laboratory, Offshore Wind Jobs and Economic Development Impacts in the United States: Four Regional Scenarios (2015)
- New Jersey Board of Public Utilities and the Interagency Taskforce on Offshore Wind, New Jersey Offshore Wind Strategic Plan: Navigating Our Future (2020)
- New York State Energy Research and Development Authority, 2019 OSW Jobs Fact Sheet
- New York State Energy Research and Development Authority, The Workforce Opportunity of Offshore Wind in New York (2017)
- Offshore Wind Industry Council, The UK Offshore Wind Industry: Supply Chain Review January 2019
- Rhode Island Office of Energy Resources, 2019 Rhode Island Clean Energy Industry Report
- US Department of Energy & US Department of the Interior, 2016 National Offshore Wind Strategy
- Workforce Development Institute, New York State and the Jobs of Offshore Wind Energy (2017)

The annual job years reported by task and occupation were all translated to and averaged by 5-digit Standard Occupational Classification (SOC) occupation; the occupations were broken out by phase and average completion years were assigned each phase.

As a follow-up, several offshore wind developers were asked to estimate job years via executive interviews. Job year estimates were adjusted and revised as necessary.

COSTS

Land-based and offshore wind project costs per megawatt installed was provided through NREL's Jobs and Economic Development Impacts (JEDI) model.*

MODEL INPUTS

The model calculates output based on selected project type and a simple user input. Radio buttons are provided for project type selection.

The labor tool component includes a single input value:

- Project megawatts (MW)

MODEL OUTPUTS

Each model provides the following outputs based on user inputs:

- Job Years
- Total Cost

MODEL UPDATES

The model is fully customizable and allows for updates to job years per task/occupation whether through primary data collection or the inclusion of a labor efficiency factor. Costs can also be updated in the data tab.

4. BATTERY STORAGE MODELING

MODEL DEVELOPMENT

As part of the 2020 New York Clean Energy Industry Report (NYCEIR), a supplemental effort to model the labor hours, job years, and costs associated with utility and distributed battery storage projects was conducted.

Due to the youth of the battery storage industry, the project relied heavily on literature reviews, supplemented by industry verification.

BW Research conducted a comprehensive review and compilation of existing battery storage documents, including but not limited to:

- Asian Development Bank, Handbook on Battery Energy Storage System (2018)
- US Department of Energy, 2020 Grid Energy Storage Technology Cost and Performance Assessment (2020)
- American Jobs Project, The New York Jobs Project: A Guide to Creating Jobs in Energy Storage (2018)
- The Solar Foundation, Solar + Storage Jobs (2016)
- City of Santa Paula, Santa Paula Battery Energy Storage System (2017)
- Platte River Power Authority, 2019 Energy Storage Technology Assessment
- City of Goleta, NRG Ellwood Battery Storage Project (2017)
- Regenerate Power, Stingray Energy Storage Project Description (2016)
- California Flats Solar, California Flats Solar Project Battery Energy Storage System Modification (2020)
- Pacific Gas and Electric Company, Elkhorn Battery Energy Storage System Project (2020)
- Sungrow, Energy Storage System ST556KWH-250UD Installation (2021)
- Tesla, Installation Day (2021)

As a follow-up, several storage installers were asked to estimate labor hours via executive interviews. Labor hour estimates were adjusted and revised as necessary.

COSTS

Utility storage project costs per megawatt installed was provided by the US Energy Information Administration.** Distributed storage project costs were provided by the National Renewable Energy Laboratory.***

MODEL INPUTS

The model calculates output based on selected project type and a simple user input. Radio buttons are provided for project type selection.

The labor tool component includes a single input value:

- Project megawatts (MW)

** https://www.nrel.gov/analysis/jedi/wind.html - The land-based project assumed the 2020 US-based construction of 131 2300-kW turbines. Offshore project assumed the 2020 US-based construction of five 6000-kW turbines with a jacket foundation, two substations, and 23km to port and landfall.*

*** ISO-NE utility-scale battery storage power capacity cost, 2013-2018. https://www.eia.gov/todayinenergy/detail.php?id=45596*

**** Median residential battery storage cost (mostly lithium-ion), 2018. https://data.nrel.gov/submissions/101*

MODEL OUTPUTS

Each model provides the following outputs based on user inputs:

- Labor hours
- Job Years
- Total Cost

MODEL UPDATES

The model is fully customizable and allows for updates to job years per task whether through primary data collection or the inclusion of a labor efficiency factor. Costs can also be updated in the data tab to reflect changes on a yearly basis.

MODEL TASKS SUPPLEMENT

ENERGY EFFICIENCY MODEL

Category	Measure/Task
Appliance	Install Residential Clothes Washer (per unit)
Appliance	Install a Residential Electric Clothes Dryer (per unit)
Appliance	Install a Residential Gas Clothes Dryer (per unit)
Appliance	Install Dehumidifier (per unit)
Appliance	Install Air Purifier (per building)
Appliance	Install a Commercial Gas Clothes Dryer (per unit)
Appliance	Install Commercial Clothes Washer (per building)
Appliance	Install Commercial Electric Clothes Dryer (per building)
Appliance	Install Residential Refrigerator w/o icemaker (per unit)
Appliance	Install Residential Refrigerator with icemaker (per unit)
Appliance	Install Residential Freezer (upright or chest) (per unit)
Appliance	Install Residential Dishwasher (per unit)
Appliance	Install ENERGY STAR Insulated Hot Food Holding Cabinets (per unit)
Appliance	Replace Commercial Refrigerator (per unit)
Appliance	Replace Fan Motor with EC Motor, for Refrigerated Case or Walk-In Cooler (per unit)
Appliance	Repair or Replace Strip Curtains for Walk-in Freezers and Coolers (per unit)
Appliance	Install Evaporator Fan Control for Freezer (per unit)
Appliance	Install Door Gaskets for Freezer or Cooler (per unit)
Appliance	Install Efficient Air-Cooled Refrigeration Condenser (per building)
Appliance	Install Anti-Condensation Heater Control Doors in Vertical Refrigerators (per building)
Appliance	Install ENERGY STAR Ovens, Steamers, Fryers and Griddles (per unit)
Appliance - Control	Install Time Clocks in Vending Machines and Novelty Coolers (per unit)
Appliance - Control	Replace Power Strips with Advanced Power Strips (per unit)
Building Shell	Add Exterior Window Film (per unit)
Building Shell	Replace Window (per unit)
Building Shell	Commercial Cool Roof (per building)
Building Shell	Air Sealing (per 1,000 square feet)
Building Shell	Install Wall Batt Insulation (per 1,000 square feet)
Building Shell	Install Wall Closed or Open Cell Foam Insulation (per 1,000 square feet)
Building Shell	Install Basement Wall Batt Insulation (per 1,000 square feet)
Building Shell	Install Basement Wall Spray Foam Insulation (per 1,000 square feet)

Category	Measure/Task
Building Shell	Install Attic Batt Insulation (per 1,000 square feet)
Building Shell	Install Attic Spray Foam Insulation (per 1,000 square feet)
Building Shell	Duct Sealing (per 1,000 square feet)
Building Shell	Window and Through-the-Wall Air Conditioner Cover and Gap Sealer (per unit)
Building Shell	Opaque Shell Insulation (per 1,000 square feet)
Building Shell	Install Refrigerated Case Night Cover (per unit)
Building Shell	Window Glazing (per 1,000 square feet)
Compressed Air	Install variable frequency drive (VFD)-controlled Refrigerated Air Dryer on a compressed air system with a non-cycling air dryer (per unit)
Compressed Air	Install No Air Loss Water Drain (per unit)
Compressed Air	Replace Oil-Flood Rotary Screw Compressor with Variable Frequency Air Compressor (per building)
Domestic Hot Water	Replace Electric Water Heater with Electric Heat Pump Water Heater (per unit)
Domestic Hot Water	Replace Electric Water Heater with High Efficiency Electric Water Heater (per unit)
Domestic Hot Water	Replace Gas/Propane Water Heater with High Efficiency Gas/ Propane Water Heater (per unit)
Domestic Hot Water	Replace Oil Water Heater with High Efficiency Oil Water Heater (per unit)
Domestic Hot Water	Replace Gas/Electric Water Heaters with Storage tank and Instantaneous Domestic Water Heater (per building)
Domestic Hot Water	Replace Water Heater with Indirect Water Heater (per building)
Domestic Hot Water	Tune-Up Storage Tank Water Heater (per building)
Domestic Hot Water - Control	Replace Spray Valves with Low-Flow Pre-Rinse Spray Valve (per unit)
Domestic Hot Water - Control	Install Thermostatic Shower Restriction Valve (per unit)
Domestic Hot Water - Control	Replace Existing Showerhead with Low-Flow Model (per unit)
Domestic Hot Water - Control	Replace Existing Bathroom Faucet with Low-Flow Model (per unit)
Domestic Hot Water - Control	Replace Existing Kitchen Faucet with Low-Flow Model (per unit)
Energy Management	Develop Behavior Reports (Implementation of an indirect feedback program on energy habits designed to create a behavior induced reduction in energy usage) (per building)
Energy Management	Auditing, project planning, building commissioning, and/or benchmarking (per building)
HVAC	Replace Furnace Blower Fan with Electronically Commutated (EC) Motor (per unit)
HVAC	Wrap/ Insulate Pipes for In-Unit Water Heating (per unit)
HVAC	Wrap/ Insulate In-Unit Water Tank (per unit)
HVAC	Wrap/ Insulate In-Unit Boiler Pipe (per unit)
HVAC	Upgrade AC and Heat Pump - Right Sizing (per unit)
HVAC	Hot Water Pipe Insulation (per 1,000 square feet)
HVAC	Replace Oil-Fired In-Unit Furnace with High Efficiency Oil-Fired Furnace (per unit)
HVAC	Replace Room Air Conditioner (per unit)
HVAC	Replace In-Unit Central Air Conditioner (per unit)
HVAC	Upgrade AC and Heat Pump - Refrigerant Charge Correction (per unit)

Category	Measure/Task
HVAC	Tune Up Central A/C System (per building)
HVAC	Tune Up Central Heating System (per building)
HVAC	Replace Gas/Propane-Fired In-Unit Furnace with High Efficiency Gas/Propane-Fired Furnace (per building)
HVAC	Install Boiler Economizer (per building)
HVAC	Replace Furnace Fan with Efficient Fan (per building)
HVAC	Boiler Tune-Up (per building)
HVAC	Replace Oil-Fired Central Boiler with High Efficiency Oil-Fired Boiler (per building)
HVAC	Replace Gas/Propane-Fired Central Boiler with High Efficiency Gas/Propane-Fired Boiler (per building)
HVAC	Install BPM Motors for HVAC Circulation (Blower) fan (per building)
HVAC	Install Air and Water Cooled Chiller to apply constant and variable speed to built-up HVAC systems (per building)
HVAC	Install Cooling Tower to water-cooled chillers used for space heating (per building)
HVAC	Chiller System Tune-Up (per building)
HVAC - Control	Replace Thermostat with Programmable/ WiFi Model (per unit)
HVAC - Control	Retrocommisioning of HVAC Controls (per building)
HVAC - Control	Install Outdoor Reset Control for Hydronic Boiler (per building)
HVAC - Control	Install Circulator Pump with Electronically Communicated (EC) Motor, for Hydronic Distribution (per unit)
HVAC - Control	Install a Thermostatic Radiator Value - One Pipe Steam Radiator (per building)
HVAC - Control	Install an Energy Management System (EMS) (per building)
HVAC - Control	Replace or Repair Steam System with Low Pressure Space Heating (per unit)
HVAC - Control	Install Demand Control Ventilation (DCV) System (per building)
HVAC - HP	Install Air-Source Heat Pump (per unit)
HVAC - HP	Install Ductless, Mini-Split Air-Source Heat Pump (per unit)
HVAC - HP	Install Absorption Heat Pump (per unit)
HVAC - HP	Install Ground Source Heat Pump (per unit)
HVAC - HP	Install Variable Refrigerant Flow Heat Pump (per unit)
HVAC - HP	Install Packaged Thermal Air Conditioner Heat Pump (per unit)
HVAC - HP	Install Geothermal Heat Pump (per unit)
Lighting	Retrofit Interior Lighting Fixtures (retrofit bulbs and ballast) (per 1,000 square feet)
Lighting	Replace Interior Fixtures to Reduce Lighting Power Density (new fixtures and high efficiency lighting (per 1,000 square feet)
Lighting	Replace Refrigerated Case Lights with LED's (per unit)
Lighting	Replace Existing Exit Sign with LED Exit Sign (per building)
Lighting - Control	Daylight Harvesting (i.e. photo-sensors and controls) (per building)
Lighting - Control	Install Occupancy Sensors to Control Interior Lighting (per building)
Lighting - Control	Centralized Lighting Control System - interior and/or exterior (per building)
Lighting - Control	Install Bi-level lighting (per 1,000 square feet)
Motors and Drives	Install Variable Frequency Drives in Fans and Pumps (per building)

SOLAR ENERGY MODEL

Category	Measure/Task
Project Development	Sales and marketing (including callbacks)
Project Development	Engineering site evaluation visit(s), including measurement recording
Project Development	Investigate integrity of building/land for PV system, including topography and wetlands
Project Development	Solar system design and modeling
Project Development	Financial modeling
Project Development	Design solar system - Electrical
Project Development	Design solar system - Civil/Structural
Project Development	Product selection and procurement
Project Development	Apply for permits with local planning and zoning commission
Project Development	Apply for government solar incentives
Project Development	Apply for interconnection with utilities
Project Development	Other local engagement
Project Development	Contractor selection
Project Development	Legal services and insurance
Construction	Construction site surveillance
Construction	Staging construction equipment
Construction	Site preparation (including roofing, land levelling, landscaping, etc.)
Construction	Install foundations/racks
Construction	Install PV solar panels
Construction	Install inverter(s)
Construction	Install meter(s)
Construction	Wiring
Construction	Install transformer(s)
Construction	Install energy storage system (and related components)
Construction	Install converter(s)
Construction	Install data acquisition system(s)
Construction	Install weather system(s)
Construction	Electrical trenching
Construction	Construct roads
Construction	Construct fences
Construction	Install security measures (including cameras)
Construction	Install additional property features (i.e. bird houses, pollination, grass seeding, etc.)
Operations & Maintenance	Account Management
Operations & Maintenance	System Inspection
Operations & Maintenance	Structural repairs/maintenance
Operations & Maintenance	Electrical repairs/maintenance
Operations & Maintenance	Other repairs/maintenance
Operations & Maintenance	Equipment replacement

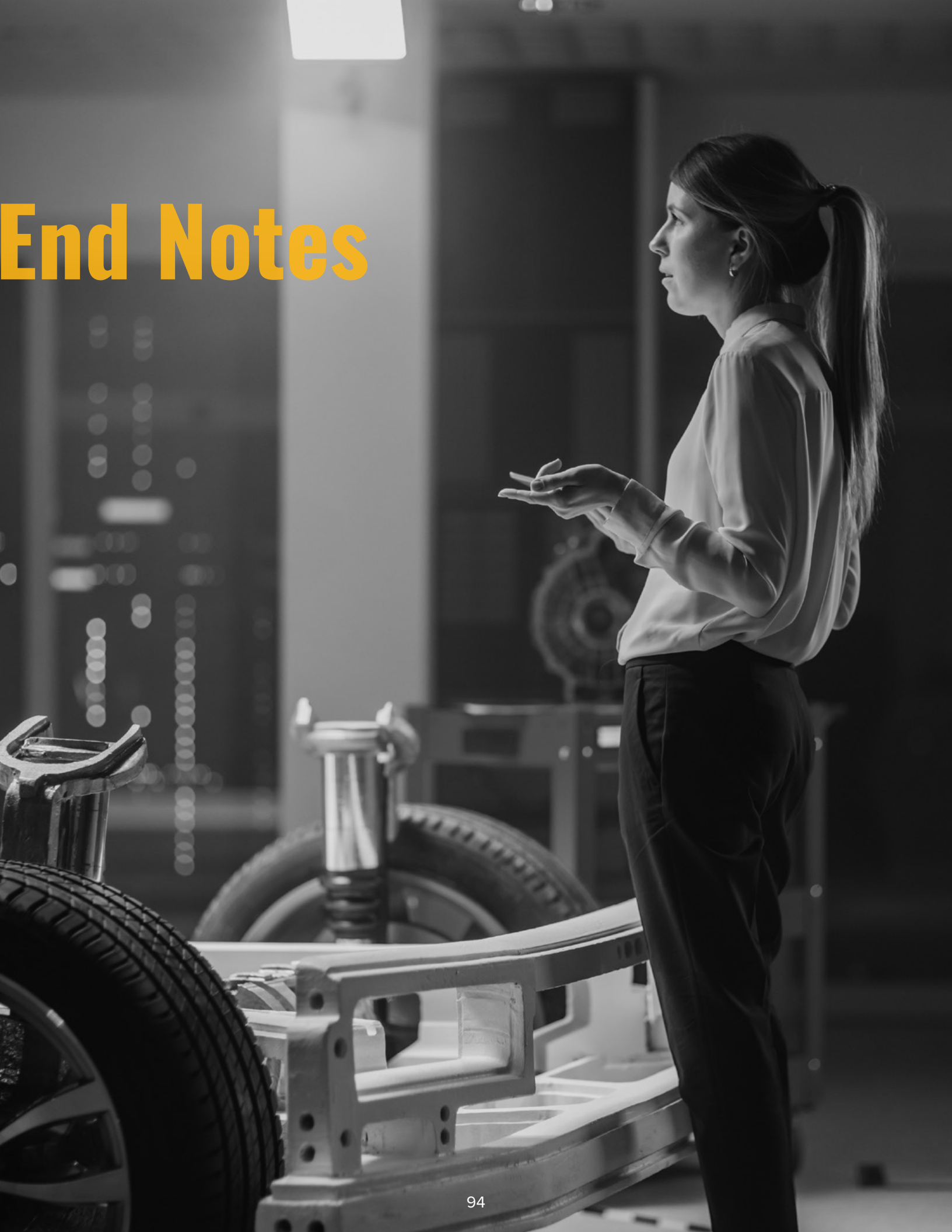
WIND ENERGY MODEL

Category	Measure/Task
Project development (including design, financing, permitting, procurement, and other professional services)	Area Identification (wind resources, bathymetry, shipping routes, etc)
Project development (including design, financing, permitting, procurement, and other professional services)	Engineering site evaluation visit, including measurement recording geological surveying
Project development (including design, financing, permitting, procurement, and other professional services)	Sales and marketing
Project development (including design, financing, permitting, procurement, and other professional services)	Investigate integrity of land/seafloor for wind system
Project development (including design, financing, permitting, procurement, and other professional services)	Design and calculate turbine(s) total potential capacity
Project development (including design, financing, permitting, procurement, and other professional services)	Designing the wind system – Electrical
Project development (including design, financing, permitting, procurement, and other professional services)	Designing the wind system – Civil/structural
Project development (including design, financing, permitting, procurement, and other professional services)	Product selection and procurement (blades, towers, etc.)
Project development (including design, financing, permitting, procurement, and other professional services)	Apply for permits with local planning and zoning commission
Project development (including design, financing, permitting, procurement, and other professional services)	Apply for government wind incentives
Project development (including design, financing, permitting, procurement, and other professional services)	Apply for interconnection
Project development (including design, financing, permitting, procurement, and other professional services)	Other stakeholder engagement (community members, environmental protection organizations, etc.)
Project development (including design, financing, permitting, procurement, and other professional services)	Environmental and technical reviews
Project development (including design, financing, permitting, procurement, and other professional services)	Contractor selection
Project development (including design, financing, permitting, procurement, and other professional services)	Legal services

Category	Measure/Task
Construction/ installation	Construction site surveillance
Construction/ installation	Staging construction equipment
Construction/ installation	Construct and bury cable lines
Construction/ installation	Construct transmission lines
Construction/ installation	Install turbine towers
Construction/ installation	Install generators
Construction/ installation	Install rotors
Construction/ installation	Construct substation(s)
Construction/ installation	Install security measures (including cameras and lighting)
Construction/ installation	Install weather systems
Construction/ installation	Transportation
Construction/ installation - Land-based	Site preparation (including landscaping)
Construction/ installation - Land-based	Construct roads
Construction/ installation - Land-based	Install turbine base pads
Construction/ installation - Land-based	Construct power line posts
Construction/ installation - Land-based	Construct fences
Construction/ installation - Land-based	Install additional property features (i.e. bird houses, pollination, grass seeding, etc.)
Construction/ installation - Offshore	Install mitigation features (scour protection, scaring devices to keep marine mammals away, pile driving noise attenuation, etc.)
Operations and maintenance (including asset management)	Account management (including system monitoring and report generation)
Operations and maintenance (including asset management)	System inspection
Operations and maintenance (including asset management)	Structural repairs/maintenance
Operations and maintenance (including asset management)	Electrical repairs/maintenance
Operations and maintenance (including asset management)	Other repairs/maintenance (including landscape)
Operations and maintenance (including asset management)	Equipment replacement
Operations and maintenance (including asset management)	Insurance reporting
Operations and maintenance (including asset management)	Tax filing
Operations and maintenance (including asset management)	Wildlife surveillance

Category	Measure/Task
Manufacturing/ assembly	Determining project materials, equipment and calculating costs
Manufacturing/ assembly	Procurement of project materials and equipment
Manufacturing/ assembly	Design and modeling
Manufacturing/ assembly	Financial modeling
Manufacturing/ assembly	Metal cutting and fitting
Manufacturing/ assembly	Welding
Manufacturing/ assembly	Assembling and testing electrical components
Manufacturing/ assembly	Contractor selection
Manufacturing/ assembly	Safety compliance
Manufacturing/ assembly	Quality control
Manufacturing/ assembly	Transportation
Manufacturing/ assembly - Tower, Blades, or Foundations	Plating, coating, and painting

End Notes



1 These include the following industries: (a) machinery manufacturing, (b) computer and electronic product manufacturing, (c) electrical equipment, appliance, and component manufacturing (including charging stations), and (d) transportation equipment manufacturing.

2 Phase III is the final stage of innovation funding, in which companies bring fully-developed products to wide commercial availability. For more information, please see the

3 For the purposes of this research, offshore wind jobs are broken out into five occupational groups based on project development phase; they are as follows: Planning and Development, Manufacturing and Assembly, Construction and Installation, Operations and Maintenance, and Support Services. These categories are described in more detail on Page 29 of this report.

4 For an example of industry and occupational employment growth projections for offshore wind, see generally: The American Clean Power Association. 2021 Clean Energy Labor Supply. https://cleanpower.org/resources/cleanenergylaborsupply/.

5 Part of NYSERDA's priority population definition also includes unemployed power plant workers, though these individuals were not specifically targeted in this research effort. https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Workforce-Development/Definitions.

6 Overall statewide employment estimates are from the Bureau of Labor Statistics, Quarterly Census of Employment and Wages. Data was extracted in August 2021.

7 It should be noted that the quarterly employment change featured in this figure is slightly different from the USEER methodology upon which annual employment estimates are based on. Though the values may differ slightly, the overall trend — which features a significant decline in Q2 2020, followed by growth throughout the first two quarters of 2021 — are the same. Quarterly estimates are based on Unemployment Insurance (UI) filings, while the annual USEER uses BLS QCEW data. Because the two methodologies cannot be reconciled, quarterly percent changes are used in Figure 3 to provide a visual illustration of the decline and subsequent recovery trend.

8 Industry employment change is taken from JobsEQ 2020 Q4.

9 These categories correspond with the following delineations: 0% to 49% of labor hours, 50% to 99% of labor hours, and 100% of labor hours. For a full description of this methodology, please refer to Appendix A.

10 Other energy efficiency technologies include variable speed motors, other design services not specific to a sub-technology, software not specific to a sub-technology, energy auditing, rating, monitoring, metering, and leak detection, energy efficiency policy not specific to a sub-technology, LEED certification, consulting not specific to a sub-technology, and phase-change materials.

11 The wind energy employment estimate represents both land-based and offshore wind energy.

12 Advanced natural gas includes efficient, low emission, leak free natural gas, including systems that use any of the following technologies: high efficiency compressor, advanced low NOx combustion technology, first application of closed loop steam cooling in an industrial gas turbine, advanced turbine blade and vane materials, high temperature TBC and abradable coatings, advanced row 4 turbine blades, 3-D aero technology, advanced brush seal.

13 NYSERDA, Offshore Wind Projects. https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Focus-Areas/NY-Offshore-Wind-Projects

14 The New York Bight is defined as an offshore area that extends northeast from Cape May in New Jersey to Montauk Point on the eastern tip of Long Island.

15 Wood Mackenzie. Economic Impact of New Offshore Wind Lease Auctions by BOEM. August 2020. https://tethys.pnnl.gov/sites/default/files/publications/Offshore-wind-economic-impact-analysis.pdf.

16 Id.

17 NYSERDA, 2020 Offshore Wind Solicitation. https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Focus-Areas/Offshore-Wind-Solicitations/2020-Solicitation

18 Stori, Val. New York State Announces Second Offshore Wind Solicitation for up to 2,500 MW of Projects. August 2020. https://www.cleanegroup.org/new-york-state-announces-second-offshore-wind-solicitation/.

19 Vockrodt, Jeff. Statement on New York's Historic Renewable Energy Job Standards. April 2021. https://www.climatejobsny.org/news/2021/4/6/cjnys-statement-on-new-yorks-historic-renewable-energy-job-standards.

20 Climate Jobs NY: Response to RFI OSW-2018. https://www.nyserda.ny.gov/-/media/Files/Programs/offshore-wind/Climate-Jobs-New-York-RFI-OSW-2018-Comments.pdf.

21 For list of works cited and consulted, please refer to Appendix E of this report.

22 For the purposes of this research, offshore wind jobs are broken out into five occupational groups based on project development phase; they are as follows: Planning and Development, Manufacturing and Assembly, Construction and Installation, Operations and Maintenance, and Support Services.

23 All time frame estimates were compiled from the UK Offshore Wind Industry: Supply Chain Review and The Workforce Opportunity of Offshore Wind in New York reports.

24 https://www.nyserda.ny.gov/All-Programs/Programs/Offshore-Wind/Focus-Areas/NY-Offshore-Wind-Projects

25 All lifetime cost estimates were compiled from the UK Offshore Wind Industry: Supply Chain Review report.

26 All workforce addition estimates were compiled from the New York State and the Jobs of Offshore Wind Energy report.

27 Topham, Eva and David McMillan. Renewable Energy Journal. Sustainable Decommissioning of an Offshore Wind Farm. October 2016.

28 Bureau of Labor Statistics, Quarterly Census of Employment and Wages (QCEW), 2020 Annual Average. Data accessed August 2021.

29 U.S. Bureau of Labor Statistics. Occupational Employment and Wage Statistics. May 2020. https://www.bls.gov/oes/tables.htm.

30 Industry employment data is taken from JobsEQ 2020 Q4.

31 Id.

32 Hydroelectric energy storage used by electric power systems for load balancing. This method stores the gravitational potential energy of water pumped from a lower elevation reservoir to a higher elevation.

33 This includes battery storage for solar generation and lithium batteries, lead-based batteries, other solid-electrode batteries, vanadium redox flow batteries, and other flow batteries.

34 This includes flywheels and compressed air energy storage.

35 Temporary storage of energy for later use when heating or cooling is needed.

36 A smart grid is an electricity supply network that uses digital communications technology to detect and react to local changes in usage.

37 Other ethanol/ non-woody biomass includes fuel made from other materials such as straw, manure, vegetable oil, or animal fats.

38 The 2020 survey did not include specific follow-up questions for those firms impacted by COVID-19 and as such, outside of employment data, there is limited additional information regarding the impacts of COVID-19 on New York's clean energy industry.

39 This was a multiple-choice question, and respondents were given the option to select yes for more than one program. However, individuals who selected “no, we have not received emergency funds” were not able to select “yes” for any other response.

40 The demographic estimation for additional sectors cannot be provided due to low sample sizes.

41 Demographic data for New York overall are compiled from JobsEQ using the average of four quarters ending in Q1 2020.

42. Help Wanted: Diversity in Clean Energy. September 2021. https://e2.org/reports/diversity-in-clean-energy-2021/.

43 https://www.nyserda.ny.gov/All-Programs/Programs/Clean-Energy-Workforce-Development/Definitions

44 Not all investments are able to be classified under or assigned to a single technology sector because some investments are more general in nature (i.e. innovation competitions, research labs, etc.) and cannot be 100% dedicated or directed towards a specific technology area. As such, totals will not sum to Figure 35.

45 Totals will not sum to Figure 35 because not all investments could be categorized as public or private due to lack of information.

46 Totals will not sum to Figure 35 because not all investments could be categorized as public or private due to lack of information.

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

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

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