UNITED STATES
CLIMATE ALLIANCE

2020

JOBS IN THE CLEAN ENERGY ECONOMY

[bw] RESEARCH PARTNERSHIP

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About This Report

The United States Climate Alliance (USCA) commissioned BW Research Partnership to produce the following 2020 Clean Energy Employment Report. The report details clean energy employment from 2016 through 2019 [1] aggregated across the 24 Alliance states. [2] Specifically, this report includes total jobs for each clean energy technology sector as well as their component sub-technologies and industry, or value chain, segments. [3] The major clean energy sectors examined in this report are featured below in Table 1.

It is important to note that the U.S. Climate Alliance does not have an agreed upon definition of clean energy, nor is this report intended to define clean energy. A set of technologies is defined solely for the purpose of aggregating data across states. Each state may define clean energy differently; these differences are captured in each state's fact sheet and in independently commissioned state-specific clean energy jobs reports.

Data in this report is based on the overall 2020 United States Energy and Employment Report (USEER)[4], an annual report that has been tracking energy jobs across the nation since 2015. The methodology relies on the most recently available data from the BLS Quarterly Census of Employment and Wages (QCEW), together with a detailed supplemental survey of business establishments across the United States. Together, the BLS and survey data provide the most comprehensive calculation of energy employment available. This methodology has been used for local, state, and federal energy employment data collection and analysis for nearly a decade, including the Solar Foundation's *National Solar Jobs Census* series, clean energy reports for state agencies in Massachusetts, New York, Vermont, Rhode Island, and numerous nonprofit agencies across the United States. The USEER survey was administered by telephone and web, and roughly 25,000 business establishments participated in the effort, resulting in a margin of error for incidence in the index of +/- 0.62 percent at a 95 percent confidence interval.

The report provides an Alliance state-aggregated overview of clean energy workforce demographics, such as race, ethnicity, gender, age, veteran status, union membership, and educational attainment, as well as employer needs related to hiring difficulty and business growth. Appendix A provides occupational wages across all clean energy technology sectors. Appendix B includes a more focused examination of 10 clean energy occupations, detailing career pathway information such as employment benefits, necessary knowledge and skills, wages for multiple career stages, typical certifications, and promotion opportunities.

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[1] Clean energy jobs data is portrayed back to 2016 as this is the earliest year of data collection with sufficiently similar methodologies to allow for year-over-year growth comparisons.

[2] Though Puerto Rico is part of the Climate Alliance, there is insufficient data to profile Puerto Rico's clean energy jobs.

[3] It should be noted that individual state reports may include or exclude different sub-technologies in their definition of clean energy. For the purposes of this report clean energy technologies are defined by the U.S. Climate Alliance; the list of these may be found in Appendix E.

[4] https://www.usenergyjobs.org/

Altogether, the data in this report highlight how the Alliance states have provided a national and global example for how climate mitigation policies and job growth could go hand-in-hand. The report is not meant to be a roadmap for workforce development initiatives, as these actions are best reserved for local- and state-level research efforts and partnerships. The focus of this report is to provide a clean energy jobs benchmark for the Alliance states. These data provide an overview of how many jobs were created between 2016 and 2019 and a framework through which to understand the growth and development of clean energy jobs by technology sector and industry value chain segment. A brief overview of job quality in this report is reserved to comparative wages and employment benefits data; a more robust or nuanced discussion on clean energy job quality may be considered for alternative avenues of research. It is important to advance both job quality and workforce standard alongside climate and clean energy policies. Efforts to prioritize job access and quality through growth of industries poised to reduce greenhouse gas emissions can provide opportunity for residents across Alliance states as they rebuild their economy.

This report was commissioned before the global Coronavirus (COVID-19) pandemic, which has significantly altered labor market and employment realities across the United States. The U.S. Climate Alliance's Clean Energy Employment Report is based on data collected in the last quarter of 2019, before the emergence of COVID-19 in the United States. As a result, the employment figures included throughout this report serve as a baseline of clean energy industry employment pre-pandemic. BW Research estimates that the Alliance states lost a net 301,541 clean energy jobs between March and August 2020 due to the COVID-19 economic fallout—a 3.4 percent decline compared to the 2019 baseline.[5]

Numerous economic uncertainties remain, including the volatility of policy and relief programs, the unpredictability of a novel virus, and future consumer spending patterns. As the nation experiences record levels of unemployment claims, it is difficult to forecast how the labor market and specific industry sectors will continue to respond to the aftershock of a nationwide economic shutdown. Nevertheless, the data presented in this report provide a useful baseline from which to understand historical clean energy job growth across the Alliance states. It will be important to track and understand the needs of clean energy employers as recovery unfolds. Targeted state-level workforce development and retraining research, initiatives, and partnerships could provide meaningful and actionable insight as the Alliance states' clean energy businesses seek to recover from the economic recession.

[5] Further employment analyses related to the COVID-19 pandemic's economic impacts can be found at http://bwresearch.com/covid19.

TABLE 1. FIVE CLEAN ENERGY TECHNOLOGY SECTORS

Technology Sector	Definition	Sample Job Titles
Energy Efficiency	The Energy Efficiency sector comprises the manufacture, wholesale trade, distribution, construction, installation, or repair and maintenance of any good or service that reduces electricity demand pursuant to the EPA's ENERGY STAR® Standards or the Department of Energy's Efficiency Standards. This also includes establishments that are involved with heating, ventilation, and air conditioning (HVAC) from renewable energy sources or that otherwise work to increase the energy efficiency of HVAC Systems.	• Heating, Ventilation, and Air Conditioning (HVAC) Mechanics and Installers • Electricians • Energy Auditors • Plumbers, Pipefitters, and Steamfitters • Insulation Workers • Construction Laborer
Clean Energy Generation	Clean Energy Generation is defined as the process of generating electric power from clean or renewable sources of energy, including solar, wind, geothermal, biomass, nuclear, or hydropower. This sector includes employment across utilities, construction, manufacturing, wholesale trade, and professional and business services such as engineering, consulting, legal, or financial support.	• Solar Photovoltaic Installers • Wind Turbine Technicians • Nuclear Engineers or Technicians • Power Plant Operators • Construction Laborers
Alternative Transportation	The Alternative Transportation sector includes the manufacture, wholesale trade, and repair and maintenance of, or professional and business service support for transportation vehicles and their component parts that use non-traditional fuel resources such as electricity, natural gas, hydrogen, or fuel cells.	• Assemblers and Fabricators • Automotive Service Technicians and Mechanics • Welders, Cutters, Solderers, and Brazers • Sales Representatives (Wholesale and Manufacturing)
Grid Modernization and Storage	Grid Modernization and Storage encompasses the research and development, manufacture, wholesale trade, construction, and professional and business service support for storage and grid modernization technologies such as smart grid and microgrids. Storage technologies include battery storage, pumped hydropower, mechanical storage, thermal storage, and biofuel and nuclear storage.	• Electric Power-Line Installers and Repairers • Electricians • First-Line Supervisors of Mechanics, Installers, and Repairers • Construction Laborers • Operating Engineers
Clean Fuels	Clean Fuels includes the production, manufacture, sales, distribution, and transport of non-fossil fuel substances that produce useful energy when they undergo a chemical or nuclear reaction. These include corn ethanol, woody and non-woody biomass, and nuclear fuels.	• Farmworkers and Laborers (Crop, Nursery, and Greenhouse) • Geological and Hydrologic Technicians • Agricultural Engineers • Soil and Plant Scientists • Industrial Production Managers

Executive Summary

KEY FINDINGS

As of the fourth quarter of 2019, there were 2.14 million clean energy workers[6], as defined in Table 1 above, across the Alliance states. For every 10,000 workers in the Alliance states' labor market, there were 254 clean energy jobs. Before the onset of COVID-19, clean energy workers represented about three percent of total jobs in these states. These included jobs such as engineers, chief executives, analysts, lawyers, and supervisors, as well as sales representatives, technicians, machinists, installers, electricians, assemblers, and welders. Much of employment is concentrated in the construction industry, which accounted for 43 percent of clean energy jobs in the Alliance states at the end of 2019.

Alliance states accounted for 55 percent of the U.S. population and 60 percent of all clean energy jobs in America.

As of August 2020, BW Research estimated that the economic downturn resulted in a net job loss of 301,541 workers, wiping out three years of job growth in under six months.[7] As with nearly all sectors of the economy, clean energy job losses occurred from March through May, with a slight return of roughly 87,000 clean energy jobs over June through August, resulting in the net loss of almost 302,000 jobs.

Concentration of clean energy activity in the Alliance states was on the rise prior to COVID-19.

Out of the 2.14 million clean energy workers employed as of 2019, just under 1.5 million were full-time equivalent workers that spent all their labor hours on clean energy work. This report counts all clean energy workers regardless of how much time they spend on clean energy-related activities. For example, an electrician that spends only a quarter of total labor hours installing energy-efficient lighting technologies is included in the overall clean energy jobs estimate. An estimate of full-time equivalent (FTE) clean energy identifies the change in intensity, or concentration, of clean energy activity. If the electrician begins to spend the majority of labor hours or all labor hours dedicated to installing or servicing efficient lighting technologies, this reflects as a corresponding increase in FTE clean energy jobs.

[6] This estimate is based on the U.S. Climate Alliance clean technology definition found in Appendix E. Other clean energy report estimates may vary based on decisions to either include or exclude specific sub-technologies as part of the clean energy economy, such as nuclear fuels and generation, traditional hydropower, corn ethanol, etc.

[7] These job losses are cumulative and based on March 2020 through August 2020.

An example can illustrate the importance of tracking FTE clean energy employment. If an HVAC firm had 6 installers in 2018 who occasionally installed heat pumps, and now has 6 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, FTE jobs would show a corresponding increase.

Across the Alliance states, FTE clean energy jobs have grown faster than the overall clean energy labor market. Between 2016 and 2019, FTE clean energy jobs across Alliance states grew by about 17 percent, or 220,348 workers. At the end of 2019, seven in ten (70 percent) clean energy workers spent all of their labor hours on clean energy-related activities, up from 64 percent in 2016.[8]

The energy efficiency sector represented the largest share of jobs and the greatest absolute growth.

Energy efficiency jobs accounted for 67 percent of all clean energy employment across the Alliance states. Between 2016 and 2019, this sector grew by just over eight percent, which resulted in an additional 109,312 jobs in three years. At the end of 2019, 63 percent of all energy efficiency jobs in America were found in one of the 24 Climate Alliance states. However, from March through July of 2020, the energy efficiency sector in the Alliance states shed the largest number of jobs related to COVID-19 employment losses. Energy efficiency firms accounted for 216,384 jobs lost, or 69 percent of total COVID-19 clean energy job losses over this time period.

Other major areas of growth prior to the COVID-19 pandemic included the grid modernization and storage sector and alternative transportation. Employment in these sectors grew by a respective 32 percent and 18 percent between 2016 and 2019, together equating to roughly 41,800 new jobs across the U.S. Climate Alliance states. However, as of July 2020, these sectors collectively lost 223,206 jobs.

Prior to COVID-19, clean energy employers reported difficulty finding qualified job applicants.

At the time of data collection, employers reported that they had significant difficulty finding qualified workers to fill open positions at their clean energy firms. One-third of Alliance state clean energy employers reported that hiring had been “very difficult” between 2018 and 2019 and another 52 percent of employers indicated that hiring had been “somewhat difficult”; in total, 85 percent of employers reported some level of hiring difficulty.

[8] For more information on FTE clean energy jobs, please refer to the Clean Energy Employment Overview section of this report.

Clean energy employers attributed setbacks to growing their business and expanding revenues largely to the lack of qualified talent. This varied by sector, but generally included technicians, sales representatives, management roles such as supervisors and directors, and engineers. However, since the COVID-19 pandemic, these realities have likely changed, as global, national, and regional economies have absorbed significant shocks to their labor markets.

Many clean energy jobs in the Alliance states provide above-average wages and employment benefits.

An electrician installing energy-efficient lighting or a sales representative selling electric vehicles and electric vehicle component parts earns more per hour compared to the average electrician or sales representative across the United States. Overall, 92 percent of surveyed clean energy occupations[9] in the Alliance states across all technology sectors and levels of experience are paid more than the same occupation's national median wage. This is especially true for entry-level clean energy jobs, where 98 percent of surveyed entry-level clean energy positions receive a premium over the national corresponding occupational medians. For example, an entry-level electrician[10] earns $16.06 per hour, according to the Bureau of Labor Statistics[11], while an entry-level electrician working in the energy efficiency sector earns $20.87 per hour, a 30 percent premium for possessing the skills and knowledge specific to energy-efficient technologies.

In addition, roughly 92 percent of clean energy employers reported that they provide some level of healthcare, either full or partial coverage for their clean energy employees. This is significantly higher than the national private sector average of 69 percent.[12] Similarly, just over 84 percent of clean energy employers also reported making contributions to some type of retirement plan for their workers; this is also higher than the national private sector average of 67 percent.[13]

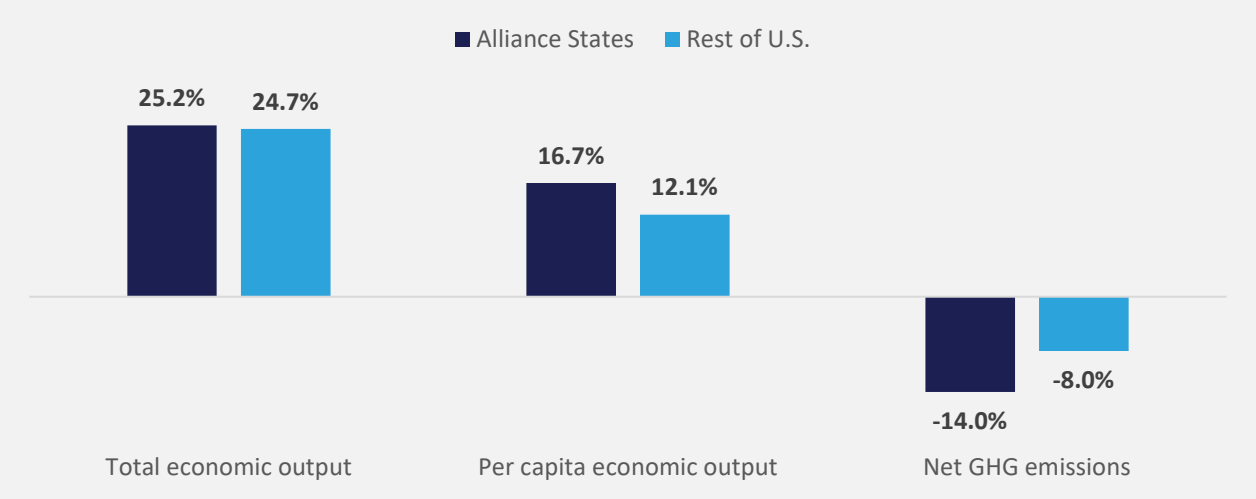
[9] This proportion is only out of surveyed occupations. Out of all 765 five-digit Standard Occupational Classification (SOC) codes from the Bureau of Labor Statistics, the dataset includes data on 78 occupations or SOCs—about 10 percent of all SOC codes.
[10] Entry-level wages in this report are defined at the 10th percentile.
[11] The occupational wages provided by the Bureau of Labor Statistics (BLS) also include clean energy jobs. For example, the national wage for electricians covers all electricians, including those working on energy efficiency-specific work. The entry-level electrician wage of $16.06 per hour is based on the 10th percentile wage from the Occupational Employment Statistics dataset from BLS (May 2019) and includes all electricians across all industries in the United States.
[12] Bureau of Labor Statistics. Employee Benefits in the United States, March 2019. https://www.bls.gov/news.release/pdf/ebs2.pdf.
[13] *Id.*

Introduction

Clean energy growth provides several benefits to statewide economies. These technologies represent a bridge to a lower-carbon future and provide both energy cost savings and job opportunities for residents. Because of this, 25 governors in the United States have committed to achieving the goals of the Paris Agreement by reducing GHG emissions by 26 to 28 percent below 2005 levels by 2025, with the knowledge that these commitments would not only help mitigate climate change but also create jobs. In addition to producing cleaner electricity, Alliance states have committed to tackling transportation emissions with policies that support the deployment of zero emission vehicles, as well as policies to increase battery storage capacity, building energy efficiency, and a number of other supportive programs that continue to reduce the Alliance states' GHG emissions and grow the clean energy labor market.

These measures have been successful thus far, as net GHG emissions declined by 14 percent between 2005 and 2018 in the Alliance states compared to only eight percent across non-Alliance states. At the same time, emissions reductions have not affected economic output over this same time period. In fact, per capita economic output in the Alliance states grew faster between 2005 and 2018 compared to non-Alliance states, indicating that sustained commitments to GHG reductions and the Paris Agreement can go hand-in-hand with economic growth.[14]

FIGURE 1. PERCENT CHANGE IN NET GHG EMISSIONS AND ECONOMIC OUTPUT, 2005-2018[15]



[14] United States Climate Alliance, 2020 Annual Report: https://www.usclimatealliance.org/annual-report.

[15] Emissions data – Rhodium Group Climate Service; GDP data – U.S. Bureau of Economic Analysis; Population data – U.S. Census Bureau.

This report highlights a particularly important component of a growing clean energy industry—the creation of employment opportunities for individuals across the country. Understanding the clean energy labor market is pivotal to identifying how policies support job growth in these sectors. Tracking and understanding labor market impacts of the clean energy economy is critical to ensuring that policy and decision-making are effective and data driven. Such considerations are particularly important as the global COVID-19 pandemic has shocked the nation's labor market, impacting clean energy businesses, and taking with it roughly 301,500 clean energy jobs from March 2020 through August 2020.

To develop a strong clean energy economy, state-level research and policy support can identify how to best support clean energy businesses. Now more than ever, developing policy support for industries can ensure that the clean energy economy continues to be a source of jobs for individuals across the nation.

Clean Energy Employment Overview

OVERALL CLEAN ENERGY EMPLOYMENT

While each Alliance state has different policy mechanisms in place to reduce GHG emissions, the policies generally include the same five technology sectors discussed in Table 1. These technologies are geared towards advancing zero-carbon electricity generation; energy efficiency building, appliance, and lighting upgrades; zero-emission vehicles; improved grid infrastructure and energy storage capacities; and clean fuels production. Numerous state-level policy efforts have led to the creation of jobs in these clean energy technology sectors.

For the purposes of this report, clean energy technologies are those which produce energy without polluting the atmosphere with net GHG emissions. These include renewable resources such as solar, wind, biomass, and hydroelectric power as well as other carbon-free resources like nuclear power generation and nuclear fuels. The report does not include jobs from fossil fuel industries such as coal, oil, or natural gas fuels for electric power generation or transportation, though the production of natural gas fuel vehicles is included. In addition to clean electric power generation, clean energy sectors in this report also include technologies that improve overall building HVAC and appliance efficiency and insulation, battery storage and grid modernization technologies, electric and hybrid vehicles, and corn ethanol, woody biomass, and other biofuels.[16]

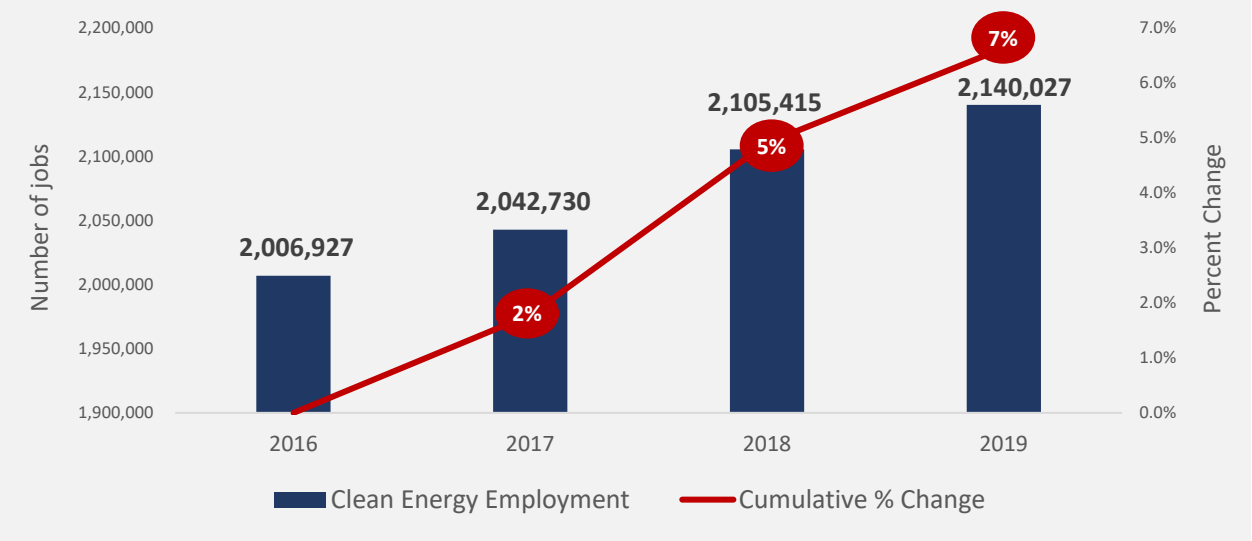
Overall, clean energy jobs across the 24 Climate Alliance states[17] grew by almost seven percent between 2016 and 2019[18], resulting in 133,100 new jobs in three years. The 24 states that comprise the U.S. Climate Alliance accounted for only 55 percent of all jobs in the United States at the end of 2019, but they supported 60 percent of all clean energy jobs across the country. For every 10,000 workers across the 24 Climate Alliance states in 2019, there were 254 clean energy jobs.

[16] For a full list of clean energy technologies and sub-technologies included in the U.S. Climate Alliance definition for clean energy, please refer to the Clean Energy Technology List in Appendix E.

[17] The 24 Climate Alliance states include California, Colorado, Connecticut, Delaware, Hawaii, Illinois, Maine, Maryland, Massachusetts, Michigan, Minnesota, Montana, Nevada, New Jersey, New Mexico, New York, North Carolina, Oregon, Pennsylvania, Rhode Island, Vermont, Virginia, Washington, and Wisconsin. Puerto Rico is also part of the U.S. Climate Alliance, but there is insufficient data to report on clean energy jobs.

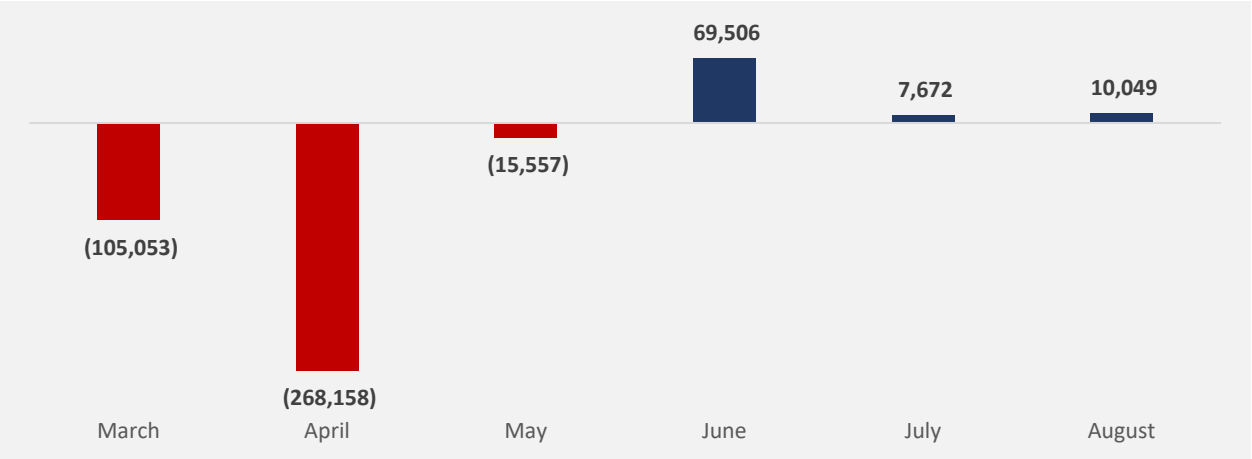
[18] Clean energy jobs data is portrayed back to 2016 as this is the earliest year of data collection with sufficiently similar methodologies to allow for year-over-year growth comparisons.

FIGURE 2. ALLIANCE STATES' CLEAN ENERGY EMPLOYMENT TOTALS, 2016-2019



It is important to note that the data for this report was collected in the last quarter of 2019, before the onset of the global COVID-19 pandemic. As such, the jobs data in this report provides an important benchmark or baseline against which to measure overall clean energy jobs and historical job growth across the Alliance states. From March through August 2020, the Alliance states' clean energy industry shed a net 301,541 jobs, with losses concentrated in March through May. Starting in June, the clean energy economy began to rebound, adding 87,227 workers back to the labor market through August.

FIGURE 3. ALLIANCE STATES' COVID-19 CLEAN ENERGY JOB CHANGES BY MONTH, MARCH-AUGUST 2020



The energy efficiency sector—the largest clean energy sector by employment—shed the greatest number of jobs, followed by clean energy generation. Energy efficiency businesses in the Alliance states accounted for 69 percent of total job COVID-19 job losses from March through August; this equates to roughly 207,000 jobs. Clean energy generation firms, meanwhile, shed about 56,000 jobs—or almost 19 percent of total job losses through August 2020.

With regards to job losses by value chain segment, the construction industry accounted for the majority of jobs lost from March through August. About 167,600 clean energy construction jobs were lost, accounting for roughly 56 percent of total job losses by value chain segment. Professional and business services shed about 20 percent of jobs—or 58,900 workers—followed by manufacturing with 41,400 job losses, or 14 percent of all jobs lost by value chain segment.

FIGURE 4. ALLIANCE STATES' COVID-19 CLEAN ENERGY JOB LOSSES BY TECHNOLOGY SECTOR, MARCH-AUGUST 2020

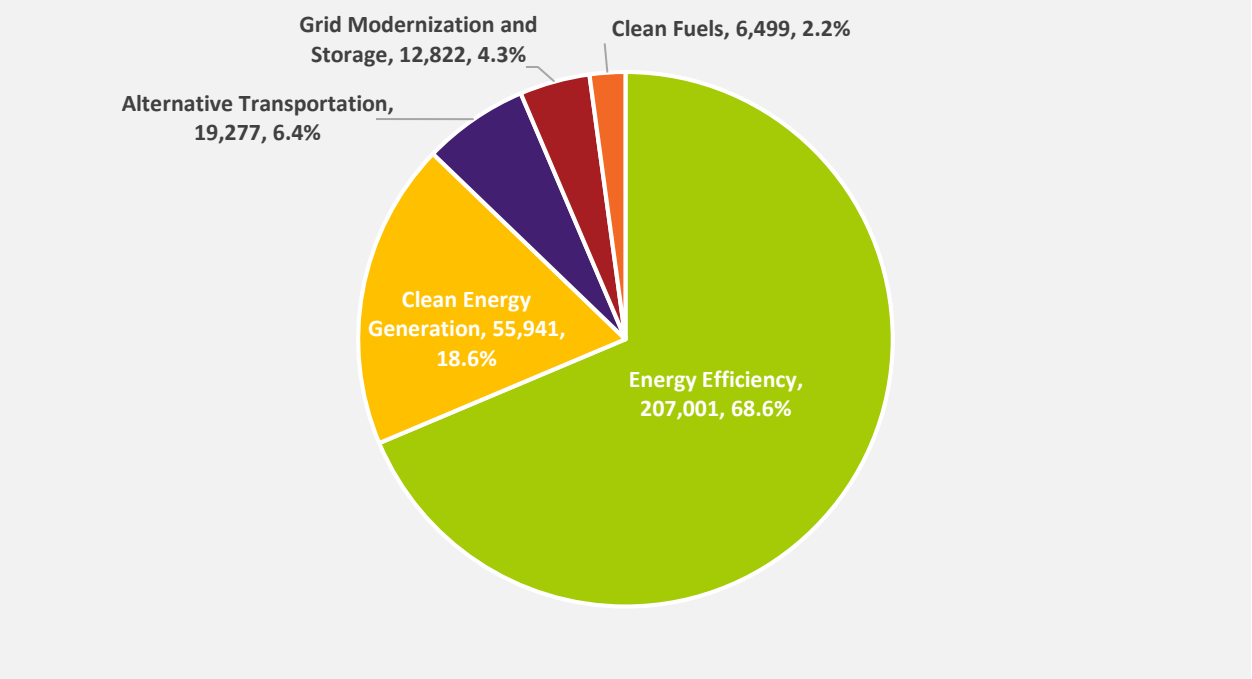
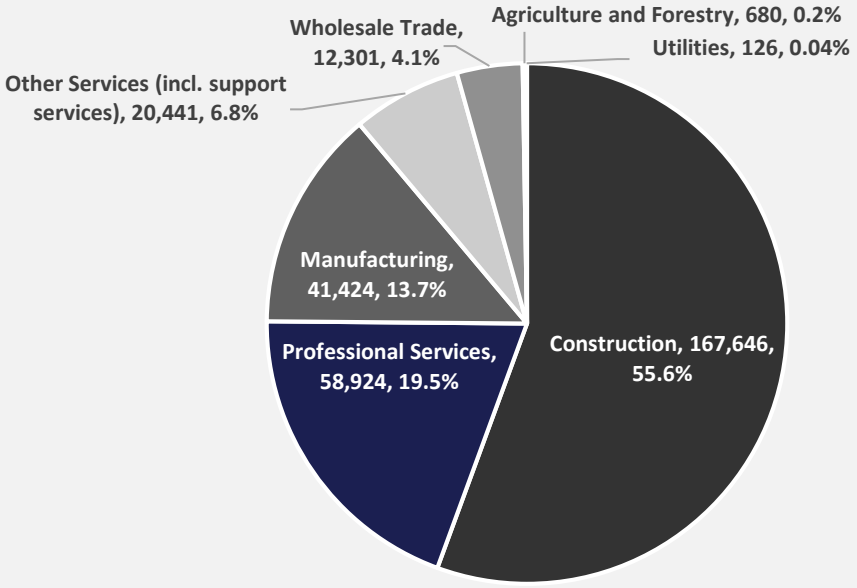


FIGURE 5. ALLIANCE STATES' COVID-19 CLEAN ENERGY JOB LOSSES BY VALUE CHAIN SEGMENT, MARCH-AUGUST 2020

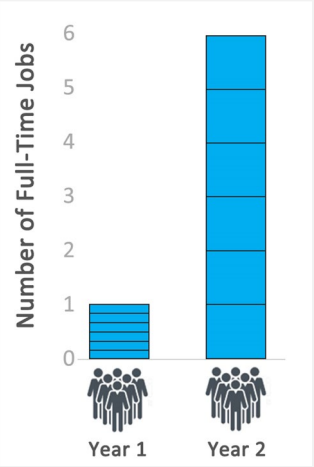


FULL-TIME EQUIVALENT CLEAN ENERGY EMPLOYMENT

Full-time equivalent (FTE) clean energy jobs are used to identify the concentration, or intensity, of clean energy activity. For the purposes of this report, an individual is counted as a clean energy worker if they spend any amount of their work week or labor hours on clean energy-related activities. Over time, as clean energy policies and fiscal incentives increase the demand for clean energy goods and services in a state, a clean energy worker that previously only spent a quarter of the work week installing high-efficiency HVAC technologies may now be spending more than half to all of their labor hours on energy efficiency-related services. This increase in the number of labor hours dedicated to clean energy services is captured through the FTE metric.[19]

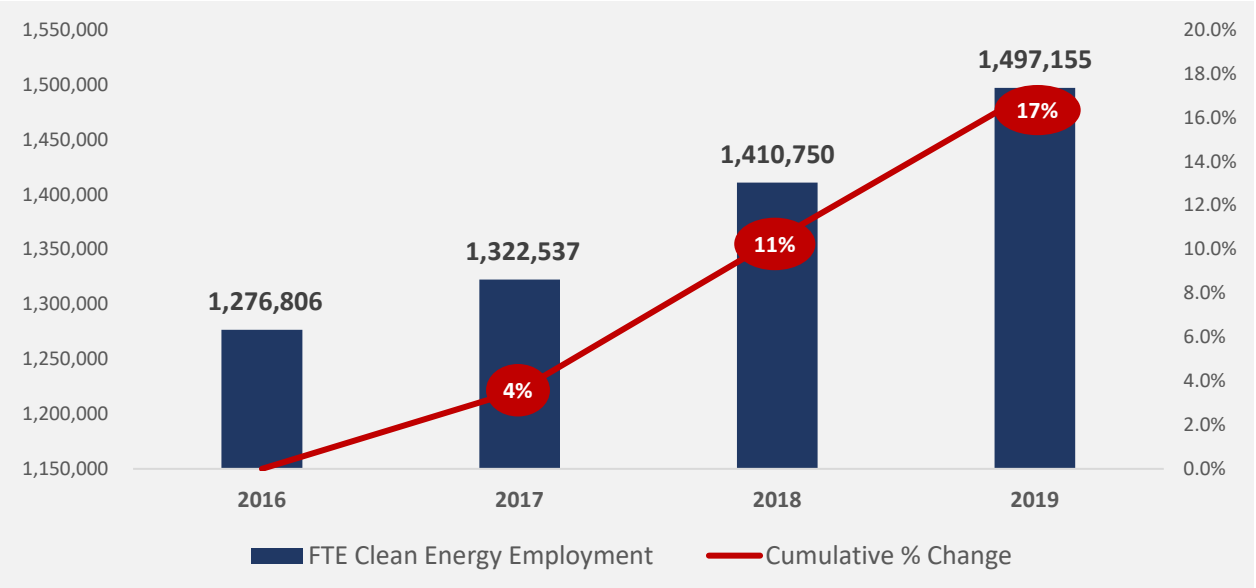
[19] These jobs were extrapolated using a combination of state-level and census region data. The data were adjusted based on revenue distribution by technology and each job is weighted according to how much time workers were reported to spend on clean energy activities (1-49 percent, 50-99 percent, or 100 percent). For a full description of this methodology, please refer to Appendix D.

An example can illustrate the importance of tracking FTE clean energy employment. If an HVAC firm had 6 installers in 2018 who occasionally installed heat pumps, and now has 6 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, FTE jobs would show a corresponding increase.



At the end of 2019, seven in ten (70 percent) clean energy workers spent all of their labor hours on clean energy-related activities across the Alliance states; this represented an increase from about 64 percent in 2016. In total, FTE clean energy jobs across the Alliance states grew by 17 percent between 2016 and 2019. There were 220,348 more FTE clean energy workers across the Alliance states at the end of 2019 compared to 2016.

FIGURE 6. ALLIANCE STATES' FTE CLEAN ENERGY EMPLOYMENT TOTALS, 2016-2019



Clean Energy Value Chain Employment

The following section provides a crosscut of clean energy jobs by value chain activity, identifying what types of clean energy functions—like production, installation, or sales—are particularly concentrated in the Alliance states. In general, the Alliance states' policies and programs are focused on clean energy and energy efficiency deployment, and this is reflected in the concentration of construction workers. Table 2 below provides more detail on the most common types of occupations that are found in each industry or value chain sector.[20]

TABLE 2. TYPES OF OCCUPATIONS BY VALUE CHAIN SECTOR

Industry/Value Chain Sector	Types of Occupations
Construction	Carpenters; Heating, Ventilation, and Air Conditioning (HVAC) Mechanics or Installers; Electricians; Solar Photovoltaic Installers
Professional Services	Engineers; Managers; Financial Analysts; Consultants; Computer Programmers
Manufacturing	Assemblers and Fabricators; Welders; First-Line Supervisors of Production and Operating Workers; Metal and Plastic Workers
Wholesale Trade	Sales Representatives (Wholesale and Manufacturing); First-Line Supervisors of Sales Workers
Utilities	Power Plant Operators; Power Distributors and Dispatchers; Electrical Power-Line Installers and Repairers
Agriculture	Farmworkers and Laborers; Agricultural Equipment Operators; First-Line Supervisors of Farming and Forestry Workers
Other Services	Automotive Service Technicians and Mechanics; Automotive Body and Related Repairers

[20] It should be noted that these are only a sample of the most common jobs found in each industry sector. However, because an industry sector's staffing patterns covers many different occupational groups, there could also be sales workers and customer service representatives in the construction industry or electricians, installers, and repairers in the utilities industry.

In the Alliance states, about four in ten clean energy workers (43 percent) were in the construction trades; this industry—which includes residential and industrial building construction, utility system construction, and building contractors—accounted for 925,426 clean energy jobs as of the last quarter of 2019. Specific occupations that conduct clean energy-related construction work include carpenters, electricians, welders, insulation and weatherization workers, HVAC workers, or installation, maintenance, and repair technicians. The prevalence of clean energy construction jobs in the Alliance states indicates that much of the clean energy activity in these regions is focused on deployment and installation of clean energy technologies as opposed to, for example, wholesale trade and distribution or manufacturing. The energy efficiency sector in particular is largely comprised of construction workers. In fact, the Alliance states have strong building and appliance efficiency standards and policies.

Following construction, just under a quarter of the Alliance states' clean energy labor force was engaged in professional service occupations (23 percent), including engineering, finance, accounting, research and analytics, or legal support. Manufacturing accounted for about 16 percent of jobs, or roughly 346,220 workers. Pennsylvania, which just joined the U.S. Climate Alliance in 2019, already had a significant number of ENERGY STAR product manufacturing plants. As of 2017, the state was home to 81 manufacturers of ENERGY STAR-certified products and 83 companies building ENERGY STAR-certified homes, three of which were committed to building 100 percent ENERGY STAR-certified homes.[21] Additionally, California is home to the Tesla electric vehicle manufacturing plant, as well as Tesla Gigafactories in both Nevada and New York manufacturing battery storage and solar modules.[22]

The remainder of clean energy jobs in the Alliance states are found across wholesale trade[23], utilities, agriculture, and forestry[24], and other services.[25] For specific information on how clean energy value chain activity varies by technology sectors such as energy efficiency or clean energy generation, please refer to the Clean Energy Sector Employment section of this report.

[21] Pennsylvania ENERGY STAR Fact Sheet, April 2017. Accessed April 2020. https://www.energystar.gov/sites/default/files/asset/document/Pennsylvania_2017.pdf.

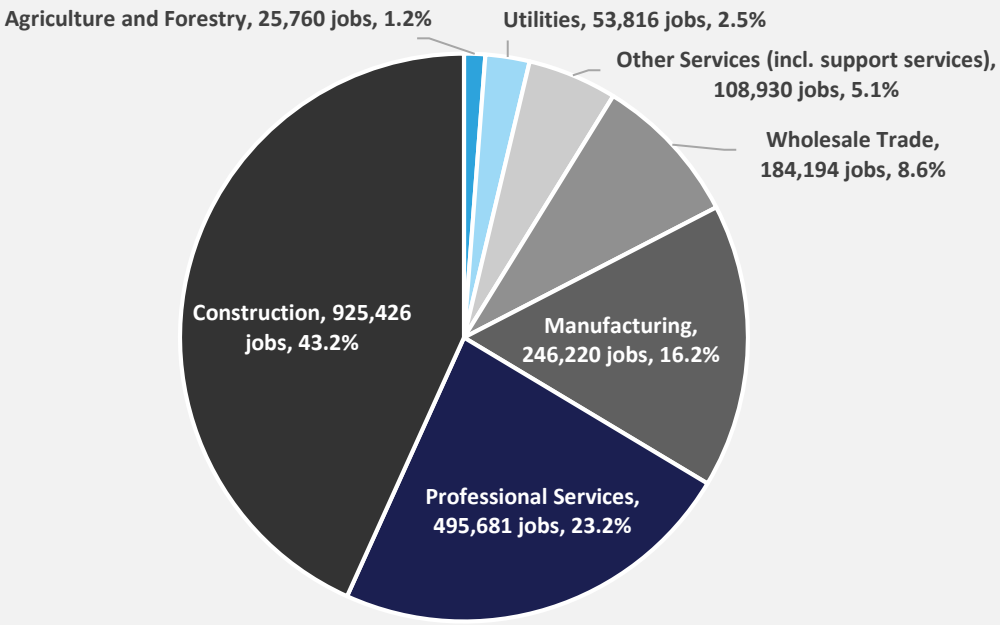
[22] https://www.tesla.com/gigafactory2

[23] The sales and distribution of clean energy goods to retailers; industrial, commercial, or institutional organizations; or other wholesalers. This explicitly excludes direct retail sales to consumers.

[24] Agriculture and forestry workers include those individuals that are engaged in the harvesting of clean fuels such as woody biomass or corn ethanol.

[25] Other services are mostly comprised of automotive repair and maintenance, but also includes business, professional, labor, political, and similar organizations such as social advocacy organizations, business associations, labor unions, or political organizations.

FIGURE 7. ALLIANCE STATES' CLEAN ENERGY EMPLOYMENT BY VALUE CHAIN, 2019



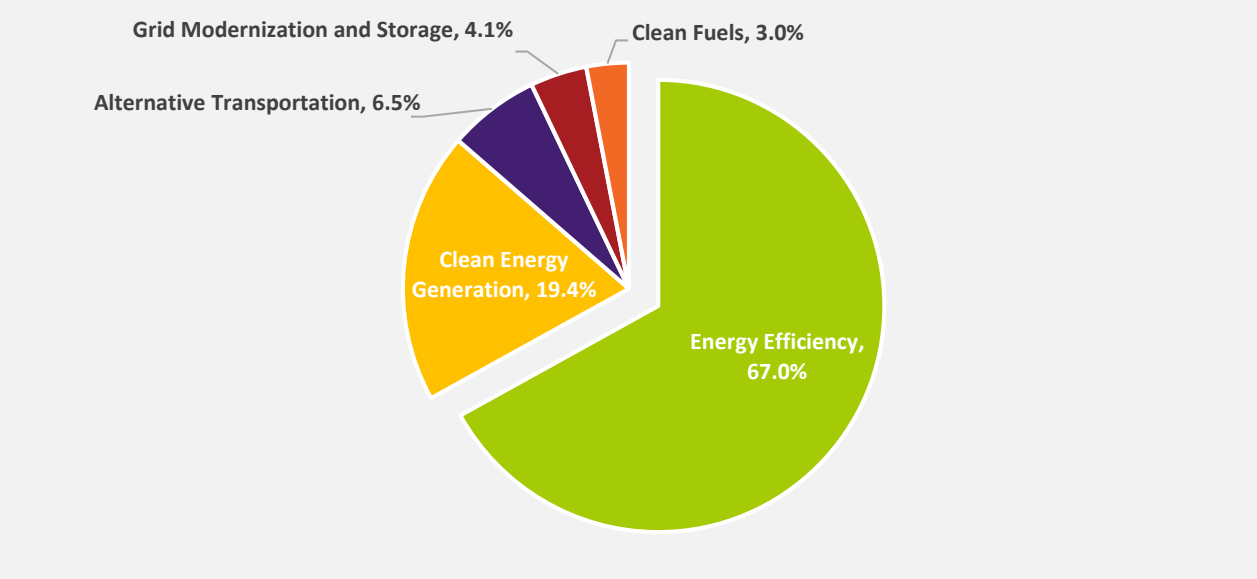
Clean Energy Technology Sector Employment

ENERGY EFFICIENCY

Energy efficiency is an important component of GHG emissions reductions and is also one of the fastest growing segments of the clean energy labor market in the Alliance states. According to the American Council for an Energy-Efficient Economy (ACEEE), energy efficiency could reduce energy-related carbon emissions in the United States by as much as 57 percent by 2050, and these low-cost measures would generate overall energy savings worth more than $700 million over the next three decades.[26]

Collectively, the Alliance states accounted for 17 of the top 20 ranked states by the ACEEE in 2019 and 70 percent of nationwide investments in utility-driven energy efficiency improvements in 2018.[27] Across the Alliance states, the energy efficiency sector was the largest component of clean energy jobs at the end of 2019. In total, the energy efficiency workforce accounted for 67 percent of all clean energy jobs in the Alliance states—over 1.43 million workers. Energy efficiency firms also exhibited the highest absolute growth since 2016, adding about 109,300 new jobs, for an overall growth rate of just over eight percent in three years.

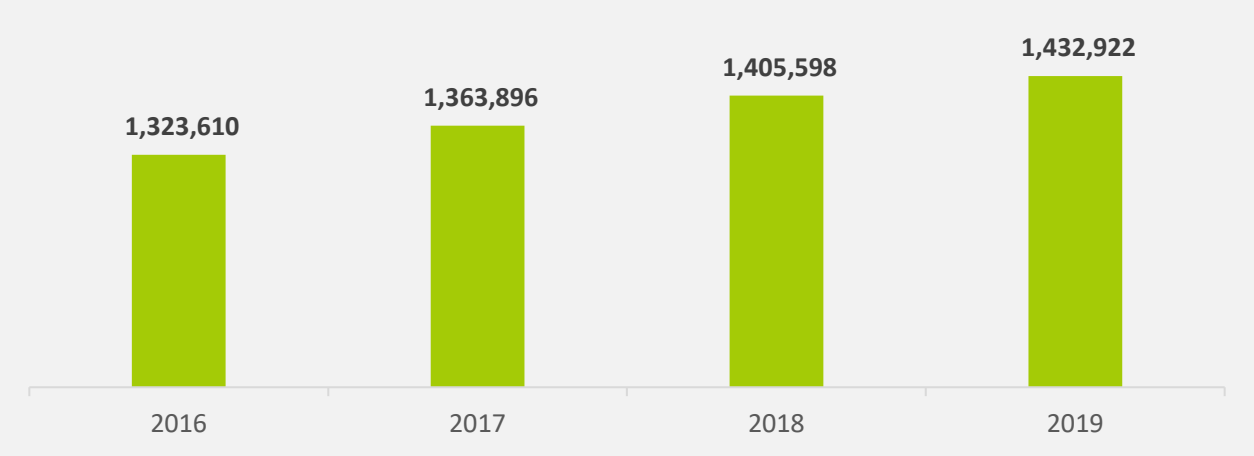
FIGURE 8. ENERGY EFFICIENCY PROPORTION OF CLEAN ENERGY JOBS, 2019



[26] Nadel, Steven and Lowell Ungar. Halfway There: Energy Efficiency Can Cut Energy Use and Greenhouse Gas Emissions in Half by 2050. ACEEE. September 2019.

[27] United States Climate Alliance, 2019 Annual Report. Ranking developed by the American Council for an Energy-Efficient Economy (ACEEE) 2019 Scorecard. Investments data from the U.S. Energy Information Agency, Annual Electric Power Industry Report.

FIGURE 9. ALLIANCE STATE TOTAL ENERGY EFFICIENCY EMPLOYMENT, 2016-2019



Alliance states such as California and Washington have implemented aggressive energy efficiency goals for all new building construction as well as large commercial buildings. Other Alliance states are similarly leading the way with energy efficiency programs that have set energy efficiency resource standards for utilities, targets for the improved efficiency of government buildings, energy and water appliance standards, energy retrofits for low-income housing, and electric utility waste reductions.

Energy efficiency upgrades, installations, and retrofits also tend to be a job creator, as much of energy efficiency work is concentrated in the construction industry—a more labor-intensive industry compared to manufacturing, for example.[28] In other words, more workers are typically required to complete an energy efficiency construction project, like the weatherization of a home or retrofit of an entire building, compared to the manufacture of an ENERGY STAR product. Such energy efficiency upgrades, particularly related to indoor air and temperature quality, will be of particular importance given the current realities of COVID-19 and related stay-at-home orders and behaviors, as many studies suggest that building air quality and temperature directly impact both individual health and student learning outcomes.[29]

Across the Alliance states, energy efficiency construction accounted for over half (52 percent) of all energy efficiency jobs, or 743,163 workers at the end of 2019 (see Figure 11). The abundance of energy efficiency construction jobs suggested that the majority of energy efficiency activity in the Alliance states is concentrated in the deployment of energy-efficient technologies and services.

Overall, energy efficiency workers in the Alliance states were more likely to spend their labor hours working with heating, ventilation, and air conditioning (HVAC) systems, efficient lighting technologies, and ENERGY STAR appliances (see Figure 10). Traditional HVAC was the largest sub-sector at the end of 2019; these jobs comprised

[28] American Council for an Energy-Efficient Economy. How Does Energy Efficiency Create Jobs? November 2011. https://www.aceee.org/files/pdf/fact-sheet/ee-job-creation.pdf

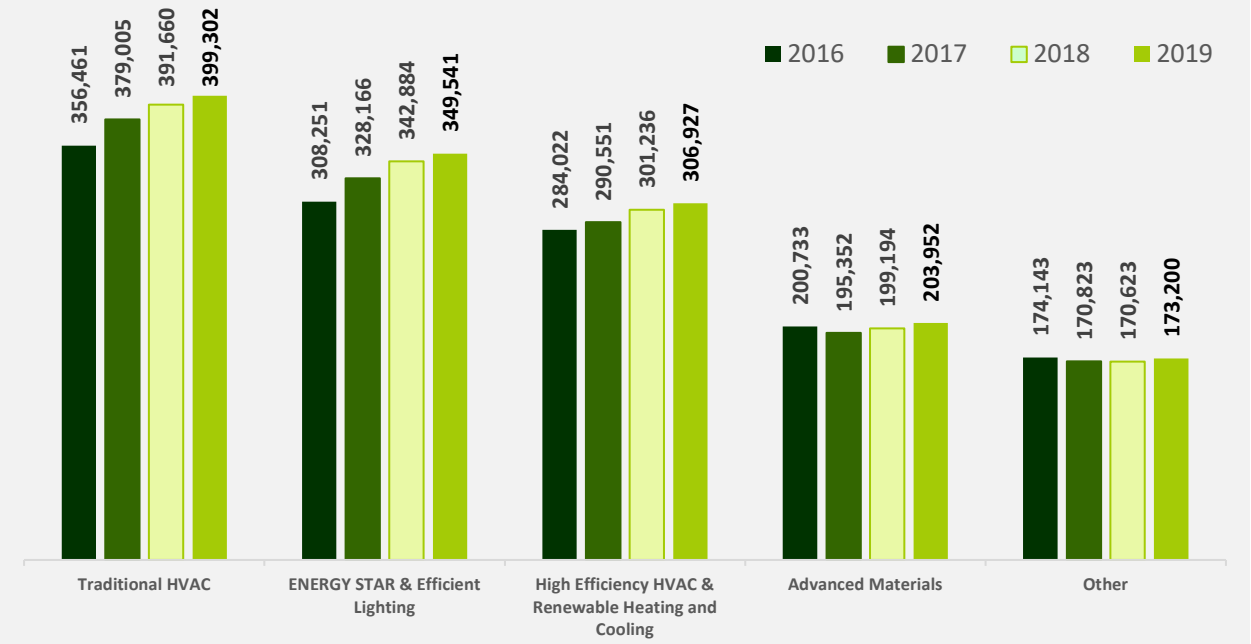
[29] *See generally:* https://hechingerreport.org/the-learning-effect-of-air-quality-in-classrooms/; https://www.epa.gov/iaq-schools/indoor-air-quality-high-performance-schools; https://www.epa.gov/report-environment/indoor-air-quality; https://www.neefusa.org/health/asthma/national-public-health-week-health-impacts-indoor-air-quality

about 28 percent of all energy efficiency workers. In total, there were 399,302 traditional HVAC workers across the Alliance states, and this workforce grew by 12 percent, or about 42,800 workers, between 2016 and 2019.

Following traditional HVAC, ENERGY STAR and efficient lighting technologies employed the second largest number of workers within the energy efficiency sector; these technologies accounted for just under a quarter (24 percent) of the energy efficiency labor force and grew by just over 13 percent or 41,300 workers from 2016 through 2019. The high efficiency HVAC and renewable heating and cooling sub-sector accounted for about 21 percent of the energy efficiency labor market and grew by eight percent, or 22,900 workers in three years. The remaining two sectors—advanced materials and other energy-efficient technologies[30]—together constituted just over a quarter (26 percent) of energy efficiency jobs.

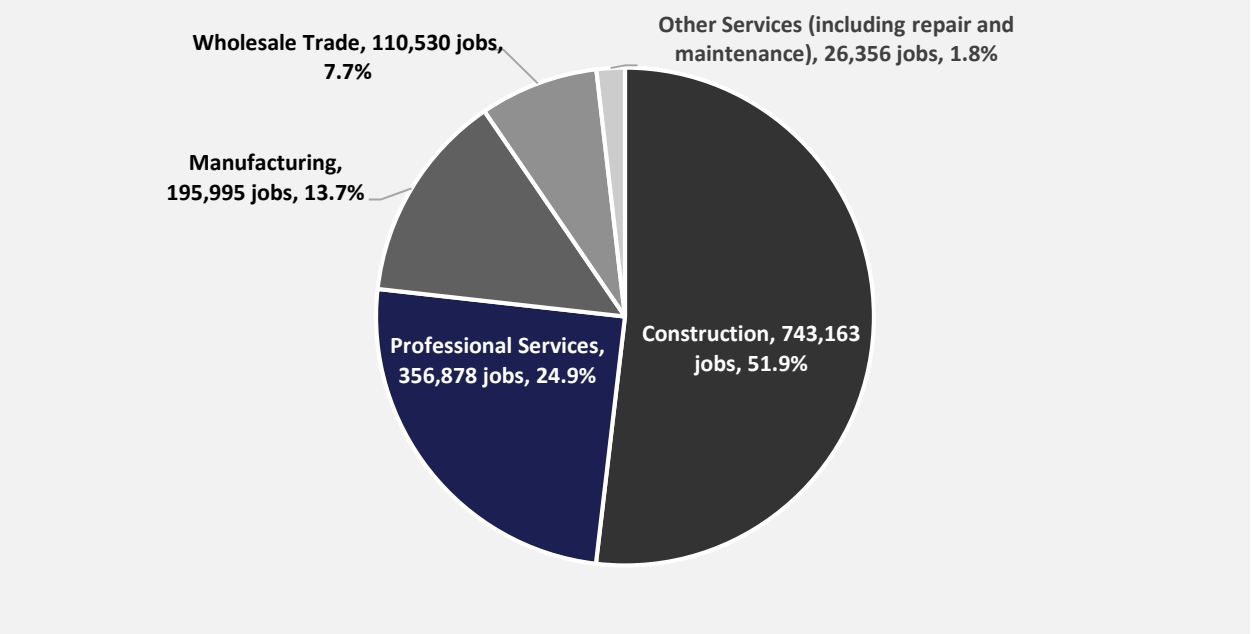
It is important to note the difference between traditional HVAC and high efficiency HVAC workers. Energy efficiency workers fall within the traditional HVAC category if they spent most of their labor hours installing or servicing traditional and non-efficient HVAC technologies, but also spent at least a portion—though less than a majority—of their time on efficient HVAC goods and services. Conversely, an individual would be counted as a high-efficiency HVAC worker if they spent the majority of their labor hours working with efficient HVAC technologies and the remainder, if any at all, on traditional HVAC technologies.

FIGURE 10. ALLIANCE STATE ENERGY EFFICIENCY EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2019



[30] Other energy efficiency includes variable speed pumps, other design services, consulting, software, policy, and non-profit work not specific to a detailed technology as well as energy auditing, rating, monitoring, metering, and leak detection, LEED certification, and phase-change materials.

FIGURE 11. ALLIANCE STATE ENERGY EFFICIENCY EMPLOYMENT BY VALUE CHAIN, 2019



CLEAN ENERGY GENERATION

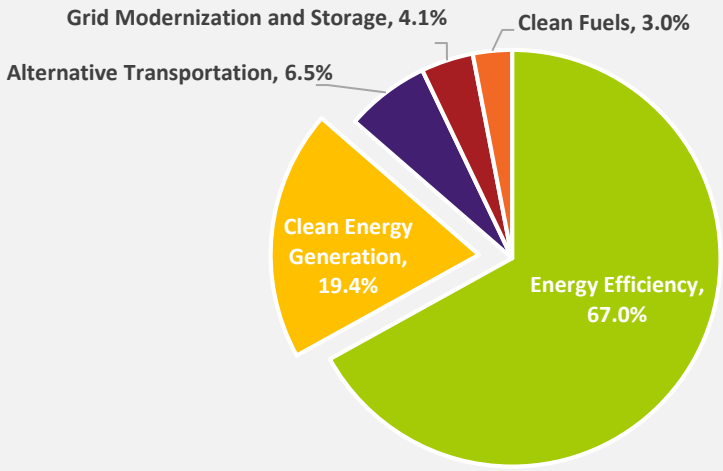
The Alliance states exhibit strong commitments to achieving zero-carbon electricity production. Over the last two decades, electricity generation across the Alliance states has been shifting away from coal and towards renewable electricity. Between 2000 and 2018, coal generation in the Alliance states declined by 51 percent[31], compared to a 37 percent decline for non-Alliance states. At the same time, renewable generation capacity from wind, solar, biomass, landfill gas/municipal solid waste, and geothermal resources grew by 457 percent between 2005 and 2018—an increase of 56 gigawatts (GW).[32] States like Hawaii, California, Puerto Rico, New Mexico, Washington, Virginia, and New York have all passed legislation requiring 100 percent carbon-free electric power generation by no later than 2050, and many other states have adopted 100 percent zero-carbon electricity goals.[33] Alliance states are also initiating large scale procurements of renewable energy and investing in grid modernization.

[31] U.S. Energy Information Administration. Detailed State Data. Net Generation by State by Type of Producer by Energy Source. Latest Revision March 2020. Data Accessed April 2020.

[32] A gigawatt is a unit of power equal to one billion watts. Data sourced from the U.S. Energy Information Administration and the United States Climate Alliance 2019 Annual Report.

[33] United States Climate Alliance, 2020 Annual Report: https://www.usclimatealliance.org/annual-report.

FIGURE 12. CLEAN ENERGY GENERATION PROPORTION OF CLEAN ENERGY JOBS, 2019



In the last quarter of 2019, clean energy generation jobs accounted for 415,613 workers in the Alliance states across sub-sectors such as solar, wind, nuclear, traditional and low-impact hydropower[34], bioenergy and combined heat and power, and geothermal generation. These workers were largely found in the construction industry, which accounted for 139,609 jobs or roughly one-third of renewable energy employment (34 percent). Clean energy generation construction workers are typically engaged in solar installation and facility or turbine construction while the remainder of the workforce includes individuals that support wholesale parts distribution, equipment and parts manufacturing, or professional services such as consulting, finance, administrative, and legal support.

Clean energy generation professional services supported 99,145 jobs at the end of 2019—just under a quarter of this sector's workforce (24 percent), while the manufacturing industry supported about 15 percent of Alliance states' clean energy jobs—or 63,800 workers. Meanwhile, clean energy generation utility workers accounted for almost 13 percent of jobs at the end of 2019 (see Figure 15).

Overall, clean energy generation jobs declined by four percent from a high of almost 433,000 workers in 2016. These declines were largely the result of losses in the solar and nuclear power generation workforce, which together shed just over 37,000 jobs in three years, and to a smaller extent declines in traditional hydropower generation employment.

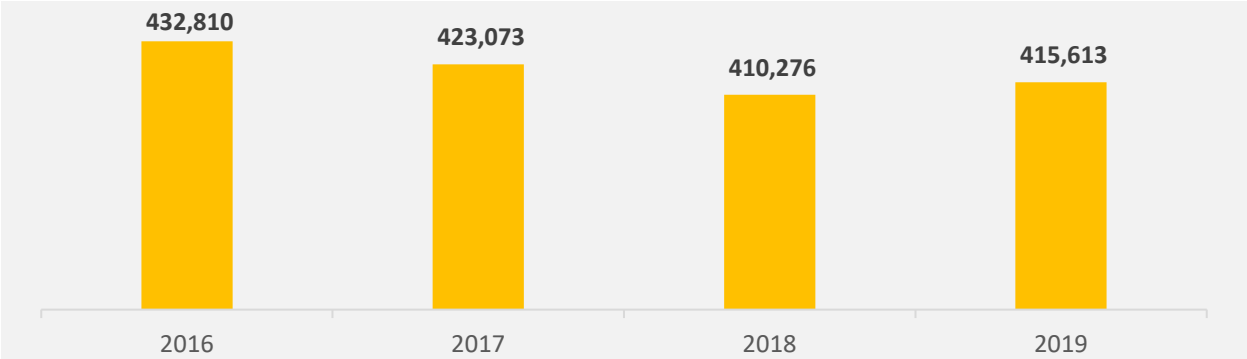
Shrinking nuclear generation employment for the Alliance states follows a long-running trend of general declines in nuclear generation capacity both nationally and within the Alliance states. Between 2005 and 2018, nuclear generation across the Alliance states declined by just over three percent[35], and few Alliance states explicitly

[34] Low-impact hydroelectric generation is similar to traditional, but certification criteria are aimed at ensuring that the certified dam adequately protects or mitigates its impacts in eight key resources areas, including river flows, water quality, fish passage and protection, watersheds, threatened and endangered species, cultural resources, and public access and recreation opportunities. The eighth criterion requires that the dam not have been recommended for removal (LIHI – Low Impact Hydropower Institute).

[35] U.S. Energy Information Administration. Form EIA860, Released September 2019.

incentivize nuclear power generation. Since 2016, the nuclear electric power generation sub-sector shed just over 4,000 jobs across the Alliance states, a decline of nearly 11 percent in three years. At the same time, job losses in the traditional hydropower sub-sector amounted to 959 jobs in three years—a three percent decline between 2016 and 2019. However, alongside losses in traditional hydropower, low-impact hydropower jobs grew by 37 percent, or 2,103 jobs.

FIGURE 13. ALLIANCE STATE TOTAL CLEAN ENERGY GENERATION EMPLOYMENT, 2016-2019



Solar jobs were the largest component of the clean energy generation workforce across the Alliance states, with particularly high concentrations of workers in California, Massachusetts, New York, Nevada, North Carolina, and Colorado. Across all 24 states, there were a total of 254,172 solar jobs in 2019. California in particular has been a long-time leader of the national solar market. Since 2006, the California Solar Initiative has contributed $3.3 billion in rooftop solar investments, incentivizing the development of almost 1,900 megawatts of solar capacity across the state. North Carolina is second in the nation in terms of installed solar capacity and the state has been working to double this capacity over the last several years. Similarly, Massachusetts continues to ramp up solar energy deployment through its Solar Massachusetts Renewable Target (SMART) program. To date, the state has enough solar installed to power 489,397 homes.[36] At the same time, New York's solar generation capacity has grown by more than 1,200 percent since 2012 with a cumulative six gigawatts of solar required by 2025.[37] In total, as of 2018, the Alliance states accounted for 70 percent of total nationwide solar capacity.[38]

Due in large part to the maturation of solar markets, increased installation efficiency has resulted in fewer workers per installed megawatt. At the same time, the shift away from direct door-to-door residential sales campaigns to retail and online sales for large companies like Tesla (formerly SolarCity) has additionally led to some declines in the solar jobs. While solar capacity was increasing prior to COVID-19, solar jobs declined by 33,000 workers in the Alliance states—roughly 12 percent in three years. Between 2018 and 2019 however, solar jobs in the Alliance states rebounded from 251,530 workers to 254,172 workers, an increase of 2,642 jobs or about one percent in 12 months. This mirrors the overall nationwide solar employment trends; between 2016 and 2019, solar jobs declined by 7.6

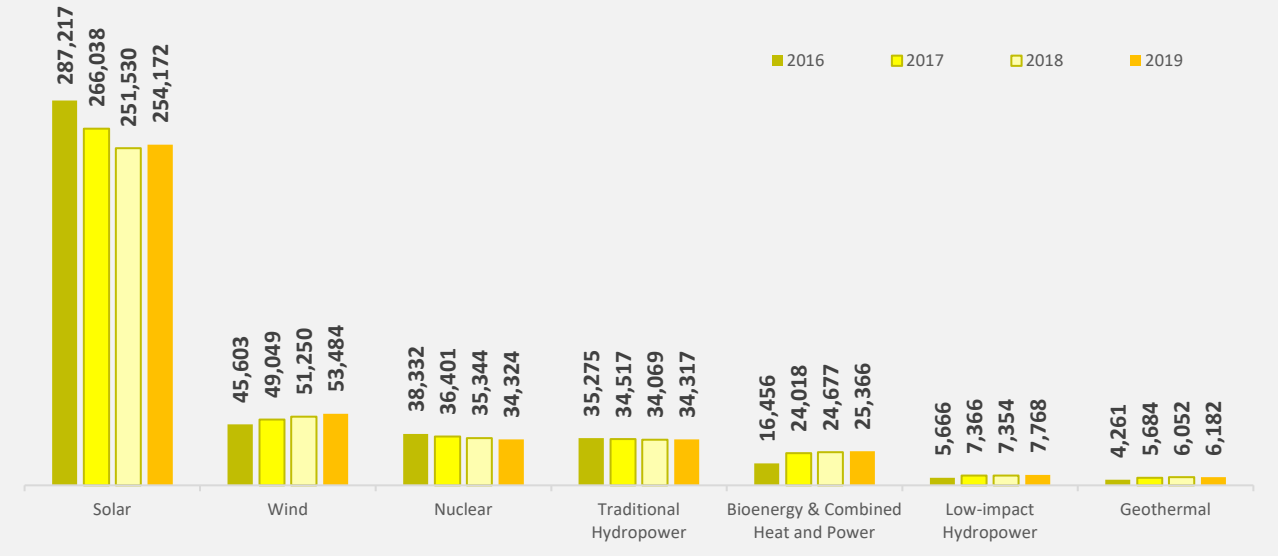
[36] Solar Energy Industries Association: https://www.seia.org/state-solar-policy/massachusetts-solar.
[37] New York Statewide Solar Projects: https://www.nyserda.ny.gov/All-Programs/Programs/NY-Sun/Solar-Data-Maps/Statewide-Projects.
[38] United States Climate Alliance, 2019 Annual Report.

percent across the United States but saw a three percent growth rate between 2018 and 2019. Of the 24 Alliance states, 14 states saw declines in solar jobs from 2016 through 2019.[39] Declines in the solar workforce may be attributed to shifting business models, as many solar companies have moved away from door-to-door sales. Of the remaining Alliance states that witnessed solar jobs grow over this time period, Minnesota and Illinois had the greatest absolute growth in jobs with the addition of a respective 1,127 and 592 solar workers.

Though solar jobs represented the majority of the clean energy generation sector in the Alliance states at the end of 2019, bioenergy and wind energy generation also created many jobs between 2016 and 2019. Wind generation employment grew by about 17 percent between 2016 and 2019, adding another 7,881 jobs to the clean energy labor force. In fact, the Alliance states accounted for 60 percent of all new wind jobs in the country over these three years. Bioenergy and combined heat and power created just over 8,900 new jobs since 2016, for a growth rate of 54 percent. This job growth comes alongside state-level policies to support the inclusion of biomass and offshore wind power in renewable energy portfolios. California, for instance, has six pilot projects running that inject biomethane from dairy digesters into the state's natural gas pipelines and eight out of the 24 Alliance states have policies specific to offshore wind energy procurement.[40] Accordingly, between 2005 and 2018, the Alliance states saw respective increases in wind and biomass generation capacity.[41]

While geothermal energy generation accounted for just under two percent of total clean energy generation jobs in the Alliance states, the sub-sector grew by just over 1,900 workers in three years—a growth rate of 45 percent. As of the last quarter of 2019, there were almost 6,200 geothermal energy generation workers in the Alliance states. Currently, five Alliance states have geothermal-specific incentives, including Delaware, Michigan, Montana, New Mexico, and Pennsylvania.[42]

FIGURE 14. ALLIANCE CLEAN ENERGY GENERATION EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2019



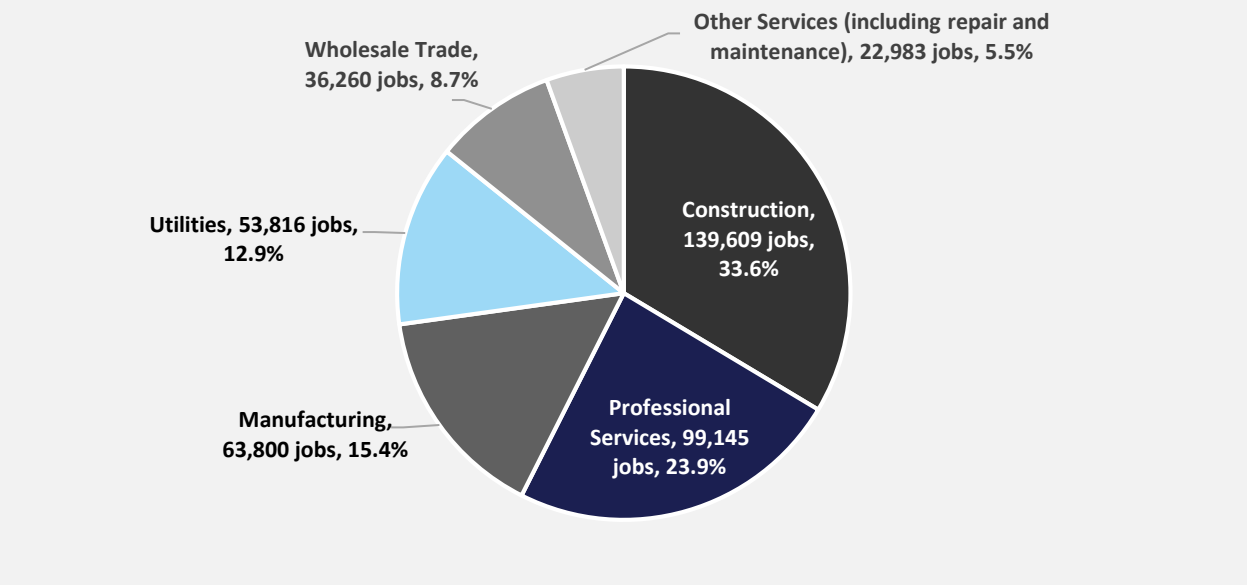
[39] The following states so an increase in solar jobs from 2016 through 2019: Montana, Minnesota, Delaware, Illinois, Pennsylvania, Virginia, Colorado, Maine, New York, and New Jersey.

[40] United States Climate Alliance, 2019 State Factsheets.

[41] United States Climate Alliance, 2019 Annual Report.

[42] *Id.*

FIGURE 15. ALLIANCE CLEAN ENERGY GENERATION EMPLOYMENT BY VALUE CHAIN, 2019



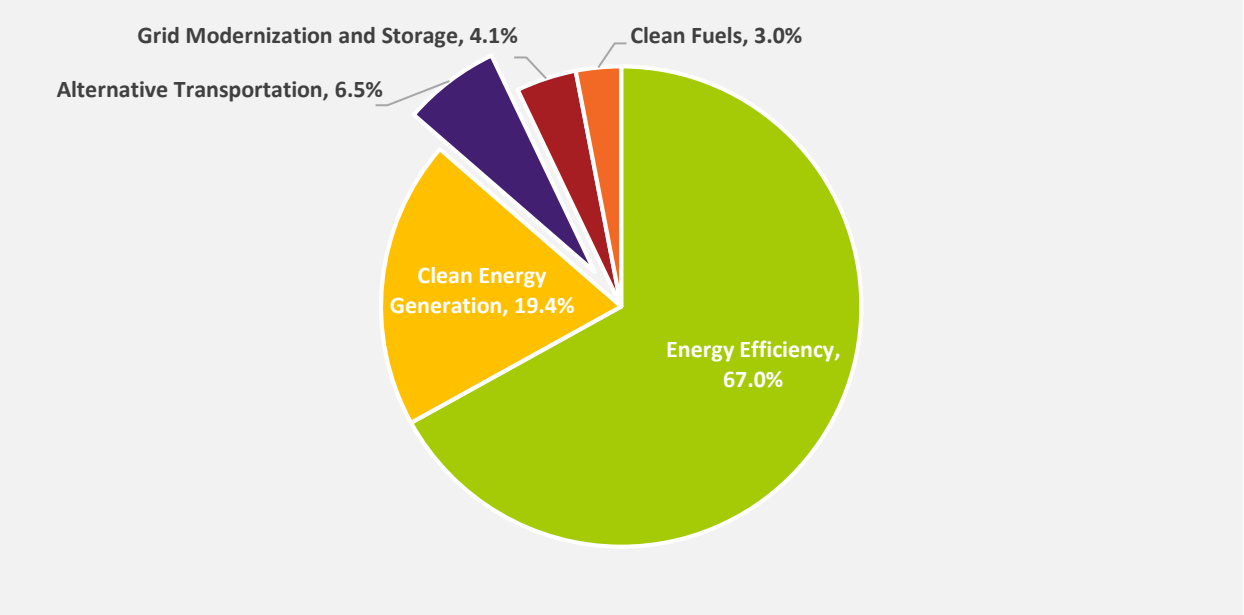
ALTERNATIVE TRANSPORTATION

As of 2017, the transportation sector accounted for 28.9 percent of domestic GHG emissions—the largest source of GHG emissions in the United States. Since 2000, nationwide transportation emissions declined by less than two percent, making the transportation sector a significant and important area to tackle as the Alliance states aim to reduce their GHG emissions.[43]

Overall, there have been steady gains in decarbonizing the U.S. transportation fleet, as annual hybrid and plug-in electric vehicle sales have skyrocketed over the last decade. In 2019, total hybrid electric vehicle sales were 50 percent higher compared to 2011, while plug-in electric vehicle sales increased six-fold.[44] The Alliance states alone accounted for just over 80 percent of all battery electric, plug-in hybrid, and fuel cell vehicles sold across the country in 2018. Alliance states are committed to putting more zero-emission vehicles (ZEVs) on their roads. Fifteen states have already adopted, or are in the process of adopting, light-duty ZEV regulations, and in July 2020, 15 Alliance states and the District of Columbia announced a joint MOU to collaborate on the creation of a self-sustaining, zero-emission medium- and heavy-duty vehicle (MHDV) market.[45]

[43] U.S. Energy Information Administration.
[44] U.S. Department of Energy. Alternative Fuels Data Center. Data accessed 10 March 2020.
[45] United States Climate Alliance, 2020 Annual Report: https://www.usclimatealliance.org/annual-report.

FIGURE 16. ALTERNATIVE TRANSPORTATION PROPORTION OF CLEAN ENERGY JOBS, 2019



Alternative transportation was the third largest clean energy job sector in the Alliance states. At the end of 2019, this sector accounted for almost seven percent of total clean energy employment. Altogether, these firms employed 139,711 workers[46] across the Alliance states, and jobs in this sector grew by about 18 percent between 2016 and 2019, or an additional 20,841 workers. Four in ten alternative transportation workers in the Alliance states were focused on automotive repair and maintenance, including general automotive repair, automotive exhaust system and transmission repair, and other automotive mechanical and electrical repair and maintenance (see "other services" in Figure 19).[47] The wholesale trade of alternative transportation vehicles and alternative transportation parts and supplies supported almost 23,000 jobs in the Alliance states, or 16 percent of the alternative transportation workforce, while professional services represented a small portion of jobs—just over three percent or 4,560 workers.

Alternative transportation manufacturing was a significant area of activity in the Alliance states. In fact, four in ten alternative transportation jobs were found in the manufacturing industry; this roughly equated to almost 56,000 workers. Examples of manufacturing jobs for the alternative transportation sector include assemblers, machine tool operators, machinists, and industrial production managers. These are typically highly-skilled individuals, as electric vehicle systems tend to be more complex than traditional internal combustion engines. It is likely that

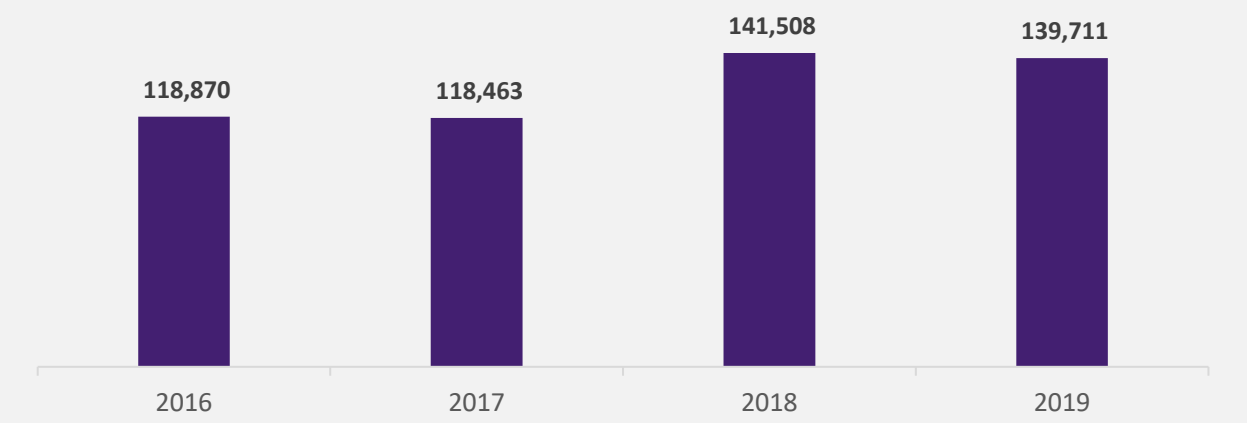
[46] Automotive retail employment such as car salesmen and car dealerships are excluded from alternative vehicle employment estimates.

[47] "Other services" is largely comprised of automotive repair and maintenance (NAICS 8111), though it can also include business, professional, labor, political, and similar organizations. The high employment total for other services is common in the alternative transportation sector, as much of the employment, outside of vehicle manufacturing and to a lesser extent wholesale trade, is concentrated in the repair and maintenance of alternative transportation vehicles.

alternative transportation manufacturing is a significant area of activity for the Alliance states as these jobs tend to be found around traditional centers of automotive manufacturing such as around the Great Lakes and the Midwest. Michigan, in particular, has a large concentration of automobile manufacturing plants and California's Tesla factory in Fremont is a significant manufacturer of electric vehicles.[48]

Indeed, the Alliance states are aware that increased deployment of ZEVs must go hand-in-hand with improved infrastructure. Because of this, Alliance states have allocated millions of dollars in funding towards electrification and transportation infrastructure improvements across their cities and towns. As of 2018, 13 Alliance states have installed about 15 percent of the public charging infrastructure necessary to support the number of plug-in electric vehicles required to meet Paris Agreement targets by 2025.[49]

FIGURE 17. ALLIANCE STATE TOTAL ALTERNATIVE TRANSPORTATION EMPLOYMENT, 2016-2019



At the end of 2019, the largest component of the alternative transportation sector was hybrid electric vehicles; this sub-sector employed just over 55,000 workers at the end of 2019. Hybrid electric vehicle companies grew their workforce by about 15 percent—or 7,273 jobs—between 2016 and 2019. Electrical vehicle companies were the second largest employer; these companies grew by 22 percent, or 8,721 additional workers from 2016 through 2019. Plug-in hybrid vehicles were also a large component of the alternative transportation sector. Companies working with this sub-technology accounted for just over 25,000 workers—a growth rate of just over 29 percent between 2016 and 2019, or roughly 5,700 new workers in three years.

The remaining alternative transportation sectors—natural gas vehicles and hydrogen and fuel cell vehicles—accounted for eight percent of the alternative transportation labor force and have either declined or grown marginally, resulting in a net loss of 850 jobs from 2016 through 2019.

[48] Hamilton, James. U.S. Bureau of Labor Statistics. Careers in Electric Vehicles. Accessed April 2020. https://www.bls.gov/green/electric_vehicles/

[49] United States Climate Alliance, 2019 Annual Report.

FIGURE 18. ALLIANCE STATE ALTERNATIVE TRANSPORTATION EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2019

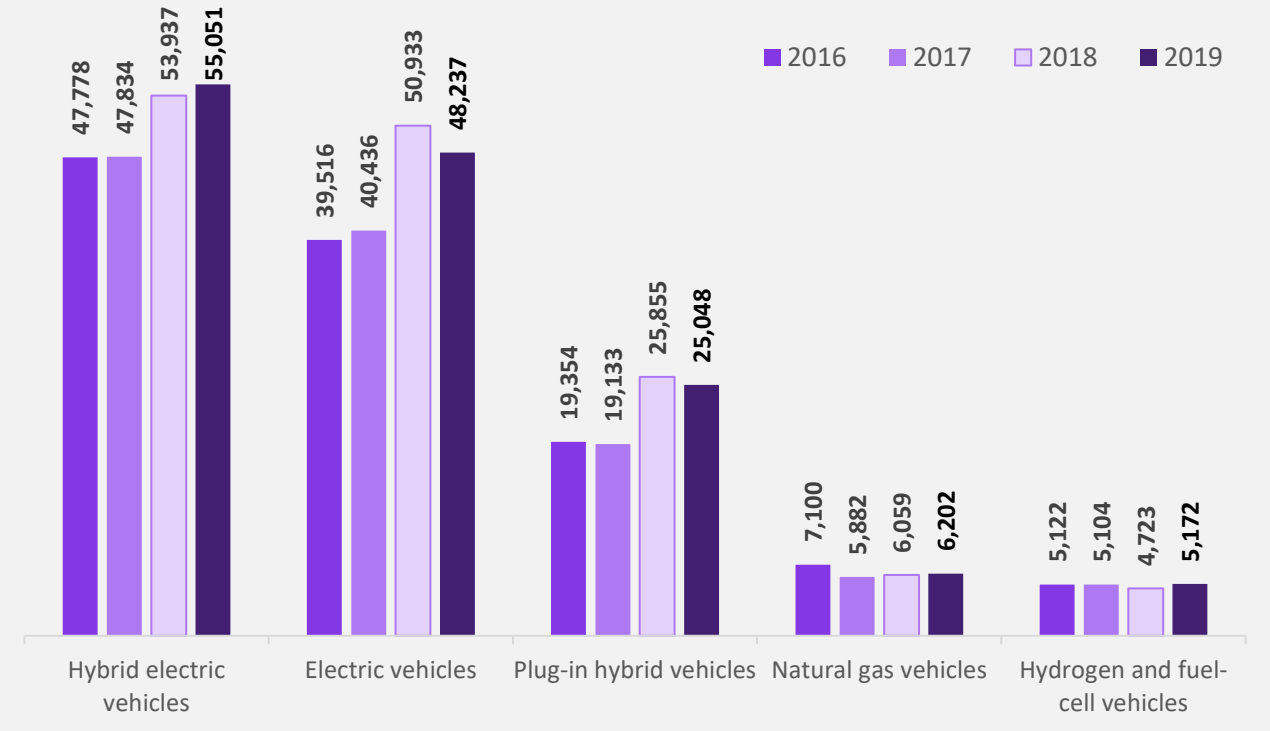
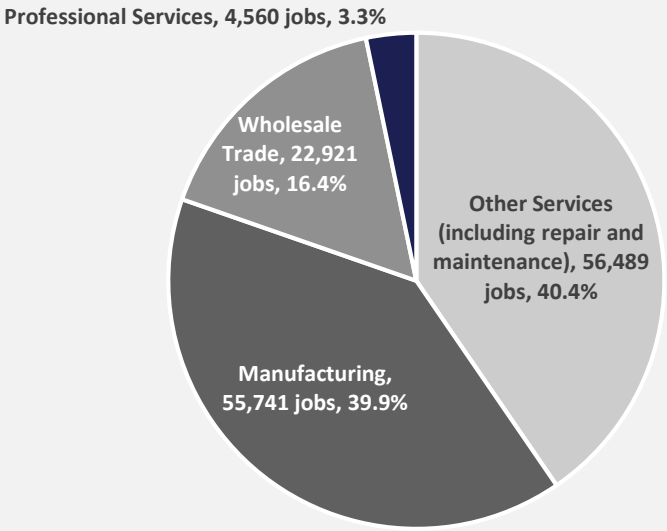


FIGURE 19. ALLIANCE STATE ALTERNATIVE TRANSPORTATION EMPLOYMENT BY VALUE CHAIN, 2019

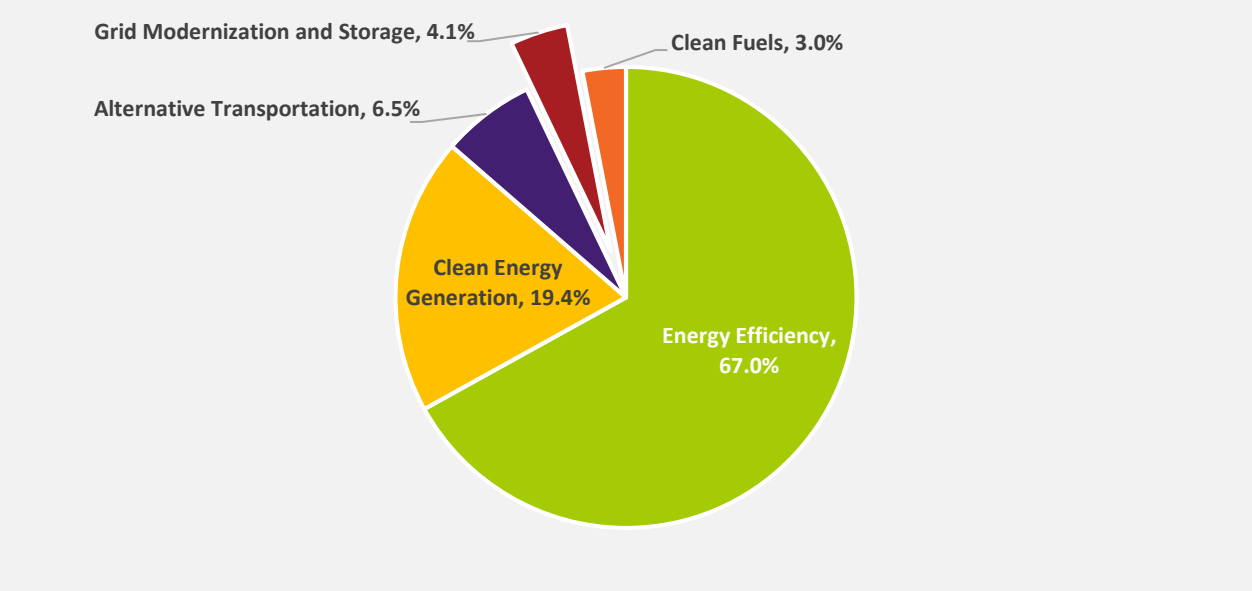


GRID MODERNIZATION AND STORAGE

New smart grid and microgrid capabilities are modernizing America's energy infrastructure, improving resiliency, consumption management, building controls, waste reduction, and storage capacities.[50] The importance of grid modernization is also connected to the more dynamic needs of a cleaner, more distributed electricity generation mix.

States across the country are pursuing a number of grid modernization activities, like policy adoption, utility reform, deployment, research and development. According to the N.C. Clean Energy Technology Center, Alliance states (California, Colorado, Hawaii, Minnesota, New York, North Carolina, and Virginia) represented seven out of the top 10 states most actively modernizing their grids as of 2019.[51] At the same time, New Jersey and Puerto Rico are developing microgrids to improve their grid resiliency, while Washington has invested $10.6 million in grid modernization funding.[52]

FIGURE 20. GRID MODERNIZATION AND STORAGE PROPORTION OF CLEAN ENERGY JOBS, 2019



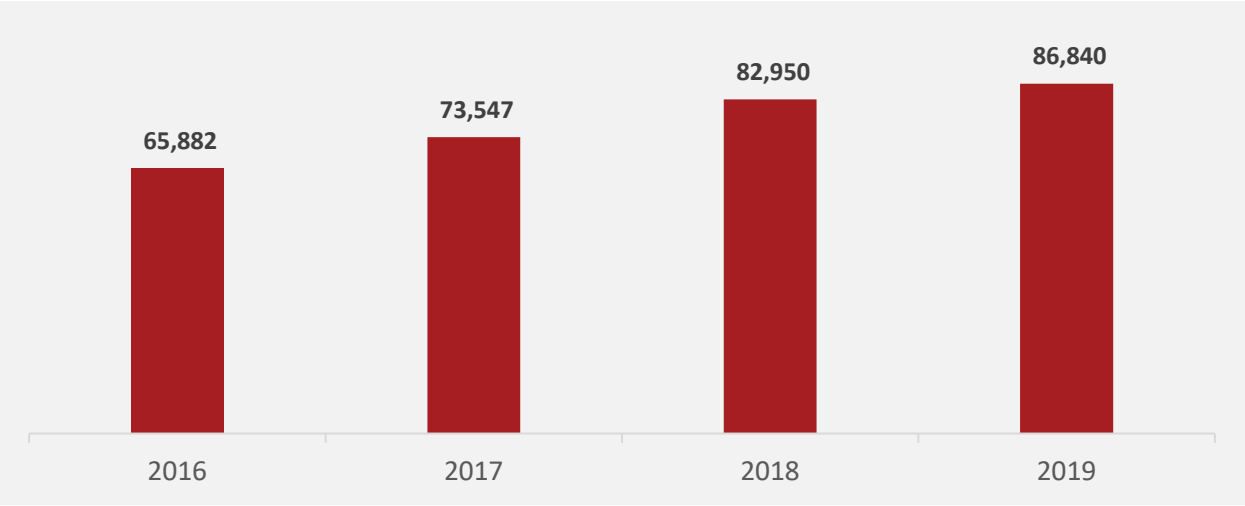
[50] *See generally:* U.S. Department of Energy, Office of Electricity Delivery and Energy Reliability.
[51] NC Clean Energy Technology Center. 50 States of Grid Modernization, Q1 2019 Quarterly Report, May 2019.
[52] United States Climate Alliance, 2019 State Factsheets.

As Alliance states move towards 100 percent renewable energy generation capacity, there may also be an increased need for energy storage capabilities. The Alliance states host 13 of the 18 operating battery energy storage sites with an installed power capacity of roughly 20 MW or greater across the nation. In fact, the Alliance states accounted for 65 percent of all operating energy storage capacity at the end of 2018.[53]

Grid modernization and storage firms represented 86,840 clean energy workers at the end of 2019. Between 2016 and 2019, this clean energy sector grew by 31.8 percent, or nearly 21,000 additional workers. As with clean energy generation and energy efficiency, much of employment for grid modernization and storage firms was found in construction, professional services, and manufacturing. Construction firms accounted for almost half of the Alliance states' grid modernization and storage workers—roughly 42,700 jobs—followed by professional services with about 24 percent of jobs and manufacturing with almost 19 percent of employment (see Figure 23).

Storage was the largest sub-sector, accounting for about 54,000 jobs, or 62 percent of the overall grid modernization and storage sector at the end of 2019.[54] Altogether, storage jobs grew by 37 percent, creating 46,668 new jobs between 2016 and 2019. In fact, all grid modernization and storage subsectors grew over this time period, with microgrid technologies increasing employment by about 36 percent (3,300 additional jobs), while smart grid technologies experienced a 37 percent growth (2,700 additional jobs) and other grid modernization technologies grew by approximately three percent (270 jobs). A particular strength in the Alliances states' clean storage sector is Tesla's Gigafactories in Nevada and New York, which is a lithium-ion and electric vehicle subassembly factory, supplying battery packs for electric vehicles and stationary storage systems.

FIGURE 21. ALLIANCE STATE TOTAL GRID MODERNIZATION AND STORAGE EMPLOYMENT, 2016-2019



[53] United States Climate Alliance, 2019 Annual Report.

[54] Clean storage jobs encompass the following sub-technologies: pumped hydro-power storage, battery storage, mechanical storage, thermal storage, biofuels, and nuclear fuel.

FIGURE 22. ALLIANCE STATE GRID MODERNIZATION AND STORAGE EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2019

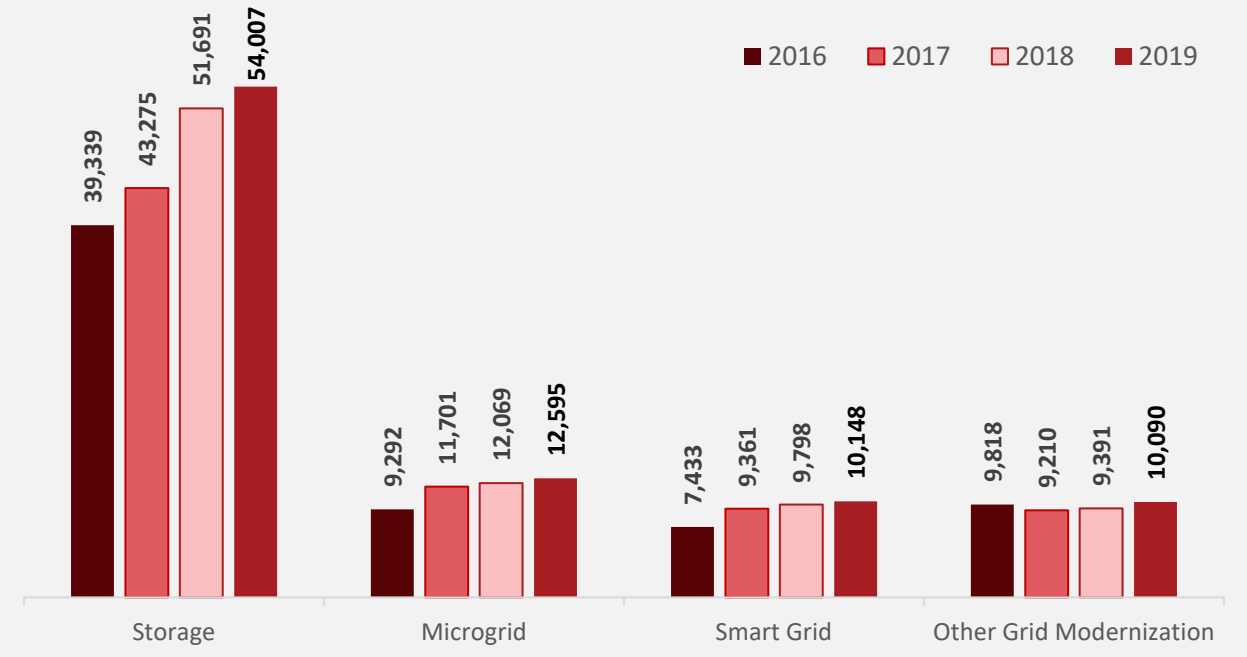
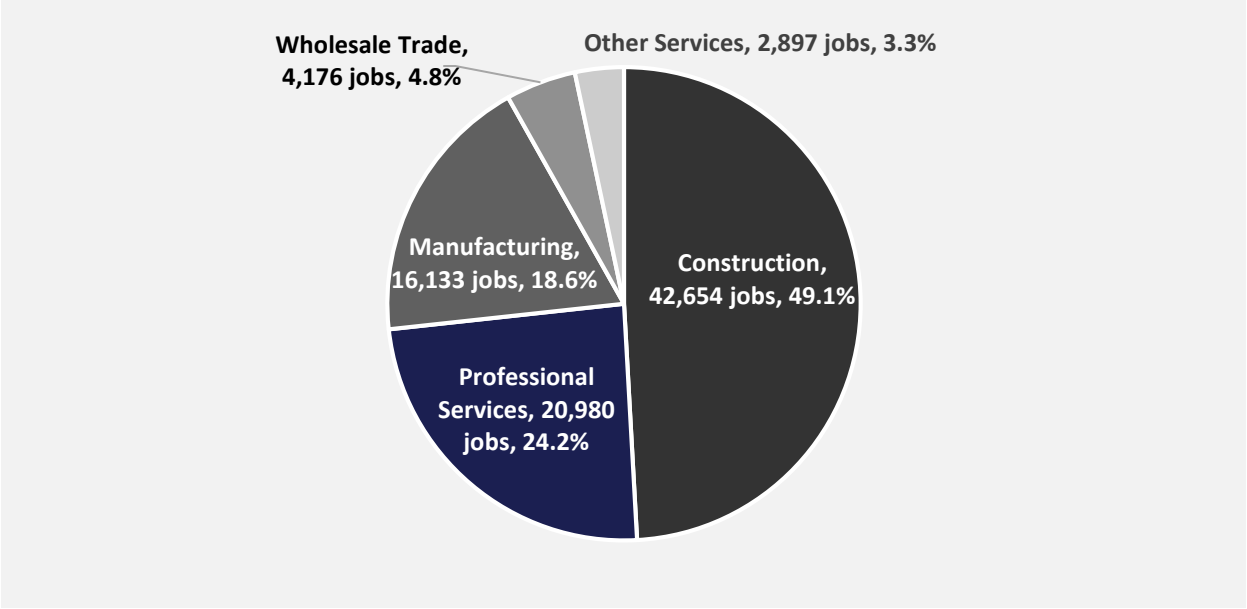


FIGURE 23. ALLIANCE STATE GRID MODERNIZATION AND STORAGE EMPLOYMENT BY VALUE CHAIN, 2019



CLEAN FUELS

With 69,941 jobs, clean fuels represented the smallest component of the Alliance states' clean energy workforce at the end of 2019—about three percent of all clean energy jobs in these states. The sector lost some jobs between 2016 and 2019, amounting to just over a one percent decline or 800 total jobs lost.

FIGURE 24. CLEAN FUELS PROPORTION OF CLEAN ENERGY JOBS, 2019

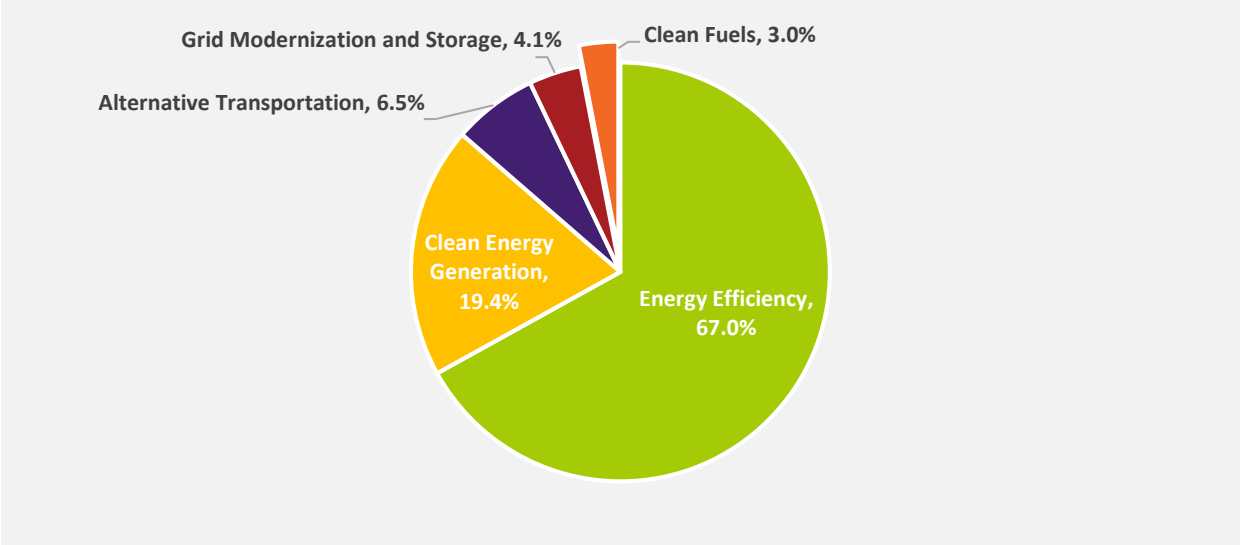
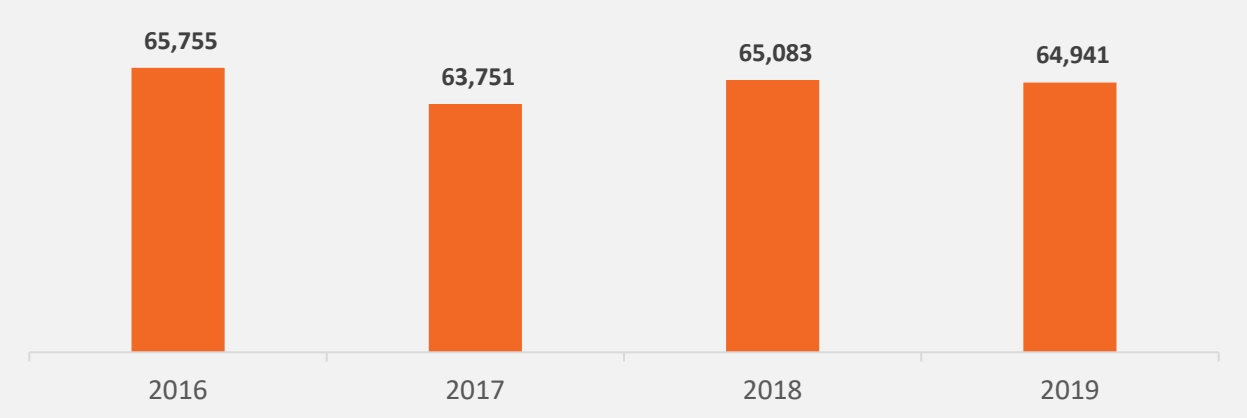


FIGURE 25. ALLIANCE STATE TOTAL CLEAN FUELS EMPLOYMENT, 2016-2019



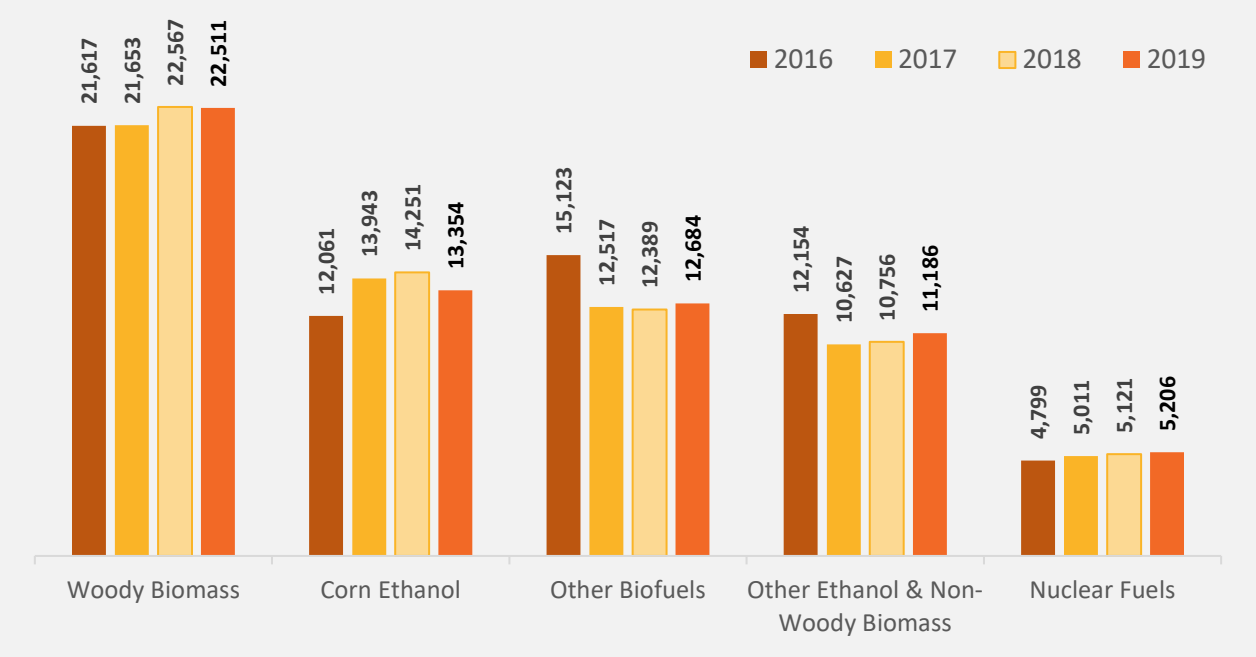
Of the top six states that accounted for more than 70 percent of national fuel ethanol production, two of them are Alliance states. As of 2018, Illinois was home to 13 ethanol plants and had the third-highest annual fuel ethanol nameplate capacity in the United States. Three-quarters of the state is farmland that provides the corn

feedstock for ethanol production. Minnesota also has 19 corn ethanol plants. Together, these two states produce 68 million barrels of fuel ethanol each year, accounting for just over a quarter of total fuel ethanol produced in the nation in 2018.[55]

Corn ethanol jobs were the second largest sub-sector within the clean fuels workforce in the Alliance states. These workers accounted for about 21 percent of total clean fuels jobs, or roughly 13,400 workers. Corn ethanol jobs in the Alliance states grew by almost 11 percent between 2016 and 2019. The largest clean fuels sub-sector in the Alliance states was woody biomass[56], which accounted for about a third of the clean fuels workforce at the end of 2019. From 2016 through 2019, woody biomass jobs grew by four percent or 894 workers.

The nuclear fuels sub-sector accounted for roughly 5,200 jobs in the Alliance states, with a growth rate of almost nine percent, or about 400 jobs, between 2016 and 2019. The remaining sub-sectors of other biofuels[57] and other ethanol or non-woody biomass[58] have shed jobs over the last three years, resulting in an overall job loss of about 3,400 workers.

FIGURE 26. ALLIANCE STATE CLEAN FUELS EMPLOYMENT BY SUB-TECHNOLOGY, 2016-2019



[55] U.S. Energy Information Administration. Six States Account for More than 70 percent of U.S. Fuel Ethanol Production. August 2018. Accessed April 2020.

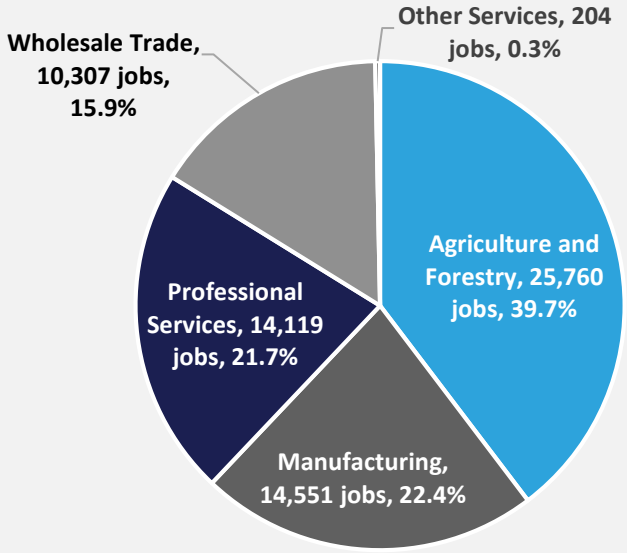
[56] Woody biomass fuels are developed from the by-product of management, restoration, and hazardous fuel reduction treatments, as well as the product of natural disasters, including trees and woody plants (limbs, tops, needles, leaves, and other woody parts, grown in a forest, woodland, or rangeland environment).

[57] Any other clean fuel that is derived directly from living matter.

[58] Includes fuels made from other materials such as straw, manure, vegetable oil, animal fats, etc.

Clean fuels strength lies in production and manufacturing, likely due to the aforementioned ethanol plants in Illinois and Minnesota. Pennsylvania too is home to clean fuels manufacturing capacities. The state has two biodiesel manufacturing plants that produce an annual 90 million gallons of biodiesel and five wood pellet manufacturing plants, which support a combined annual capacity of 354,000 tons.[59] With farmland and clean fuels manufacturing capacities, much of clean fuels employment in the Alliance states was concentrated in agriculture and forestry and manufacturing. The agriculture and forestry industry accounted for four in ten clean fuels workers in the Alliance states; these are individuals involved in crop production for corn ethanol, for example, or timber tract operations and other forestry activities that support woody biomass fuels, such as wood pellet and wood chip production. In total, agriculture and forestry workers that contribute to the clean fuels sector in the Alliance states accounted for almost 25,800 jobs. Clean fuels manufacturing workers represented just under a quarter (22 percent) of the workforce—roughly 14,600 jobs. Clean fuels manufacturing includes industries such as ethyl alcohol manufacturing or other basic organic chemical manufacturing.

FIGURE 27. ALLIANCE STATE CLEAN FUELS EMPLOYMENT BY VALUE CHAIN, 2019



[59] U.S. Energy Information Administration (EIA). Pennsylvania State Profile and Estimates. Last Updated August 2019. Accessed April 2020.

Hiring & Challenges

Prior to COVID-19, clean energy employers across Alliance and non-Alliance states alike reported that they were having difficulty finding qualified workers to fill clean energy positions at their firms (Figure 28). This varied by sector, but generally included technicians, sales representatives, management roles such as supervisors and directors, and engineers. The main reported reasons for hiring difficulty across all technology sectors included lack of experience, training, or technical skills; a small applicant pool; difficulty finding industry-specific knowledge, skills, and interest; inability to provide competitive wages; insufficient non-technical skills; and insufficient qualifications, such as certifications or educational attainment (Table 3).

Unfortunately, these sentiments were gathered before the global COVID-19 outbreak, and as such have likely changed significantly since the survey was originally fielded. Numerous job losses across the nation that have additionally impacted the clean energy industry (see the Clean Energy Employment Overview section for specific job losses) are likely altering the employment demands and realities for both clean energy employers and employees.

FIGURE 28. REPORTED HIRING DIFFICULTY BY TECHNOLOGY SECTOR, 2019

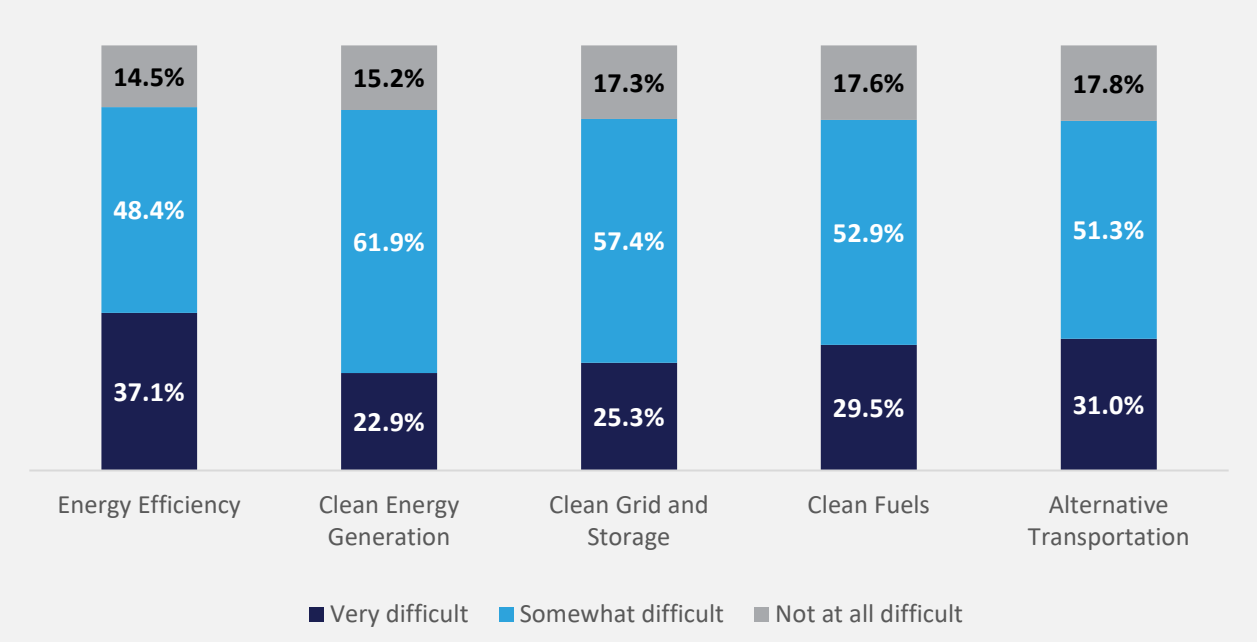


TABLE 3. REPORTED REASONS FOR HIRING DIFFICULTY BY TECHNOLOGY SECTOR, 2019[60]

	Energy Efficiency	Clean Energy Generation	Grid Modernization and Storage	Clean Fuels	Alternative Transportation
Insufficient non-technical skills[61]	17%	12%	10%	18%	63%
Lack of experience, training, or technical skills	54%	43%	38%	9%	38%
Competition/ small applicant pool	26%	36%	38%	18%	13%
Insufficient qualifications (certifications or education)	17%	14%	24%	36%	0%
Difficulty finding industry-specific knowledge, skills, and interest	21%	24%	33%	18%	13%
Cannot provide competitive wages	17%	10%	10%	18%	25%

Prior to COVID-19, clean energy firms across the Alliance states additionally reported that the inability to find qualified talent was stifling their business growth and profitability. Additional challenges were related to policy, the cost or supply of materials, permitting delays, and lack of capital. A common theme among employers that reported policy-related challenges cited policy volatility and uncertainty, particularly around federal tariffs.

[60] Percentages will not sum to 100 percent, as this was a multiple-choice question. The data in the table indicates what percentage of employers selected these as reasons for hiring difficulty. For example, 17 percent of surveyed energy efficiency employers indicated that their inability to provide competitive wages contributed to hiring difficulty between 2018 and 2019.
[61] Non-technical skills such as work ethic, dependability, or critical thinking.

TABLE 4. REPORTED CHALLENGES TO GROWTH AND PROFITABILITY BY TECHNOLOGY SECTOR, 2019[62]

	Energy Efficiency	Clean Energy Generation	Grid Modernization and Storage	Clean Fuels	Alternative Transportation
Lack of qualified talent	89%	88%	88%	75%	73%
Policy challenges	72%	89%	83%	73%	73%
Permitting delays	53%	80%	77%	40%	80%
Interconnection delays	40%	80%	76%	42%	20%
Cost or supply of materials	60%	72%	57%	75%	73%
Lack of capital	60%	61%	52%	50%	45%
Poor demand	45%	34%	45%	46%	45%

[62] This table illustrates the proportion of employers within each major technology sector that reported these challenges are either "very" or "somewhat" significant to their ability to grow a profitable clean energy business. Percentages will not sum to 100 percent, as this was a multiple-choice question. For example, 89 percent of surveyed energy efficiency employers reported that lack of qualified talent was a challenge to their business' growth and profitability.

Educational Attainment & Employment Benefits

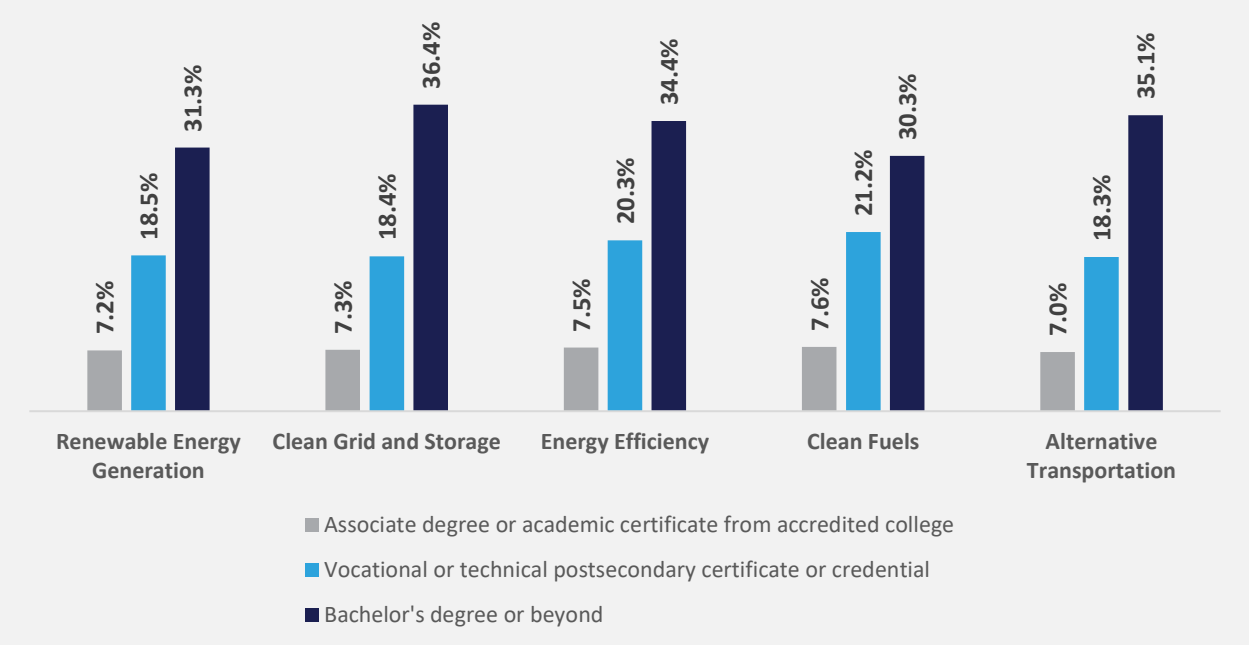
The following section provides a brief overview of clean energy jobs in the Alliance states, including average educational attainment of recent hires, wages, and employment benefits. For a more detailed examination of specific clean energy careers, please refer to Appendix C which identifies 10 clean energy occupations and their typical career progressions, wage levels, common certifications, healthcare and retirement benefits, and knowledge, skills, and abilities.

EDUCATIONAL ATTAINMENT

Across the board, new clean energy openings that had been filled in the 12 months between the end of 2018 and the end of 2019 ranged in educational attainment. For each technology sector, between 18 and 21 percent of new hires were required to have at most a vocational or technical postsecondary credential, while 30 to 36 percent were required to have a Bachelor's degree or higher. Roughly seven to eight percent of new hires were required to have no more than an Associate's degree or certificate from an accredited college.

Please note that this data refers solely to clean energy workers that were hired over the 12 months between Q4 2018 and Q4 2019 across the Alliance states. This does not represent the educational requirements for the overall clean energy workforce.

FIGURE 29. REQUIRED EDUCATION LEVEL OF NEW HIRES OVER LAST 12 MONTHS



This type of variability in educational attainment—where requirements fall at both ends of the spectrum—is typical of clean energy careers and is largely due to the fact that clean energy sectors house occupations ranging from technicians, electricians, or maintenance workers, to engineers, executives, and analysts. These are occupations with vastly different education levels and aggregated data by technology sector can often mask these occupational differences. For example, a study by The Brookings Institution found that because educational attainment by occupation varies so significantly, aggregate statistics can be misleading. An energy efficiency electrician is much more likely to have a high school diploma or less compared to electrical or environmental engineers, which tend to have at least a Bachelor's degree. Overall, however, the study found that clean energy workers tend to have less formal education compared to the national average.[63]

WAGES AND EMPLOYMENT BENEFITS

Despite lower-than-average educational attainment, many clean energy workers still earned above-average wages.[64] Across the Alliance states, nine in ten (92 percent) clean energy-specific jobs surveyed in this research effort[65] earned more than the corresponding national median wage for each occupation. This means that an electrician installing energy efficient lighting or a wholesale trade sales representative selling electric vehicle component parts earned more per hour compared to the average electrician or sales representative in the United States. In fact, this was true across all levels of experience—clean energy workers from entry- to senior-level positions were earning more than their corresponding occupational medians. Wage data from the United States Energy and Employment Report (USEER) for the Alliance states found that of surveyed clean energy occupations, nearly all entry-level clean energy jobs (98 percent) paid a premium, and respectively, 97 percent and 82 percent of all surveyed mid- and senior-level clean energy positions also paid a premium above the corresponding national medians.[66] For a full list of all clean energy occupational wages by sector, occupation, and experience level, please refer to Appendix B of this report.

The majority of clean energy workers in the Alliance states received healthcare and retirement benefits from their employers. Nine in ten (92 percent) clean energy employers in the Alliance states reported providing some form of healthcare insurance coverage—either their business covers all health insurance costs or at least some of their health insurance costs. This compared to the national private sector average of 69 percent.[67]

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[63] The Brookings Institution, Metropolitan Policy Program. Advancing Inclusion Through Clean Energy Jobs. April 2019. This Brookings study relied partially on data from the USEER report to develop its methodology and definition of clean energy jobs. Because the USEER methodology and data underpin this USCA report, findings from the Brookings report may be used as a comparable proxy for clean energy jobs in the Alliance states and nation overall.

[64] *Id.* The Brookings study found that clean energy workers earn higher wages compared to all workers nationally—roughly eight to 19 percent above national averages. Workers at lower ends of the income spectrum also earn $5 to $10 more per hour than other jobs.

[65] This proportion is only out of surveyed occupations. Out of all 765 five-digit Standard Occupational Classification (SOC) codes from the Bureau of Labor Statistics, the dataset includes data on 78 occupations or SOCs—about 10 percent of all SOC codes.

[66] While these percentages may seem high, it is important to note that in general, most jobs across the Alliance states tend to provide a premium over the national average.

[67] Bureau of Labor Statistics. Employee Benefits in the United States, March 2019. https://www.bls.gov/news.release/pdf/ebs2.pdf.

The majority of clean energy workers in the Alliance states also received retirement contributions from their employers. Eighty-four percent of clean energy employers in the Alliance states reported some form of retirement contribution for their workers; this is significantly higher than the national private sector average of 67 percent.[68]

In a separate study that examined only energy efficiency jobs across the state of Massachusetts, clean energy workers reported other additional employment benefits, such as high levels of career satisfaction, flexible work schedules, company vehicles, tuition support, and transportation stipends.[69]

FIGURE 30. HEALTH INSURANCE BENEFITS FOR ALLIANCE STATE CLEAN ENERGY JOBS, 2019

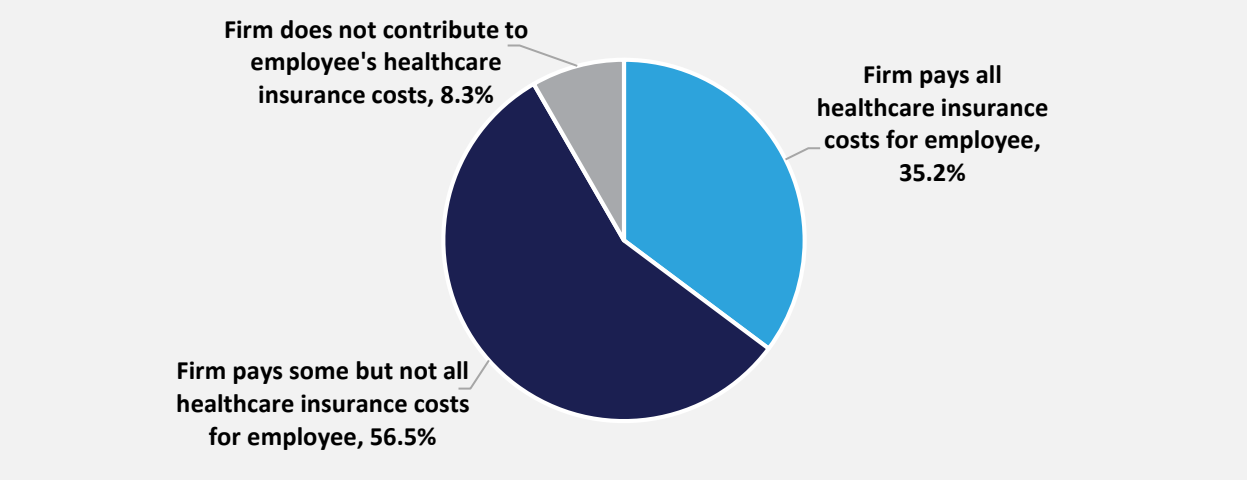
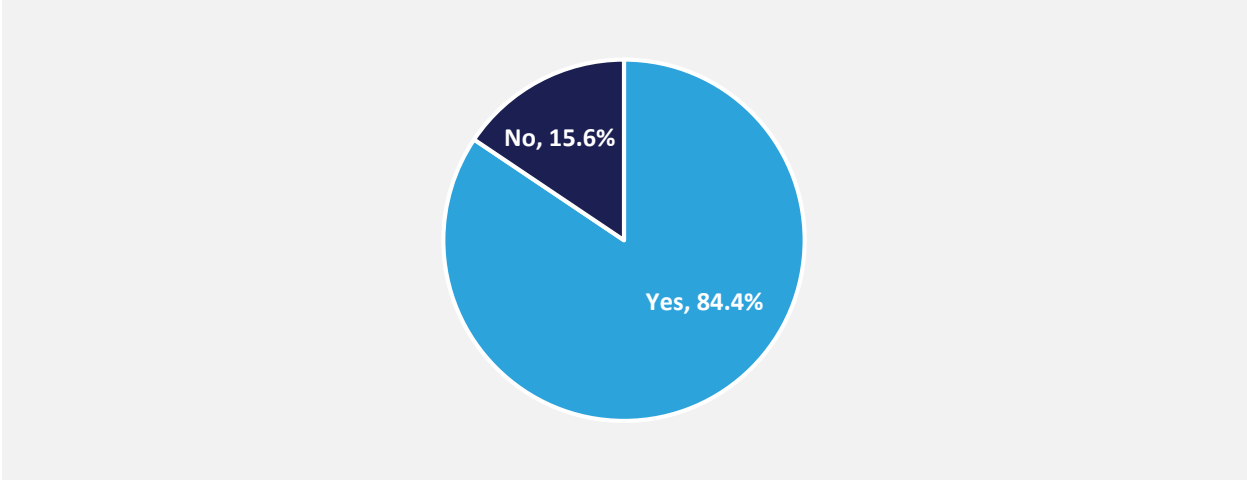


FIGURE 31. RETIREMENT CONTRIBUTIONS FOR ALLIANCE STATE CLEAN ENERGY JOBS, 2019



[68] *Id.*

[69] Massachusetts Program Administrators. Massachusetts Energy Efficiency Workforce Development Needs Assessment. March 2020. http://ma-eeac.org/wordpress/wp-content/uploads/Massachusetts-Energy-Efficiency-Workforce-Development-FINAL-REPORT-CAREER-PROFILES.pdf

Clean Energy Demographics

Overall, the clean energy industry lacked ethnic, racial, and gender diversity at the end of 2019. Nationally, Hispanic or Latinx individuals comprised almost 18 percent of the U.S. labor force, but for all technology sectors in the Alliance states except clean energy generation, Hispanic or Latinx representation was about one to seven points lower than this national average. Similarly, the national average for Black or African American workers in the U.S. labor force was 12 percent in 2019, four points higher than the proportion of Black or African American workers in the Alliance states' clean energy industry.

There was also low representation for women across all technology sectors. Nationally, women represented 47 percent of the American workforce. As a proportion of the clean energy workforce in Alliance states, women represented approximately one quarter of clean energy jobs. However, Alliance states did tend to have more private-sector Union members compared to non-Alliance states.

TABLE 5. ALLIANCE STATE CLEAN ENERGY DEMOGRAPHICS, 2019

	Alliance States	Non-Alliance States	Overall National Workforce Average[70]
Male	74.7%	74.6%	53.0%
Female	25.3%	25.4%	47.0%
Hispanic or Latinx	16.3%	15.4%	17.6%
Not Hispanic or Latinx	83.7%	84.6%	82.4%
American Indian or Alaska Native	1.4%	1.3%	1.3%
Asian	6.9%	5.7%	6.5%
Black or African American	8.0%	8.3%	12.3%
Native Hawaiian or Pacific Islander	1.1%	1.1%	0.2%
White	74.9%	77.2%	77.7%
Two or more races	7.6%	6.6%	2.8%
Veterans	8.5%	9.3%	5.7%
55 and over	12.6%	15.0%	23.6%
Union	10.1%	7.9%	6.2%

[70] Demographics for the overall nationwide workforce are from the Bureau of Labor Statistics, Labor Force Statistics from the Current Population Survey, 2019, and Emsi Population Demographics of the United States, 2019. Union membership is from the Bureau of Labor Statistics, 2019 Union Members News Release, 22 January 2020. The union membership rate is exclusive to private-sector workers. https://www.bls.gov/news.release/pdf/union2.pdf.

Appendix A: Clean Energy Wages

The following tables provide hourly earnings for clean energy occupations in the Alliance states by major technology sector, and for three levels of experience—entry-, mid-, and senior-level.[71]

Energy Efficiency

Standard Occupational Classification (SOC) Code	Description	Entry-level	Mid-level	Senior-level
11-1011	Chief Executives	$52.17	$96.91	$159.31
11-1021	General and Operations Managers	$30.11	$52.77	$106.75
11-9021	Construction Managers	$37.47	$49.51	$72.17
13-1199	Business Operations Specialists, All Other	$21.17	$34.36	$55.45
13-2011	Accountants and Auditors	$26.72	$35.64	$53.31
15-1122	Information Security Analysts	$32.97	$48.65	$71.17
15-1199	Computer Occupations, All Other	$26.61	$43.26	$68.18
17-2199	Engineers, All Other	$29.03	$48.53	$71.33
19-2041	Environmental Scientists and Specialists, Including Health	$23.44	$33.55	$51.12
19-2042	Geoscientists, Except Hydrologists and Geographers	$25.20	$37.38	$61.59
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$23.90	$39.90	$68.72
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$15.61	$23.63	$32.58
43-5061	Production, Planning, and Expediting Clerks	$16.38	$26.08	$38.54
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$14.24	$19.80	$27.61
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$23.77	$34.52	$51.56
47-2011	Boilermakers	$23.61	$37.06	$49.18
47-2021	Brickmasons and Blockmasons	$20.27	$29.52	$45.05
47-2031	Carpenters	$18.08	$27.45	$43.21
47-2061	Construction Laborers	$14.99	$21.23	$36.12
47-2073	Operating Engineers and Other Construction Equipment Operators	$20.43	$29.66	$45.55
47-2081	Drywall and Ceiling Tile Installers	$17.70	$25.93	$42.91
47-2111	Electricians	$20.25	$32.13	$50.57

[71] National wage comparatives are from the Bureau of Labor Statistics, Quarterly Census of Employment and Wages, Q4 2019. Entry-level wages are at the 20th percentile, mid-level are median hourly wages, and senior-level wages are at the 90th percentile.

47-2131	Insulation Workers, Floor, Ceiling, and Wall	$15.47	$21.32	$35.81
47-2132	Insulation Workers, Mechanical	$19.05	$28.01	$45.95
47-2151	Pipelayers	$17.04	$24.71	$36.14
47-2152	Plumbers, Pipefitters, and Steamfitters	$19.60	$31.01	$50.20
47-2181	Roofers	$17.41	$25.29	$37.55
47-2211	Sheet Metal Workers	$17.54	$28.83	$45.12
47-2221	Structural Iron and Steel Workers	$21.00	$34.53	$47.81
47-3012	Helpers--Carpenters	$11.93	$17.00	$23.20
47-3013	Helpers--Electricians	$12.76	$17.37	$24.68
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$12.74	$16.67	$23.01
47-4031	Fence Erectors	$11.81	$14.38	$18.83
47-4098	Miscellaneous Construction and Related Workers	$12.56	$16.73	$24.98
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$22.12	$35.33	$51.10
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$23.63	$38.50	$50.64
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$20.42	$29.84	$43.02
49-9041	Industrial Machinery Mechanics	$22.44	$30.85	$41.34
49-9051	Electrical Power-Line Installers and Repairers	$29.25	$46.23	$57.63
49-9071	Maintenance and Repair Workers, General	$16.33	$23.51	$34.00
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$13.87	$17.81	$25.40
49-9099	Installation, Maintenance, and Repair Workers, All Other	$16.68	$23.63	$35.32
51-1011	First-Line Supervisors of Production and Operating Workers	$21.33	$32.29	$47.45
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$13.06	$16.75	$24.65
51-4121	Welders, Cutters, Solderers, and Brazers	$17.83	$23.44	$33.12
51-4199	Metal Workers and Plastic Workers, All Other	$14.09	$18.42	$29.44
51-9199	Production Workers, All Other	$11.38	$15.06	$24.53
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$13.83	$17.36	$24.98
53-7199	Material Moving Workers, All Other	$15.10	$18.32	$28.93

Clean Energy Generation

Standard Occupational Classification (SOC) Code	Description	Entry-level	Mid-level	Senior-level
11-1011	Chief Executives	$54.95	$100.24	$162.10
11-1021	General and Operations Managers	$31.71	$54.58	$108.61
11-9021	Construction Managers	$40.52	$52.14	$74.18
13-1199	Business Operations Specialists, All Other	$22.20	$34.36	$56.70
13-2011	Accountants and Auditors	$27.48	$36.48	$53.74
15-1122	Information Security Analysts	$35.76	$52.96	$76.01
15-1199	Computer Occupations, All Other	$28.86	$47.09	$72.81
17-2199	Engineers, All Other	$33.00	$59.10	$93.43
17-3019	Drafters, All Other	$18.78	$26.39	$38.49
17-3029	Engineering Technicians, Except Drafters, All Other	$20.54	$29.98	$43.50
17-3031	Surveying and Mapping Technicians	$16.70	$24.26	$37.08
19-2041	Environmental Scientists and Specialists, Including Health	$22.67	$33.47	$53.01
19-2042	Geoscientists, Except Hydrologists and Geographers	$24.37	$37.29	$63.86
19-4041	Geological and Petroleum Technicians	$20.37	$29.41	$52.94
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$26.67	$42.52	$72.59
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$15.87	$24.78	$32.96
43-5041	Meter Readers, Utilities	$16.03	$26.39	$39.55
43-5061	Production, Planning, and Expediting Clerks	$15.99	$24.24	$36.54
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$14.24	$20.27	$28.32
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$25.89	$36.63	$57.00
47-2011	Boilermakers	$23.38	$37.54	$48.37
47-2061	Construction Laborers	$14.84	$21.50	$35.52
47-2073	Operating Engineers and Other Construction Equipment Operators	$20.24	$30.05	$44.79
47-2111	Electricians	$20.05	$32.55	$49.74
47-2132	Insulation Workers, Mechanical	$18.87	$28.37	$45.19
47-2151	Pipelayers	$16.88	$25.03	$35.54
47-2152	Plumbers, Pipefitters, and Steamfitters	$19.41	$31.41	$49.37
47-2181	Roofers	$17.25	$25.61	$36.93
47-2211	Sheet Metal Workers	$17.37	$29.20	$44.37
47-2221	Structural Iron and Steel Workers	$20.80	$34.97	$47.02
47-2231	Solar Photovoltaic Installers	$15.40	$21.83	$31.41
47-3013	Helpers--Electricians	$12.76	$17.29	$24.31

47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$12.74	$16.60	$22.66
47-4098	Miscellaneous Construction and Related Workers	$12.73	$16.61	$25.32
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$23.68	$35.39	$52.51
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	$58.17	$66.71	$71.71
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$23.95	$39.35	$50.33
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$20.69	$30.50	$42.76
49-9041	Industrial Machinery Mechanics	$22.74	$31.53	$41.09
49-9051	Electrical Power-Line Installers and Repairers	$29.64	$47.25	$57.28
49-9071	Maintenance and Repair Workers, General	$16.55	$24.03	$33.80
49-9081	Wind Turbine Service Technicians	$19.50	$27.28	$40.69
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$14.05	$18.21	$25.25
49-9099	Installation, Maintenance, and Repair Workers, All Other	$16.90	$24.15	$35.10
51-1011	First-Line Supervisors of Production and Operating Workers	$21.33	$30.62	$45.70
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$12.53	$16.75	$24.65
51-4121	Welders, Cutters, Solderers, and Brazers	$16.61	$21.91	$30.44
51-4199	Metal Workers and Plastic Workers, All Other	$13.12	$17.22	$27.06
51-8012	Power Distributors and Dispatchers	$46.14	$53.90	$64.33
51-8013	Power Plant Operators	$35.97	$49.46	$58.73
51-8099	Plant and System Operators, All Other	$29.27	$35.86	$45.02
51-9199	Production Workers, All Other	$12.17	$15.69	$25.02
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$15.29	$20.56	$32.12
53-7199	Material Moving Workers, All Other	$16.69	$21.69	$37.20

Alternative Transportation

Standard Occupational Classification (SOC) Code	Description	Entry-level	Mid-level	Senior-level
11-1011	Chief Executives	$56.43	$100.71	$163.21
11-1021	General and Operations Managers	$32.57	$54.84	$109.36
13-1199	Business Operations Specialists, All Other	$21.53	$33.65	$57.21
13-2011	Accountants and Auditors	$26.72	$35.09	$53.02
15-1122	Information Security Analysts	$34.65	$50.80	$72.69
15-1199	Computer Occupations, All Other	$27.97	$45.17	$69.63
17-2199	Engineers, All Other	$32.74	$61.25	$93.11
17-3019	Drafters, All Other	$18.92	$27.16	$40.53
17-3029	Engineering Technicians, Except Drafters, All Other	$20.70	$30.86	$45.80
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$25.26	$40.84	$68.96
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$15.87	$24.21	$32.96
43-5061	Production, Planning, and Expediting Clerks	$18.08	$29.33	$39.50
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$14.24	$20.20	$28.32
47-2061	Construction Laborers	$17.03	$24.94	$41.74
47-2073	Operating Engineers and Other Construction Equipment Operators	$23.21	$34.85	$52.63
47-2111	Electricians	$23.00	$37.76	$58.44
47-2132	Insulation Workers, Mechanical	$21.64	$32.91	$53.09
47-2152	Plumbers, Pipefitters, and Steamfitters	$22.27	$36.43	$58.01
47-2211	Sheet Metal Workers	$19.93	$33.87	$52.14
47-2221	Structural Iron and Steel Workers	$23.85	$40.57	$55.25
47-3013	Helpers--Electricians	$14.03	$17.50	$25.66
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$14.01	$16.79	$23.92
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$22.74	$33.92	$50.00
49-3021	Automotive Body and Related Repairers	$13.62	$22.03	$36.22
49-3023	Automotive Service Technicians and Mechanics	$12.50	$21.09	$34.19
49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	$16.11	$24.74	$36.80
49-3042	Mobile Heavy Equipment Mechanics, Except Engines	$22.96	$29.35	$38.40
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$21.39	$33.55	$43.88
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$18.48	$26.00	$37.28
49-9041	Industrial Machinery Mechanics	$20.31	$26.88	$35.82
49-9071	Maintenance and Repair Workers, General	$14.78	$20.49	$29.47
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$12.55	$15.52	$22.01
49-9099	Installation, Maintenance, and Repair Workers, All Other	$15.10	$20.59	$30.60

51-1011	First-Line Supervisors of Production and Operating Workers	$19.82	$29.80	$45.03
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$12.16	$16.29	$24.65
51-4121	Welders, Cutters, Solderers, and Brazers	$17.39	$22.72	$32.31
51-4199	Metal Workers and Plastic Workers, All Other	$13.74	$17.85	$28.72
51-9199	Production Workers, All Other	$11.99	$15.27	$25.91
53-3031	Driver/Sales Workers	$13.50	$15.66	$27.06
53-3032	Heavy and Tractor-Trailer Truck Drivers	$22.39	$26.69	$35.77
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$11.92	$15.66	$24.53
53-7199	Material Moving Workers, All Other	$13.02	$16.52	$28.41

Grid Modernization and Storage

Standard Occupational Classification (SOC) Code	Description	Entry-level	Mid-level	Senior-level
11-1011	Chief Executives	$52.97	$97.86	$164.58
11-1021	General and Operations Managers	$30.57	$53.29	$110.27
11-9021	Construction Managers	$36.86	$50.68	$75.62
13-2011	Accountants and Auditors	$26.72	$35.37	$52.81
15-1122	Information Security Analysts	$35.19	$51.82	$74.78
15-1199	Computer Occupations, All Other	$28.40	$46.08	$71.64
17-2199	Engineers, All Other	$26.67	$46.16	$76.07
19-2041	Environmental Scientists and Specialists, Including Health	$23.44	$32.13	$51.12
19-2042	Geoscientists, Except Hydrologists and Geographers	$25.20	$35.79	$61.59
19-4041	Geological and Petroleum Technicians	$17.30	$26.00	$49.72
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$25.26	$40.68	$70.06
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$15.87	$24.21	$33.50
43-5041	Meter Readers, Utilities	$16.47	$27.29	$41.90
43-5061	Production, Planning, and Expediting Clerks	$16.42	$25.07	$38.72
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$14.24	$20.00	$28.19
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$21.96	$31.41	$48.55
47-2011	Boilermakers	$24.01	$37.35	$50.64
47-2061	Construction Laborers	$15.24	$21.39	$37.19
47-2073	Operating Engineers and Other Construction Equipment Operators	$20.78	$29.90	$46.89
47-2111	Electricians	$20.59	$32.38	$52.07
47-2132	Insulation Workers, Mechanical	$19.37	$28.23	$47.30
47-2151	Pipelayers	$17.33	$24.91	$37.21
47-2152	Plumbers, Pipefitters, and Steamfitters	$19.93	$31.25	$51.69
47-2181	Roofers	$17.71	$25.49	$38.66
47-2211	Sheet Metal Workers	$17.83	$29.05	$46.46
47-2221	Structural Iron and Steel Workers	$21.35	$34.80	$49.22
47-3013	Helpers--Electricians	$13.29	$18.43	$26.91
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$13.27	$17.70	$25.09
47-4031	Fence Erectors	$13.04	$14.59	$20.00
47-4098	Miscellaneous Construction and Related Workers	$13.88	$16.98	$26.53
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$23.68	$34.62	$52.39
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	$61.18	$69.44	$72.83

49-3042	Mobile Heavy Equipment Mechanics, Except Engines	$25.52	$31.31	$40.12
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$24.56	$41.14	$51.59
49-9041	Industrial Machinery Mechanics	$23.32	$32.96	$42.11
49-9051	Electrical Power-Line Installers and Repairers	$30.40	$49.40	$58.71
49-9071	Maintenance and Repair Workers, General	$16.97	$25.12	$34.64
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$14.41	$19.03	$25.88
49-9099	Installation, Maintenance, and Repair Workers, All Other	$17.33	$25.25	$35.98
51-1011	First-Line Supervisors of Production and Operating Workers	$19.82	$30.05	$45.03
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$12.63	$16.23	$23.91
51-4121	Welders, Cutters, Solderers, and Brazers	$17.63	$23.44	$34.15
51-4199	Metal Workers and Plastic Workers, All Other	$13.93	$18.42	$30.36
51-8012	Power Distributors and Dispatchers	$44.99	$54.65	$63.26
51-8013	Power Plant Operators	$35.07	$50.14	$57.75
51-8099	Plant and System Operators, All Other	$28.54	$36.36	$44.27
51-9199	Production Workers, All Other	$12.45	$14.52	$25.68
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$14.58	$20.34	$29.86
53-7199	Material Moving Workers, All Other	$15.91	$21.46	$34.58

Clean Fuels

Standard Occupational Classification (SOC) Code	Description	Entry-level	Mid-level	Senior-level
11-1011	Chief Executives	$52.22	$97.48	$162.61
11-1021	General and Operations Managers	$30.14	$53.08	$108.96
11-9021	Construction Managers	$39.30	$52.31	$73.23
13-1199	Business Operations Specialists, All Other	$21.17	$34.36	$55.95
13-2011	Accountants and Auditors	$26.72	$36.03	$52.50
15-1122	Information Security Analysts	$33.97	$49.54	$71.30
15-1199	Computer Occupations, All Other	$27.42	$44.05	$68.31
17-2199	Engineers, All Other	$32.60	$60.07	$94.41
17-3019	Drafters, All Other	$18.83	$26.07	$38.49
17-3029	Engineering Technicians, Except Drafters, All Other	$20.59	$29.62	$43.50
17-3031	Surveying and Mapping Technicians	$16.74	$23.97	$37.08
19-2041	Environmental Scientists and Specialists, Including Health	$25.35	$34.98	$53.76
19-2042	Geoscientists, Except Hydrologists and Geographers	$27.25	$38.97	$64.77
19-4041	Geological and Petroleum Technicians	$19.59	$28.88	$50.18
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$26.32	$42.19	$73.18
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$15.67	$23.63	$32.41
43-5061	Production, Planning, and Expediting Clerks	$16.04	$25.53	$37.33
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$14.24	$20.00	$27.43
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$24.56	$34.79	$51.97
47-2061	Construction Laborers	$15.04	$20.68	$36.06
47-2073	Operating Engineers and Other Construction Equipment Operators	$20.51	$28.90	$45.46
47-2111	Electricians	$20.32	$31.31	$50.48
47-2151	Pipelayers	$17.11	$24.08	$36.07
47-2152	Plumbers, Pipefitters, and Steamfitters	$19.67	$30.21	$50.11
47-2181	Roofers	$17.48	$24.64	$37.48
47-2211	Sheet Metal Workers	$17.60	$28.08	$45.04
47-2221	Structural Iron and Steel Workers	$21.07	$33.64	$47.72
47-3013	Helpers--Electricians	$12.32	$17.64	$24.90
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$12.30	$16.93	$23.22
47-5081	Helpers--Extraction Workers	$15.17	$19.27	$24.33
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$24.82	$35.59	$51.50
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$24.59	$40.09	$50.91

49-9041	Industrial Machinery Mechanics	$23.35	$32.12	$41.56
49-9071	Maintenance and Repair Workers, General	$16.99	$24.48	$34.19
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$14.43	$18.55	$25.54
49-9099	Installation, Maintenance, and Repair Workers, All Other	$17.36	$24.60	$35.51
51-1011	First-Line Supervisors of Production and Operating Workers	$21.08	$31.10	$47.25
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$13.02	$16.99	$25.12
51-4121	Welders, Cutters, Solderers, and Brazers	$17.75	$22.99	$32.20
51-4199	Metal Workers and Plastic Workers, All Other	$14.02	$18.07	$28.63
51-9199	Production Workers, All Other	$12.45	$15.61	$26.89
53-3031	Driver/Sales Workers	$13.77	$15.92	$26.03
53-3032	Heavy and Tractor-Trailer Truck Drivers	$22.84	$27.14	$34.42
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$15.56	$21.13	$30.84
53-7199	Material Moving Workers, All Other	$16.99	$22.29	$35.71

Appendix B: Clean Energy Career Profiles

The following career profiles present additional detail on 10 occupations that are commonly found working in clean energy technology sectors. These include:

1. General and Operations Managers
2. Bookkeeping, Accounting, and Auditing Clerks
3. Engineers
4. Electricians
5. Solar Photovoltaic Installers
6. Construction and Maintenance Trades Workers
7. Sales Representatives (Wholesale and Manufacturing, Technical and Scientific Products)
8. Drafters, Engineering Technicians, and Mapping Technicians
9. Heating, Air Conditioning, and Refrigeration Mechanics and Installers
10. Electrical Power-Line Installers and Repairers

Data and information for these profiles was pulled from a variety of sources, including public data from the Bureau of Labor Statistics and the Department of Labor, as well as the 2020 United States Energy and Employment Report (USEER). The occupations were assigned to the nearest corresponding Standard Occupational Classification Code (SOC).

Job descriptions, skills, and knowledge are compiled from O*NET OnLine, a resource managed by the US Department of Labor. Wages are based on the Bureau of Labor Statistics' Occupational Employment Statistics (OES) and a wage survey connected with the United States Energy and Employment Report (USEER). Feeder and promotion occupations as well as healthcare and retirement benefits are also tied to responses from the USEER wage survey. The estimated wages are reflective of national wages in Quarter 3 of 2019 across all clean energy technology sectors. For example, the entry-level wage of $30.60 for General and Operations Managers is an average of these jobs across clean energy generation, energy efficiency, alternative transportation, grid modernization and storage, and clean fuels. Common certifications are based on employer responses from the survey and a literature review; these are not meant to be exhaustive or comprehensive, but rather an overview of common certifications.

Appendix C: Research Methodology

EMPLOYMENT, HIRING, & DEMOGRAPHIC DATA

Data for the 2020 U.S. Climate Alliance Clean Energy Jobs Report is based on the United States Energy and Employment (USEER). The research methodology for USEER may be found at:

https://www.usenergyjobs.org/

An executive summary and appendices, which include the methodology, can also be found directly at the following links:

https://www.usenergyjobs.org/2020-report

Download USEER Appendix A

Download USEER Appendix B

FULL-TIME EQUIVALENT JOBS

FTE jobs are extrapolated using state employment thresholds weighted on census division and previous year's data. These thresholds are adjusted for response bias between our known and unknown universes, then the proportion of firm revenues from energy projects are incorporated. Employment thresholds are survey data from questions asking what percent of a firm's employment spends at least 50 percent of their time working on clean energy-related activities and what percent spends all their time. Using the weighted and adjusted thresholds, employment by state is then split into three groups, those that spend all (100 percent) of their time on clean energy-related activities, those that spend a majority (50 to 99 percent) of their time, and those that spend less than a majority (0 to 49 percent) 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 percent group. FTE jobs are the sum of these products.

WAGE DATA

Reported technology wages at the detailed occupational level (as determined by the Standard Occupational Classifications, or SOCs) are a product of detailed occupational (5-digit SOC) wages provided by the Bureau of Labor Statistics, a technology-specific multiplier created at the broad (2-digit) occupational level, and a geographic-specific multiplier created at the broad occupational level.

As stated above, technology-specific detailed occupation wages are a product of BLS-provided detailed occupation wages and a technology-specific broad occupation multiplier. These technology-specific broad occupation multipliers are the quotients of adjusted broad occupation wages over BLS-provided broad occupation wages. The adjusted broad occupation wages are four-fifths BLS-provided broad occupation wages and one-fifth survey-produced broad occupation wages from USCA-abiding firms. The survey-produced broad occupation wages are

averages of survey-produced detailed occupation salaries divided by 2080 (a year's working hours assuming full-time employment).

The geographic-specific multiplier is the quotient of the BLS broad occupation wages among the USCA participating states over the national BLS provided broad occupation wages. This allows the research team to capture the premium or discount the USCA-defined region has over the rest of the nation.

Appendix D: Clean Energy Technology List

An clean energy job is defined as any worker that 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; Grid Modernization 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. Included in these sectors are the following sub-technologies that are considered to be clean energy-specific for the purposes of this report. Note that the U.S Climate Alliance does not have a uniform definition of clean energy and this list includes some technologies that would not be defined as clean energy technologies by some member states. In general, technology definitions are largely similar across other reports from state agencies or national organizations, particularly for the grid modernization and storage and energy efficiency sectors. Technology differences are largely related to the inclusion or exclusion of sub-technologies in other sectors such as clean energy generation, clean fuels, and alternative transportation.

Other clean energy report estimates may vary based on decisions to either include or exclude specific sub-technologies as part of the clean energy economy, such as nuclear fuels and generation, traditional hydropower, corn ethanol, etc. The state-specific fact sheets follow different definitions based on state policy frameworks. It should be noted that manually summing jobs across the state fact sheets will not total to the cumulative values in this main report as state-specific definitions of clean energy may differ from the technologies considered in this report.

CLEAN ENERGY GENERATION

- Solar photovoltaic
- Concentrated solar
- Wind
- Geothermal
- Bioenergy/Biomass
- Low-Impact hydroelectric, including wave/kinetic
- Traditional hydroelectric
- Nuclear
- Combined heat and power
- Other clean energy generation

GRID MODERNIZATION AND STORAGE

- Smart grid
- Microgrids
- Other grid modernization
- Pumped hydro-power 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 (flywheels, compressed air energy storage, etc.)
    - Thermal storage, excluding fossil-related
    - Biofuels, including ethanol and biodiesel
    - Nuclear fuel

ENERGY EFFICIENCY

- ENERGY STAR Certified Appliances, excluding HVAC
- 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
- Traditional HVAC goods, control systems, and services
- 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
- Solar thermal water heating and cooling
- Other renewable heating and cooling (geothermal, biomass, heat pumps, etc.)
- Advanced building materials/insulation
- Recycled building materials
- Reduced water consumption products and appliances
- Other energy efficiency

CLEAN FUELS

- Corn ethanol
- Other ethanol/non-woody biomass, including biodiesel
- Woody biomass/cellulosic biofuel
- Other biofuels
- Nuclear fuel
- Other clean fuels

ALTERNATIVE TRANSPORTATION

- Plug-In Hybrid Vehicles
- Electric Vehicles
- Natural Gas Vehicles
- Hydrogen Vehicles
- Fuel Cell Vehicles
- Other Clean Vehicles