2020 Pennsylvania Clean Energy Employment Report

PRODUCED FOR THE PENNSYLVANIA DEPARTMENT OF ENVIRONMENTAL PROTECTION ENERGY PROGRAMS OFFICE

[bw] RESEARCH PARTNERSHIP

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Executive Summary

Pennsylvania was home to about 97,000 clean energy workers statewide in 2019, and job creation was on the rise. Clean energy jobs represented 1.6 percent of the overall statewide labor market in 2019. Between 2017 and 2019, clean energy businesses created almost 7,800 new jobs—a growth rate of 8.7 percent in two years.

Between 2017 and 2019, clean energy jobs grew faster than the overall statewide labor market. Jobs at clean energy firms grew by 8.7 percent, compared to a statewide average job growth of 1.9 percent over the same time frame. Seven percent of all new jobs in Pennsylvania were attributable to clean energy employment growth from 2018 to 2019.

Clean energy employment was concentrated largely in energy efficiency and energy generation. The energy efficiency industry accounted for roughly three-quarters of clean energy jobs across the state, followed by clean energy generation, which accounted for 15 percent.

Full-time equivalent clean energy jobs grew faster than total clean energy jobs. Full-time equivalent (FTE) clean energy workers grew by 15.7 percent between 2017 and 2019. FTEs equated to about 66.5 percent of total clean energy workers in Pennsylvania in 2019, an increase of four percentage points since 2017. This means the intensity (or concentration) of clean energy activity also increased, as more clean energy workers spent most, if not all, of their labor hours on clean energy-related activities. For example, HVAC installers who spent only a quarter of the work week installing high efficiency heat pumps two years ago could now be spending most, or all, of their labor hours on high efficiency HVAC systems.

Solar jobs in Pennsylvania continued to grow, despite nationwide declines. Between 2017 and 2019, Pennsylvania's solar workforce grew by 8.3 percent, or an additional 396 jobs. During the same time, the nationwide solar workforce declined 1.2 percent, shedding approximately 4,300 solar jobs from the clean energy workforce. The continued growth in solar jobs for Pennsylvania was likely the result of an increase in annual installations between 2018 and 2019. In 2018, the state installed just under 60 MW of residential, non-residential, and utility-scale solar capacity. In 2019, annual installed capacity reached about 70 MW.[1]

Jobs declined in the nuclear electric power generation sector. Although nuclear accounts for a large share of Pennsylvania's electricity generation mix, the closure of Three Mile Island at the end of 2019 and the overall national and statewide shift from fossil fuels to natural gas and clean energy reduced the nuclear generation workforce. Between 2017 and 2019, Pennsylvania's nuclear electric power generation labor force declined by 5.4 percent, or 256 jobs, mirroring the nationwide decline of 5.9 percent over the same time period.

Wind energy was a significant source of both jobs and renewable energy capacity in Pennsylvania. Since 2013, wind energy has become the largest source of Pennsylvania's renewable electricity generation,

[1] Solar Energy Industries Association (SEIA), Pennsylvania Solar Fact Sheet. Data through Q4 2019. Accessed April 2020.

accounting for 36 percent of renewable electricity in 2018.[2] Across the state, 751 wind turbines generate over 1,400 megawatts (MW) of wind power. In fact, Pennsylvania ranks 19th in the nation for installed wind capacity. In addition to generation capacity, the state is home to 29 manufacturing facilities that produce components for the wind industry.[3]

Along with the increase in wind electricity generation, the statewide wind energy workforce increased from 2017 to 2019. Wind energy jobs grew by 9.7 percent, or 259 workers, amounting to a total of 2,937 wind energy jobs. In 2019, the wind energy sector in Pennsylvania accounted for 2.6 percent of all wind energy jobs in the United States.

Construction firms were a major employer of clean energy workers in Pennsylvania. The construction industry accounted for 47 percent of clean energy jobs in the state. The high prevalence of construction activity was mostly attributable to the energy efficiency sector. Out of all clean energy construction jobs across the state, 85 percent of workers were energy efficiency workers, indicating that much of energy efficiency activity was concentrated in the deployment of energy efficient systems and technologies.

Clean grid and storage construction were also an area of significant activity in Pennsylvania, as 76 percent of clean grid and storage workers were in the construction industry. This means that about three-quarters of clean grid and storage workers were engaged in the installation, maintenance, or repair of clean storage, smart grid, microgrid, or other grid modernization technologies across the state.

Pennsylvania is also a hub for clean energy manufacturing, with potential to export these services to the rest of the nation. The state is home to significant manufacturing of clean fuels, ENERGY STAR® products, and wind turbine components. Six in ten (68.7 percent) clean fuels employees in Pennsylvania worked in the manufacturing industry, likely the result of the high annual volumes of biodiesel and wood pellet production in the state.

However, Pennsylvania's clean energy manufacturing strength lies in the energy efficiency sector. In fact, of all clean energy manufacturing workers in the state, 66.9 percent were in the energy efficiency sector. Pennsylvania is well-poised to export the state's clean energy manufacturing services to the rest of the nation. As the demand for clean energy goods and services continues to increase in the United States, Pennsylvania can likely expect to see further growth in clean energy manufacturing jobs.

The clean energy economy was a good source of jobs for veterans and Hispanic or Latinx communities. These demographic subgroups were more highly represented in the clean energy labor market compared to overall statewide averages. Just over one-tenth (12.4 percent) of clean energy workers in Pennsylvania were Hispanic or Latinx, compared to 6.1 percent of the statewide population. Similarly, 10.8 percent of clean energy workers were veterans of the U.S. Armed Forces, compared to a 5.2 percent statewide average.

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[2] U.S. Energy Information Administration. Pennsylvania State Profile and Energy Estimates. Last Updated August 2019. Accessed April 2020. https://www.eia.gov/state/analysis.php?sid=PA.
[3] American Wind Energy Association. Wind Energy in Pennsylvania. https://www.awea.org/Awea/media/Resources/StateFactSheets/Pennsylvania.pdf.

Note: It is important to note that the 2020 Pennsylvania Clean Energy Employment Report was commissioned before the global Coronavirus (COVID-19) pandemic, which has significantly altered labor market and employment nationally and statewide. This report is based on data collected in the last quarter of 2019, and therefore the employment figures presented serve as a baseline of clean energy industry employment pre-pandemic. While the full extent of the economic impact of the pandemic is yet unknown, BW Research estimates that as of April 2020, Pennsylvania has already lost more than 21,000 clean energy jobs—a 16.2 percent decline—as a result of COVID-19 economic fallout; this number may exceed 30,200 by the second quarter of 2020. Further analysis related to the COVID-19 pandemic's economic impacts can be found at http://bwresearch.com/covid19. The return of clean energy jobs over time can now be measured against the last quarter of 2019 and will serve as a benchmark for recovery in this sector within Pennsylvania.

Introduction

The Pennsylvania Department of Environmental Protection (DEP) works to protect the state's air, land, and water from pollution; restore these natural resources; and provide for Pennsylvanians' health and safety through a cleaner environment. Advancing this mission, the DEP Energy Programs Office is the primary entity under the Governor's jurisdiction responsible for programs that promote knowledge and use of energy efficiency and energy conservation technologies as well as indigenous, clean, alternative fuels, including energy production and use technologies.

Pennsylvania is transitioning towards a cleaner energy economy. By executive order in January 2019, Governor Tom Wolf set a goal for Pennsylvania to reduce its greenhouse gas emissions 80 percent by 2050 from 2005 levels. The executive order also established the GreenGov Council to create strategies to reduce state building energy consumption by three percent per year, replace 25 percent of the state's passenger car fleet with electric vehicles, and procure renewable energy to offset at least 40 percent of annual electricity use.[4]

Since 2004, Pennsylvania has implemented an Alternative Energy Portfolio Standard that requires 18 percent of electricity sales to come from alternative energy sources by 2021.[5] In 2017, Act 40 ensured that eligibility for solar renewable energy credits was limited to in-state facilities, incentivizing in-state solar development.[6] This step followed another 2017 action to add $30 million in grant funding to the state's Solar Energy Program.[7] Pennsylvania's Alternative and Clean Energy program, meanwhile, provides grants and loans for eligible clean energy programs.[8]

Act 129 of 2008 requires each of Pennsylvania's major electric distribution companies (EDCs) to reduce energy use within their service territories. Act 129, administered by the Pennsylvania Public Utility Commission (PUC), sets efficiency targets for each EDC based review of energy efficiency potential. EDCs meet these targets though incentives for high-efficiency appliances and lighting, industrial energy efficiency, new building construction, and other programs. Phase III will end in 2021, And the PUC has proposed targets for Phase IV.

Such supportive policies for the increasing deployment of clean energy technologies across the state are expected to support sustained job growth in Pennsylvania's clean energy economy in the coming years. The link between clean energy policy and employment growth is evident across several mature clean energy economies in the United States such as Massachusetts, Rhode Island, Vermont, and New York. As Pennsylvania begins to move away from coal electricity generation towards clean and renewable sources of energy, it becomes increasingly necessary to identify the labor market impacts of these shifts.

One of the core functions of the Energy Programs Office is to work with partners to gather data and develop resources to help policy makers, planners, and other leaders in Pennsylvania make informed and

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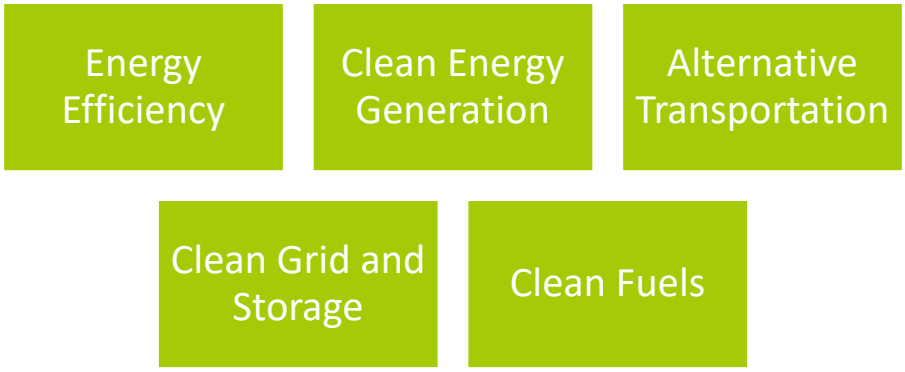
[4] https://www.governor.pa.gov/newsroom/governor-wolf-establishes-first-statewide-goal-reduce-carbon-pollution-pennsylvania/
[5] http://www.pennaeps.com/aboutaeps/
[6] https://www.governor.pa.gov/newsroom/governor-wolf-announces-new-effort-bolster-solar-energy-pennsylvania/
[7] https://www.governor.pa.gov/newsroom/pennsylvania-revives-solar-initiatives-to-boost-clean-energy-jobs/
[8] https://dced.pa.gov/programs/alternative-clean-energy-program-ace/

best-outcome energy decisions. To provide a foundation on which to understand future energy employment changes and base energy employment decisions, the Energy Programs Office commissioned BW Research to conduct a baseline analysis of Pennsylvania's clean energy workforce from 2017 through 2019. This is the 2020 Pennsylvania Clean Energy Employment Report.

This report details employment in the clean energy sector, as defined by the Energy Programs Office. Clean energy jobs are categorized into five major technology sectors and their component sub-technologies.

FIGURE 1. CLEAN ENERGY SECTORS



For a list of sub-technologies that are considered clean energy-related for the purposes of this report, please refer to Appendix A. In addition to employment totals, this report details:

- Clean energy employment by value chain segment
- Clean energy wages
- Employer hiring challenges
- Demographic distribution of clean energy workers compared to state- and nationwide averages

All data are based on the 2020 United States Energy and Employment Report (USEER) data collection effort, a joint project of the National Association of State Energy Officials and the Energy Futures Initiative.[9] For more information on the USEER methodology, please refer to Appendix B.

[9] www.USEnergyJobs.org

For a broader analysis of all energy-related employment, across both fossil fuel and renewable energy resources, please refer to the 2020 Pennsylvania Energy Employment Report.

BW Research is a full-service consulting and research firm that specializes in workforce and economic development for public entities, including workforce investment boards, economic development agencies, cities, counties, and educational institutions. BW Research has substantial experience in developing customized research projects and a deep understanding of the clean energy sector and its employers, workforce, and supply chain dynamics. BW Research has designed and conducted over 500 studies for public, private, and not-for-profit agencies throughout the United States and internationally.

Acknowledgments: This material is based upon work supported by the United States Department of Energy, Office of Energy Efficiency and Renewable Energy, under State Energy Program Award Number EE0008293.

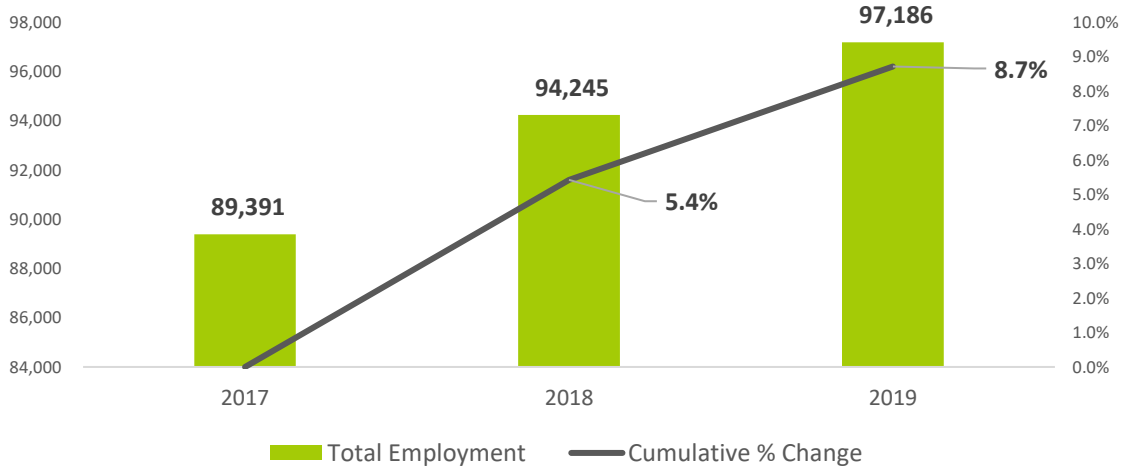
Pennsylvania Clean Energy Industry Overview

Overall Clean Energy Jobs

Pennsylvania was home to 97,186 clean energy workers across the state in 2019. Since 2017, clean energy jobs grew by 8.7 percent, or 7,794 workers (see Figure 1). As of the last quarter of 2019, clean energy jobs accounted for 1.6 percent of all employment in Pennsylvania. Between 2017 and 2019, clean energy job growth accounted for seven percent of all new jobs created. Over this same time period, the clean energy industry grew faster than the overall statewide labor market. Between 2017 and 2019, total statewide jobs grew by only 1.9 percent, compared to an 8.7 percent growth rate in the clean energy industry.[10] The majority of clean energy jobs in Pennsylvania were found in the following three counties: Allegheny, Philadelphia, and Montgomery. A third of all clean energy employment in the state can be found in these three regions. For more information on county-level employment estimates, please refer to Appendix C.

The overall proportion of clean energy jobs compared to total statewide employment in Pennsylvania was comparable to New York's clean energy economy, where 1.7 percent of total jobs were clean energy workers. However, clean energy employment concentration in Pennsylvania was lower compared to other states like Massachusetts (3.5 percent) or Rhode Island (3.4 percent).

FIGURE 2. CLEAN ENERGY EMPLOYMENT IN PENNSYLVANIA, 2017-2019



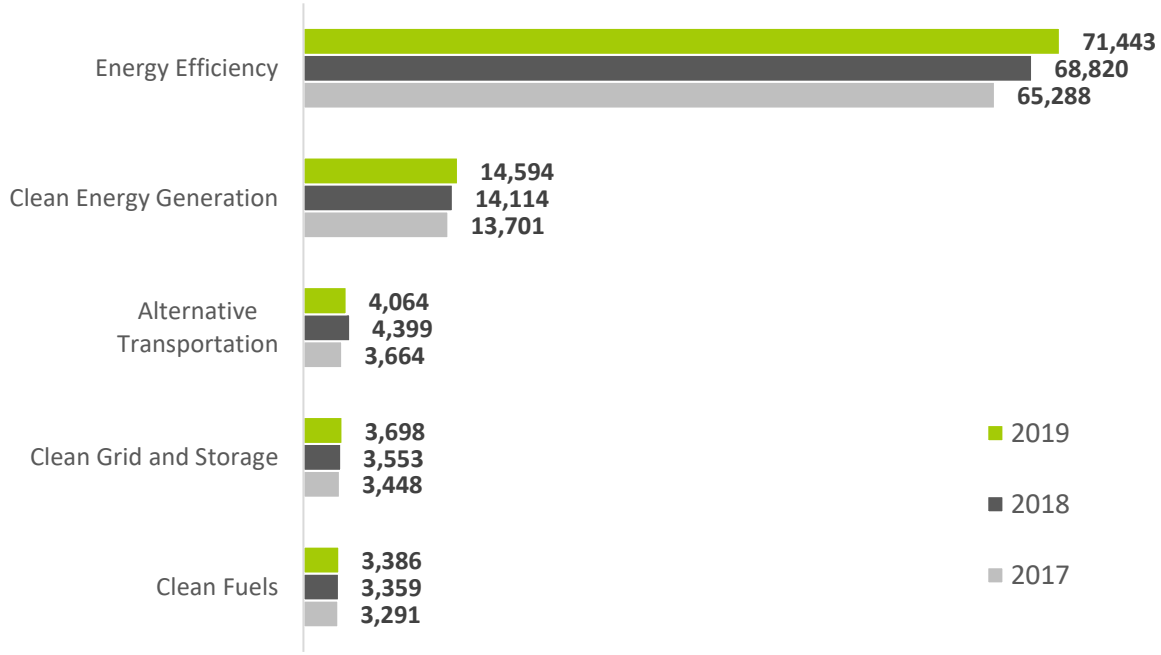
Almost three-quarters (73.5 percent) of all clean energy jobs in Pennsylvania were found in the energy efficiency sector; these businesses employed 71,443 workers and employment grew by 9.4 percent, or 6,155 jobs, since 2017. Following energy efficiency, clean energy generation firms comprised 15 percent

[10] Total state-level employment is from the Bureau of Labor Statistics, Quarterly Census of Employment and Wages. Data was accessed on February 2020.

of total clean energy jobs. Clean energy generation firms grew by 6.5 percent, creating 893 jobs since 2017 for a total of 14,594 workers.

The remaining clean energy sectors—alternative transportation, clean grid and storage, and clean fuels—together accounted for 11.5 percent of clean energy workers in Pennsylvania. Each of these three sectors grew between 2017 and 2019, creating a collective 746 jobs. Alternative transportation firms grew by 10.9 percent (400 jobs), followed by clean grid and storage firms which grew by 7.3 percent (250 jobs), and clean fuels businesses which grew by 2.9 percent (96 jobs).

FIGURE 3. CLEAN ENERGY EMPLOYMENT BY SECTOR, 2017-2019



Full-Time Equivalent Clean Energy Jobs

In

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.

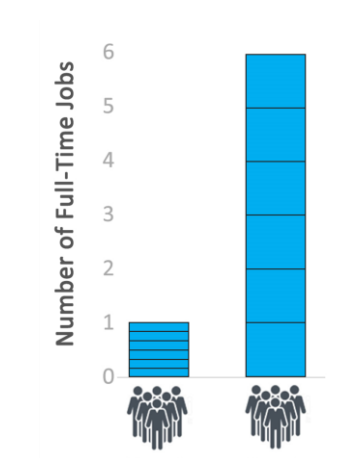


Figure 4 on the following page, Pennsylvania's FTE clean energy jobs are portrayed from 2017 through 2019. These jobs represent a subset of total clean energy jobs from Figure 2 in the previous section. FTE jobs are a useful metric to identifying the extent of clean energy activity—installation, manufacturing, trade, or professional services—going on in a state. An increase in FTE jobs indicates that more clean energy workers are dedicating an increasing amount of their work week, or labor hours, to clean energy-specific activities possibly due to increased policy support and financial incentives creating more demand for clean energy goods and services. For instance, a traditional HVAC worker might have spent only a quarter of their work week installing or maintaining energy efficient HVAC technologies in 2017. But if a state began offering rebates in 2018 for efficient heat pumps, that traditional HVAC worker would likely now be spending the majority of labor hours in a work week installing high efficiency heat pumps. This increase in clean energy-related activity per worker translates to more full-time equivalent clean energy jobs.

Overall, Figure 4 highlights that FTE clean energy jobs are growing faster than the overall clean energy labor market. Between 2017 and 2019, FTE clean energy workers grew by 15.7 percent, or 8,753 workers. As of the end of 2019, 66.5 percent of all clean energy jobs in Pennsylvania could be considered FTE clean energy jobs. This intensity (or concentration) of clean energy activity has been on the rise since 2017, when only 62.5 percent of Pennsylvania's clean energy workforce was considered FTE; this represents a growth of four percentage points in two years.

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.

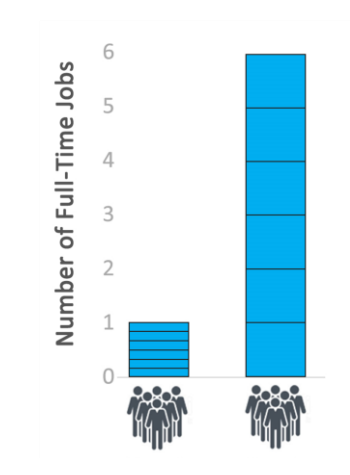
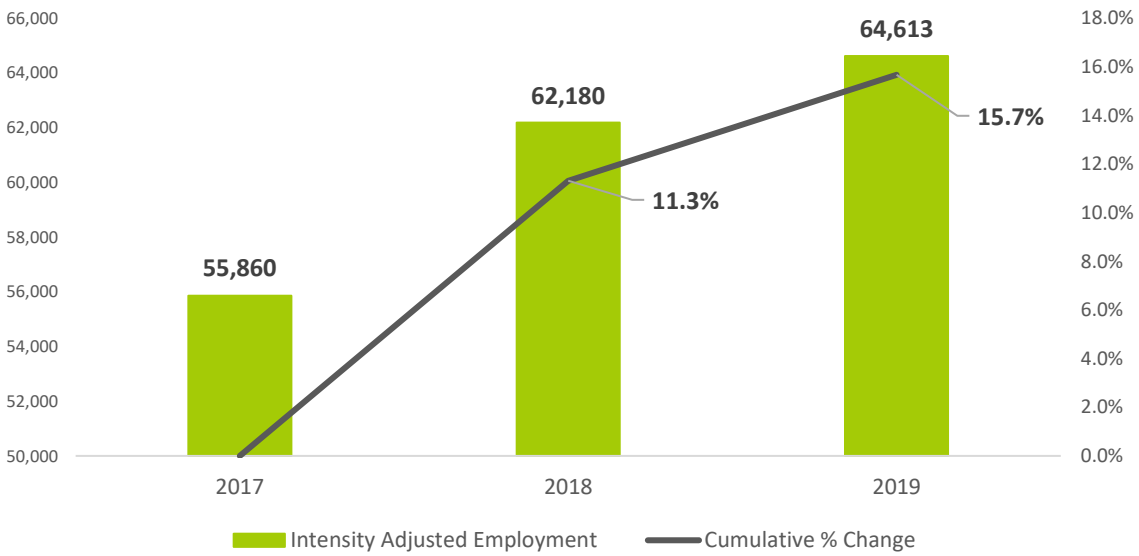


FIGURE 4. INTENSITY-ADJUSTED CLEAN ENERGY EMPLOYMENT (FULL-TIME EQUIVALENT WORKERS), 2017-2019[11]



[11] FTE clean energy jobs were extrapolated using a combination of state-level and census region data and weighted according to how much time workers were reported to spend on clean energy activities (0-49 percent, 50-99 percent, or 100 percent). For a full description of this methodology, please refer to Appendix A.

Clean Energy Value Chain Employment

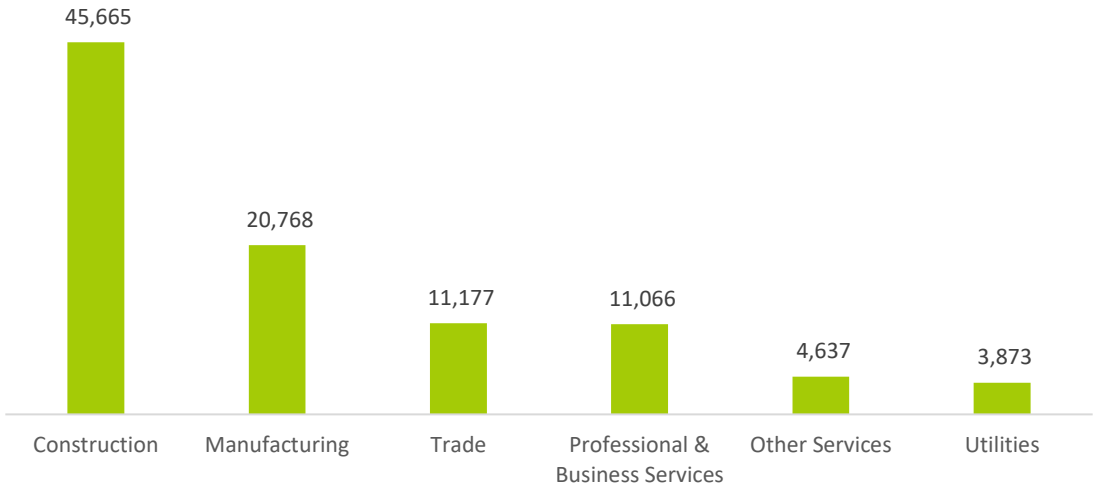
Value chain jobs examine the clean energy economy by identifying the industries in which clean energy activities are concentrated in Pennsylvania. Doing so provides context for what type of policy or workforce development assistance is needed to support clean energy employers across the state. For example, a state with a high concentration of research and development activity in the alternative transportation sector might signal the need for more early-stage investment funding to support continued prototype development and technology testing.

The major value chain segments examined include construction[12], manufacturing[13], wholesale trade[14], professional and business services[15], other services[16], and utilities.

For Pennsylvania, the construction and manufacturing industries comprised the majority of clean energy employment (see Figure 5). Almost half of all clean energy workers in Pennsylvania (47 percent) were in the construction industry, and manufacturing jobs accounted for 21.4 percent of the clean energy economy. The overall propensity of clean energy manufacturing was not surprising, given Pennsylvania's strong manufacturing industry that supported almost 10 percent of total jobs across the state in sectors such as food processing, chemicals and plastics, iron and steel production, and metal fabrication.[17]

[12] Construction is comprised of all workers engaged in residential, commercial, and industrial building construction, contracting and electrical work, insulation and weatherization, or plumbing and heating, air conditioning, and ventilation work.
[13] Manufacturing encompasses petrochemical, industrial gas, ethyl alcohol, or other basic organic chemical manufacturing as well as heating and air conditioning equipment manufacturing, engine and compressor manufacturing, semiconductor manufacturing, and energy efficient product, appliance, or lighting manufacturing, as well as motor vehicle and parts manufacturing.
[14] Wholesale trade includes fuel dealers, motor vehicle and parts wholesalers, electrical equipment and household appliance wholesalers, and other wholesale related to clean energy products and technologies.
[15] Professional business services include all finance, legal, consulting, engineering, research, or architectural support.
[16] Other services is largely comprised of automotive repair and maintenance, but also includes organizational and non-profit work such as environment and conversation organizations, business associations, or advocacy organizations.
[17] Emsi, 2019. Accessed April 2020.

FIGURE 5. CLEAN ENERGY EMPLOYMENT BY VALUE CHAIN SEGMENT, 2019



The high prevalence of construction workers can be attributed to the state's energy efficiency sector, which accounted for 85.1 percent of all clean energy construction jobs in Pennsylvania. This means that most clean energy workers in the construction industry were engaged in the installation, maintenance, and repair of HVAC systems and ENERGY STAR appliances or the weatherization of residential and commercial buildings. For more information on value chain employment for each sector, please refer to the Detailed Clean Energy Sector Employment Section of this report.

Detailed Clean Energy Sector Employment

Energy Efficiency

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

The American Council for an Energy-Efficient Economy (ACEEE) ranks Pennsylvania 18th in the nation in its support of energy efficiency policies and programs.[18] The state's flagship energy efficiency program, Act 129, enforces incremental energy consumption reductions; the program has saved over 8.8 million megawatt hours of electricity usage since 2009 resulting in $6.4 billion in savings to Pennsylvania's electric customers.[19] In 2018, the state enacted legislation allowing local governments to establish Commercial Property Assessed Clean Energy (C-PACE) programs that provide low-cost, long-term financing to businesses seeking to upgrade their property's energy efficiency, renewable energy, or water conservation.[20] The Pennsylvania Housing Finance Agency also offers loans of up to $10,000 for specific home energy efficiency repairs.[21] Pennsylvania's overall current building codes are based on 2015 international building codes as established by the International Code Council (ICC), but the city of Philadelphia has adopted the 2018 ICC.[22]

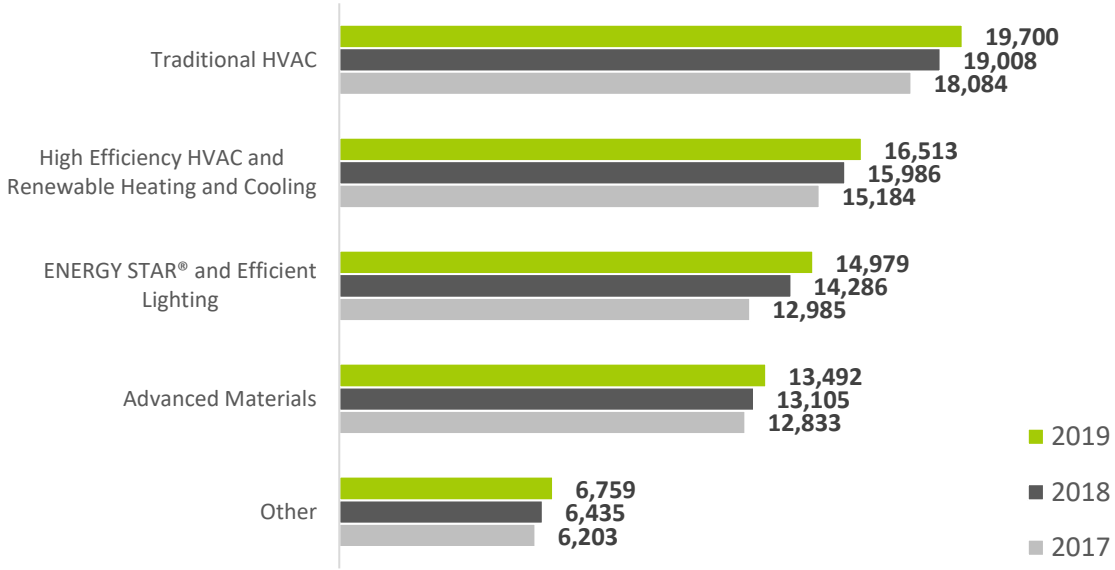
Energy efficiency workers in Pennsylvania was mostly concentrated across heating, ventilation, and air conditioning (HVAC) technologies as well as efficient lighting technologies; these sectors have the most workers and highest growth rates since 2017. There were 19,700 individuals, accounting for 27.6 percent of energy efficiency workers, engaged in traditional HVAC work.[23] Another 16,513 worked in high efficiency HVAC and renewable heating and cooling[24]; this accounted for 23.1 percent of the energy efficiency workforce. It is possible that the concentration of activity in the HVAC sector was due to rebates and incentives for residential customers to upgrade to more energy efficient heating and cooling systems. Residential customers of Met-Ed, Penelec, Penn Power, and West Penn Power are eligible for a number of

[18] https://database.aceee.org/state/pennsylvania
[19] https://www.dep.pa.gov/Citizens/Energy/EnergyEfficiencyandConservation/Pages/Incentives-Fact-Sheet-PA-PUC-Electric-Choice.aspx
[20] https://www.governor.pa.gov/newsroom/governor-wolf-signs-new-legislation-support-low-cost-clean-energy-technology-pennsylvania/
[21] https://www.dep.pa.gov/Citizens/Energy/EnergyEfficiencyandConservation/Pages/Incentives-Fact-Sheet-PA-PUC-Electric-Choice.aspx
[22] https://www.dli.pa.gov/ucc/Pages/UCC-Codes.aspx
[23] Traditional HVAC workers are individuals that spend a portion of their labor hours on energy efficient HVAC technologies, but the majority of time on traditional HVAC technologies, while high efficiency HVAC workers spend the majority of their labor hours working with efficient HVAC technologies.
[24] Renewable heating and cooling workers are involved with heating, ventilation and air conditioning (HVAC) from renewable energy sources, including solar thermal, or other work that increases the energy efficiency of HVAC systems.

rebates for the installation or upgrade of central air conditioners and heat pump systems, ENERGY STAR-certified heat pumps, thermostats, and other energy efficient measures.[25]

Energy efficiency workers that spend most of their labor hours working with ENERGY STAR® appliances and efficient lighting technologies comprised 21 percent of the energy efficiency labor force, followed by advanced materials workers (18.9 percent) and other energy efficiency workers (9.5 percent).[26] Between 2017 and 2019, ENERGY STAR and efficient lighting businesses grew by 15.4 percent—the most of all energy efficiency sub-sectors over the last two years; these firms created 1,994 new jobs.

FIGURE 6. ENERGY EFFICIENCY EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2019



The strong growth in ENERGY STAR jobs was likely attributable to the state's manufacturing capacity for ENERGY STAR products as well as state- and nationwide rebates and incentives for the adoption of ENERGY STAR technologies. As of April 2017, Pennsylvania 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.[27] Electricity providers in Pennsylvania offer rebates on ENERGY STAR appliances ranging from clothes washers and dryers, refrigerators, freezers, and dehumidifiers.

[25] https://energysavepa-home.com/hvac/

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

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

In general, the energy efficiency sector in Pennsylvania was mostly comprised of construction workers; 54.4 percent of all jobs in energy efficiency were construction jobs and 19.5 percent were found in the manufacturing industry. The large proportion of energy efficiency construction workers indicates that in-state deployment of energy efficiency technologies was high, with many of Pennsylvania's energy efficiency workers engaged in the installation of ENERGY STAR products or efficient HVAC systems, the weatherization of homes, or the upgrade of efficient lighting technologies.

The state's heavy presence in manufacturing indicates that Pennsylvania is well-poised to export energy efficiency services to the rest of the nation. Across all clean energy-related manufacturing work in Pennsylvania, the energy efficiency sector accounted for 66.9 percent of clean energy manufacturing jobs in the state. The state's overall job growth in the ENERGY STAR sub-sector indicates that Pennsylvania's ENERGY STAR manufacturers were possibly working to meet both in-state and out-of-state demand. As other states in the nation continue to offer rebates and incentives for ENERGY STAR products, Pennsylvania can likely expect to see continued growth in the energy efficiency manufacturing value chain sector.

TABLE 1. ENERGY EFFICIENCY JOBS BY VALUE CHAIN, 2019

	Energy Efficiency
Utilities	-
Construction	38,860
Manufacturing	13,902
Trade	7,750
Professional & Business Services	9,602
Other Services	1,329

Clean Energy Generation

Clean energy generation jobs encompass all workers engaged in the research, development, production, manufacture, sales, installation, maintenance, repair, or professional service support of carbon-free electricity generating technologies. Such clean energy generation technologies include solar, wind, geothermal, bioenergy, hydropower, and nuclear electric power generation.

Clean energy generation jobs in Pennsylvania were mostly concentrated across solar, nuclear, and wind generation firms. Solar workers accounted for the largest share of clean energy generation workers—35.4 percent of the clean energy generation labor force, or 5,173 jobs. Unlike the rest of the nation, solar jobs have been growing in Pennsylvania since 2017. Between 2017 and 2019, solar employment grew by 8.3 percent across the state—from 4,777 workers to 5,173 workers at the end of 2019. By contrast, nationwide solar jobs declined by 1.2 percent over the same time period. The continued growth in solar jobs for Pennsylvania was likely the result of an increase in annual installations between 2018 and 2019. In 2018, the state installed just under 60 MW of residential, non-residential, and utility-scale solar capacity. In 2019, annual installed capacity reached about 70 MW.[28]

The nuclear generation workforce in Pennsylvania has declined steadily over the last two years, shedding jobs at a rate of 5.4 percent between 2017 and 2019, mirroring the overall nationwide trend. Over the same time, the nuclear electric power generation sector in the United States lost 3,827 workers—a decline of 5.9 percent in two years. Nuclear remains a large component of Pennsylvania's energy generation mix, but the closure of Three Mile Island in September 2019 and the national shift towards more natural gas and renewable electric generation capacities signals continued job losses in the sector. Projected declines for the nuclear electric power generation utilities industries suggest an additional loss of 2.7 percent by the end of 2020.[29]

Wind energy firms continued to grow employment in Pennsylvania. The state's 2,937 wind energy generation workers accounted for 2.6 percent of all wind energy jobs across the United States. These businesses grew by 9.7 percent since 2017, creating 259 new clean energy jobs across the state. Wind energy generation job growth comes alongside increasing wind capacity in the Commonwealth. Since 2013, wind energy has become the largest renewable source of electricity generation, accounting for 36 percent of Pennsylvania's renewable electricity capacity in 2018.[30] With significant resources along the Appalachian Mountain crests and the shoreline of Lake Erie, the state currently boasts 726 installed wind turbines with over 1,400 megawatts of generating capacity. Furthermore, the state is home to 29 manufacturing facilities that produce wind turbines, blades, towers, and other components related to wind energy technologies.[31]

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[28] Solar Energy Industries Association (SEIA), Pennsylvania Solar Fact Sheet. Data through Q4 2019. Accessed April 2020.

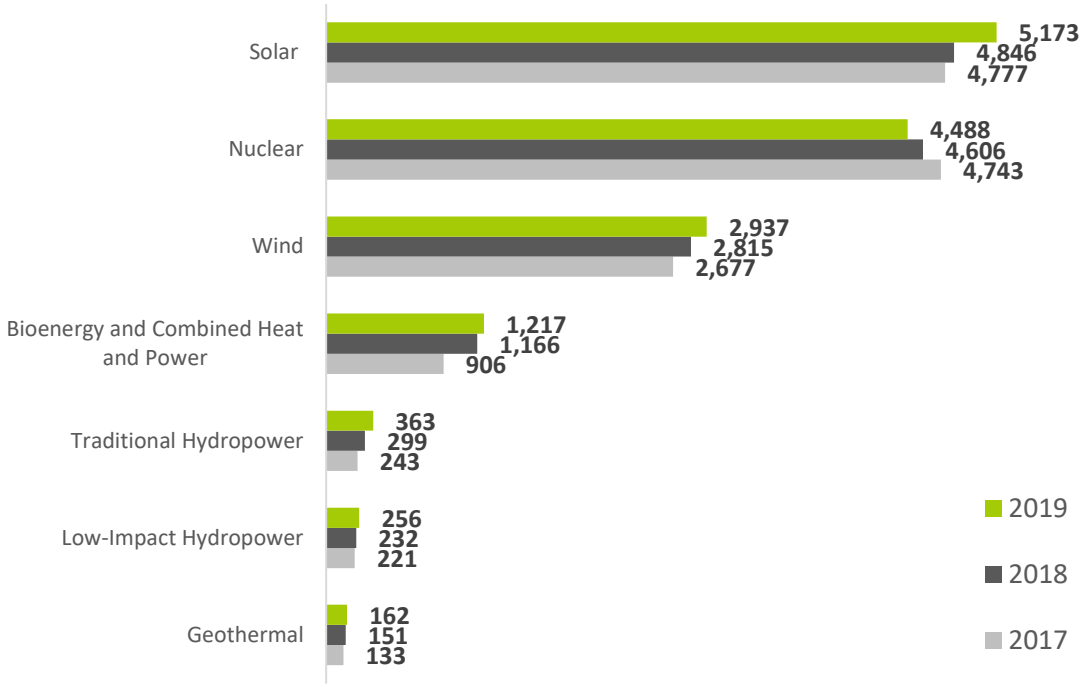
[29] Projected employment for NAICS 221113 (nuclear electric power generation) pulled from Emsi. Data accessed March 2020. This projection is based on existing economic modelling that may not fully account for COVID-19 impacts.

[30] U.S. Energy Information Administration. Pennsylvania State Profile and Energy Estimates. Last Updated August 2019. Accessed April 2020. https://www.eia.gov/state/analysis.php?sid=PA.

[31] American Wind Energy Association. Wind Energy in Pennsylvania. https://www.awea.org/Awea/media/Resources/StateFactSheets/Pennsylvania.pdf.

Bioenergy and combined heat and power (CHP), traditional hydropower, low-impact hydropower, and geothermal electric power generation technologies accounted for 13.7 percent of Pennsylvania's clean energy generation workforce and have collectively resulted in 494 new jobs since 2017, the majority of which can be attributed to the bioenergy and CHP industry. In fact, Pennsylvania is among one of the top 12 states in the nation for the amount of electricity generated from biomass resources. In 2018, biomass-fueled facilities accounted for 24 percent of statewide renewable electricity generation.[32]

FIGURE 7. CLEAN ENERGY GENERATION EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2019



Activity in the clean energy generation sector was comprised of utility workers (26.5 percent), construction workers (27.3 percent), and manufacturing workers (24.1 percent), with some remaining jobs across wholesale trade, professional and business services such as engineering, consulting, finance, and legal support, as well as other services including non-profit work or repair and maintenance.

In general, Pennsylvania's labor market strengths in the clean energy generation sector were found in solar, wind, and bioenergy. The high prevalence of utility and construction workers indicates that many clean energy generation workers in the state were focused on the deployment of solar, wind, and bioenergy electric power generation technologies. At the same time, a quarter of the workforce was engaged in the manufacture of clean electric power generation technologies, namely wind turbines, blades, and towers. As with energy efficiency manufacturing, these services are available to export to

[32] U.S. Energy Information Administration. Pennsylvania State Profile and Energy Estimates. Last Updated August 2019. Accessed April 2020. https://www.eia.gov/state/analysis.php?sid=PA.

national and global wind energy markets, setting Pennsylvania up to be a leader in wind component manufacturing.

TABLE 2. CLEAN ENERGY GENERATION JOBS BY VALUE CHAIN, 2019

	Clean Energy Generation
Utilities	3,873
Construction	3,989
Manufacturing	3,510
Trade	1,377
Professional & Business Services	644
Other Services	1,202

Alternative Transportation

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

The transportation sector in Pennsylvania represents about a quarter of total energy use in the state.[33] To combat transportation emissions in the state, Governor Tom Wolf instituted the Diving PA Forward initiative, meant to transition the state's vehicle fleet towards zero- and low-emissions transportation alternatives. The program aims to do so through a variety of consumer rebates and incentives for trucks and transit buses, such as school or shuttle buses, as well as other modes of transportation like marine and rail freight.[34] To further aid Pennsylvania in meeting diesel emissions reductions goals, the state has had the Alternative Fuels Incentive Grant (AFIG) program in place since 1992. Six million dollars in grant funding is available annually for consumers seeking to purchase alternative fuel vehicle technologies or perform research and development on such technologies.[35] Pennsylvania also provides cash rebates for purchases of new plug-in hybrid, plug-in electric, natural gas, propane, and hydrogen fuel cell vehicles through the Alternative Fuel Vehicle (AFV) Rebate Program.[36] In 2018, Pennsylvania joined a coalition of nine states and DC—The Transportation and Climate Initiative—with the purpose of further reducing transportation pollution, particularly through the expansion of electric vehicle infrastructure.

In addition to improving air quality and health outcomes for Pennsylvania residents, such policy initiatives are likely also contributing to job growth in the alternative transportation sector of the state's clean energy industry. Jobs in the alternative transportation sector were found mostly within the electric and hybrid vehicles sub-sectors. Electric vehicle companies—which manufacture, sell, service, or conduct research on vehicles that use one or more electric motors for propulsion with no onboard generator or non-electric motor—account for 43 percent of alternative transportation workers, or 1,752 jobs.

Pennsylvania also has significant employment in the plug-in hybrid sector. Plug-in hybrid vehicles use two or more distinct types of power, such as internal combustion engines and an electric motor that is powered by rechargeable batteries, or another energy storage device, that can be recharged by plugging it in to an external source of electric power. These firms accounted for 38.9 percent of workers, or 1,582 jobs, and have seen the greatest growth rate within the alternative transportation sector. Between 2017 and 2019, Pennsylvania's plug-in hybrid workforce grew by 26.6 percent, creating 332 new alternative transportation jobs across the state.

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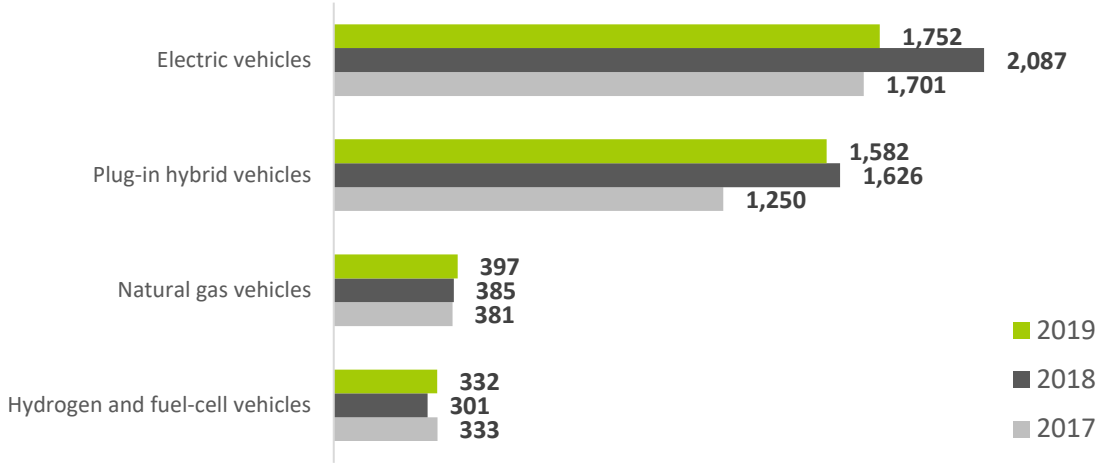
[33] U.S. Energy Information Administration (EIA). Pennsylvania State Profile and Estimates. Last Updated August 2019. Accessed April 2020.

[34] http://www.depgis.state.pa.us/drivingpaforward/

[35] https://www.dep.pa.gov/Citizens/GrantsLoansRebates/Alternative-Fuels-Incentive-Grant/pages/default.aspx

[36] https://www.dep.pa.gov/Citizens/Energy/EnergyEfficiencyandConservation/Pages/Incentives-Fact-Sheet-PA-PUC-Electric-Choice.aspx

FIGURE 8. ALTERNATIVE TRANSPORTATION EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2019



Alternative transportation activity was mostly found in the other services industry sector, which consists of repair and maintenance. Repair and maintenance work was typical of the transportation sector. Following other services, alternative transportation workers were also engaged in manufacturing (23.9 percent) and wholesale trade (23.6 percent).

With the creation of the GreenGov Council in 2019 to replace 25 percent of the state's passenger car fleet with battery electric and plug-in hybrid cars by 2025, plus other statewide alternative transportation programs, the state is gearing up to see further employment growth in the alternative transportation sector. In fact, as adoption of alternative transportation technologies increases across the nation, Pennsylvania can expect to see particular growth in the state's alternative transportation manufacturing and wholesale trade value chain segments—services with high export potential.

TABLE 3. ALTERNATIVE TRANSPORTATION JOBS BY VALUE CHAIN, 2019

	Alternative Transportation
Utilities	-
Construction	-
Manufacturing	970
Trade	958
Professional & Business Services	144
Other Services	1,991

Clean Grid & Storage

For the purposes of this report, clean grid and storage workers include any individual that supports the deployment (construction), manufacture, wholesale trade, or legal, financial, and engineering services of the following technologies: smart grid, microgrids, and other grid modernization technologies such as electric vehicle charging infrastructure, as well as clean storage technologies.

Pennsylvania is engaged in a variety of activities related to clean grid and storage technologies. The Department of Environmental Protection's Energy Programs Office has provided funding for Penn State to develop a demonstration of CHP-enabled renewable energy in a microgrid at the Philadelphia Navy Yard.[37] Meanwhile, states within the regional transmission organization PJM, including Pennsylvania, rapidly expanded battery storage in response to favorable Federal Energy Regulatory Commission compensation. Despite no additional increases since 2017, which was due in part to key changes in PJM wholesale market rules, Pennsylvania still added over 30 MW of battery storage capacity between 2009 and 2018, the 8th largest increase in the nation.[38]

Clean storage—which includes pumped hydropower storage[39], battery storage[40], mechanical storage[41], thermal storage[42], biofuel storage (including ethanol and biodiesel), and nuclear fuel storage—accounted for almost half (47.9 percent) or the clean grid and storage workforce in Pennsylvania. The clean storage industry grew by 9.2 percent, from 1,621 to 1,770 workers between 2017 and 2019. Microgrid[43] firms employed a total of 766 workers across the state and have grown by 83 jobs—a growth rate of 12.2 percent—since 2017. Smart grid[44] employment had also grown since 2017, creating 58 new jobs in two years for a total of 504 workers and a growth rate of 13.0 percent in two years.

[37] https://www.dep.pa.gov/Business/Energy/OfficeofPollutionPrevention/State-Energy-Plan/Pages/CHP_and_Micro-Grid_Technology.aspx

[38] https://pennenvironment.org/sites/environment/files/reports/PAE%20Renewables%20on%20the%20Rise%20Aug19.pdf

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

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

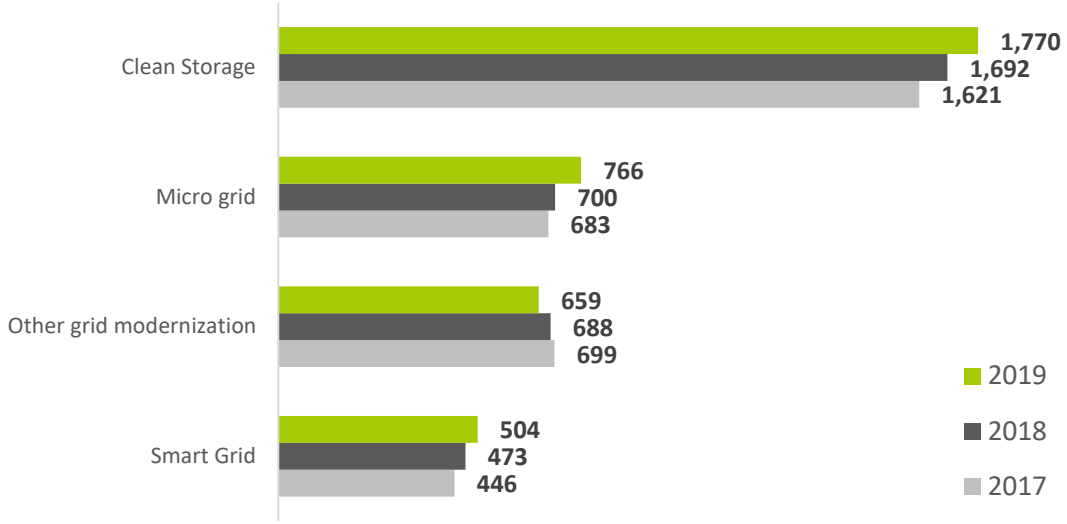
[41] This includes flywheels and compressed air energy storage.

[42] Temporary storage of energy for later use when heating or cooling is needed.

[43] Microgrids are a group of interconnected loads and distributed energy resources within clearly defined electrical boundaries that act as a single controllable entity with respect to the grid.

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

FIGURE 9. CLEAN GRID AND STORAGE EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2019



Clean grid and storage activity in Pennsylvania were mostly concentrated in the construction industry. Over three-quarters (76.1 percent) of the clean grid and storage workforce was engaged in the installation, maintenance, or repair of clean grid and storage technologies across the state. Following that, 10.8 percent of clean grid and storage workers were engaged in the manufacturing industry and 6.5 percent were found in wholesale trade.

TABLE 4. CLEAN GRID AND STORAGE JOBS BY VALUE CHAIN, 2019

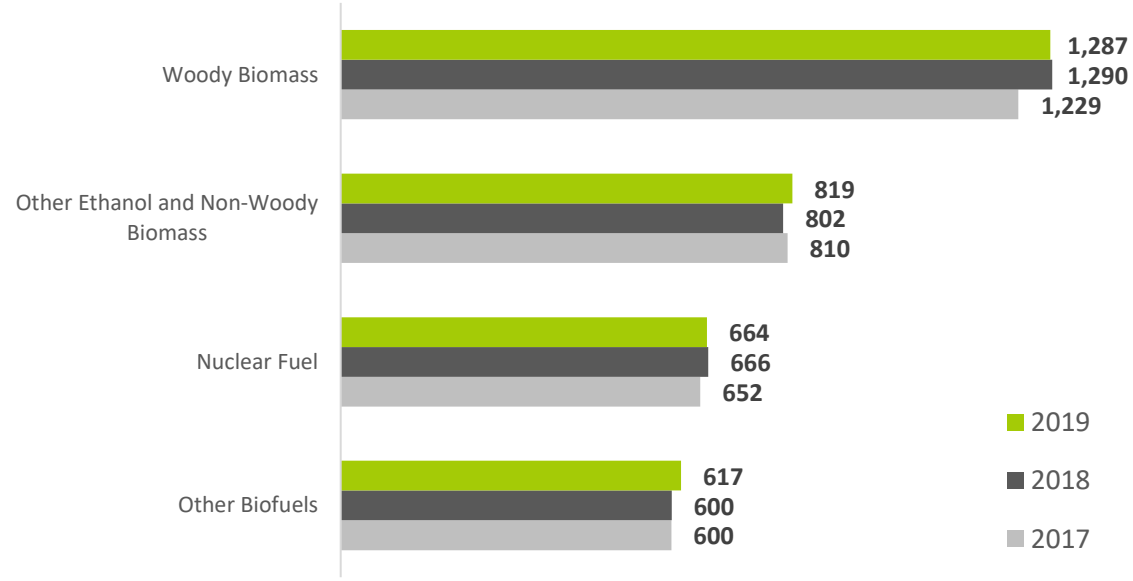
	Clean Grid and Storage
Utilities	-
Construction	2,816
Manufacturing	399
Trade	239
Professional & Business Services	159
Other Services	86

Clean Fuels

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

Pennsylvania is one of the top 12 states in the nation in terms of the amount of in-state electricity generated from biomass resources. Biomass-fueled electricity generation facilities accounted for about a quarter (24 percent) of the state's electricity generation capacity in 2018.[45] While much of the biomass generation was mostly from municipal solid waste and landfill gas, clean fuels employment in Pennsylvania was mostly concentrated in the woody and non-woody biomass industries, likely due to the state's high annual volumes of biodiesel and wood pellet production.[46] Woody biomass workers accounted for 38 percent of jobs, followed by other ethanol and non-woody biomass firms, which comprised 24.2 percent of the clean fuels workforce. Most clean fuels industries had flat growth between 2017 and 2019, but woody biomass firms did add 58 jobs to the labor force—a growth rate of 4.7 percent in two years.

FIGURE 10. CLEAN FUELS EMPLOYMENT BY SUB-TECHNOLOGY, 2017-2019



Clean fuels manufacturing is a particular strength in Pennsylvania. Over half (58.7 percent) of the clean fuels sector was dedicated to manufacturing. These clean fuels manufacturing jobs were likely the result

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

of the state's two biodiesel manufacturing plants that produce an annual 90 million gallons of biodiesel[47] as well as the eight wood pellet manufacturing plants, which support a combined annual capacity of about 368,000 tons. These wood pellet companies were spread across the state in the counties of Allegheny, Bradford, Juniata, Greene, Lancaster, Potter, and Westmoreland. Out of the eastern states, which also include Connecticut, Iowa, Indiana, Maine, Michigan, Missouri, New Hampshire, New York, Ohio, Vermont, Wisconsin, and West Virginia, Pennsylvania accounted for almost 17 percent of annual capacity productions.[48]

TABLE 5. CLEAN FUELS JOBS BY VALUE CHAIN, 2019

	Clean Fuels
Utilities	-
Construction	-
Manufacturing	1,987
Trade	853
Professional & Business Services	518
Other Services	29

[47] U.S. Energy Information Administration (EIA). Pennsylvania State Profile and Estimates. Last Updated August 2019. Accessed April 2020.
[48] U.S. Energy Information Administration (EIA). Monthly Densified Biomass Fuel Report, Manufacturing Facilities with Capacity and Status as of January 2020. Released April 2020. Accessed April 2020. https://www.eia.gov/biofuels/biomass/.

Clean Energy Hiring

Eight in ten employers (80.7 percent) who indicated that they were searching for qualified applicants between the fourth quarters of 2018 and 2019 reported that they found some level of difficulty hiring—either very difficult or somewhat difficult—and just under a quarter (23.8 percent) reported that hiring had been very difficult during that time period. This was roughly similar to the national average, where 84 percent of employers reported some level of hiring difficulty between 2018 and 2019.

For Pennsylvania's clean energy employers, the most reported reason for hiring difficulty was lack of experience, training, or technical skills (49.4 percent), followed by competition and a small applicant pool (26.9 percent). These open clean energy positions paid above average wages for Pennsylvania residents. In fact, just under three-quarters (74 percent) of clean energy jobs in Pennsylvania paid a premium compared to the occupation's statewide median across technology sectors and all levels of experience. This was particularly true for entry-level positions, where nine in ten (90.4 percent) entry-level clean energy workers earned a higher hourly wage compared to the corresponding occupational entry-level median wage. For more information on clean energy occupational wages for each technology sector, please refer to Appendix D.

It is important to note that given the global COVID-19 pandemic, it is likely that the realities of clean energy hiring have since changed, as much of industry-wide activity is currently on hold.

FIGURE 11. EMPLOYER-REPORTED HIRING DIFFICULTY, 2019

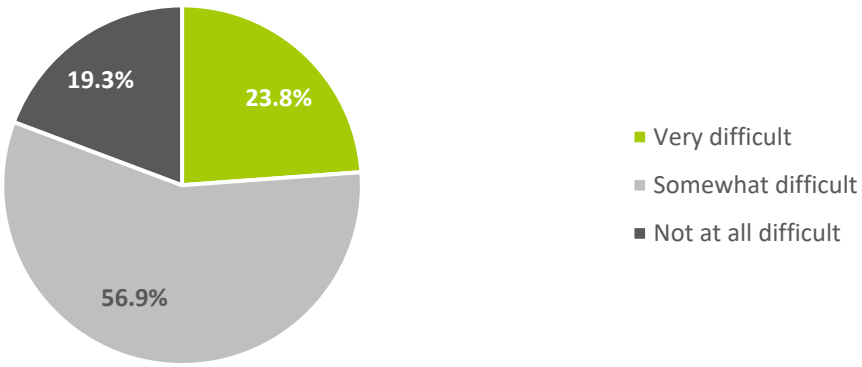
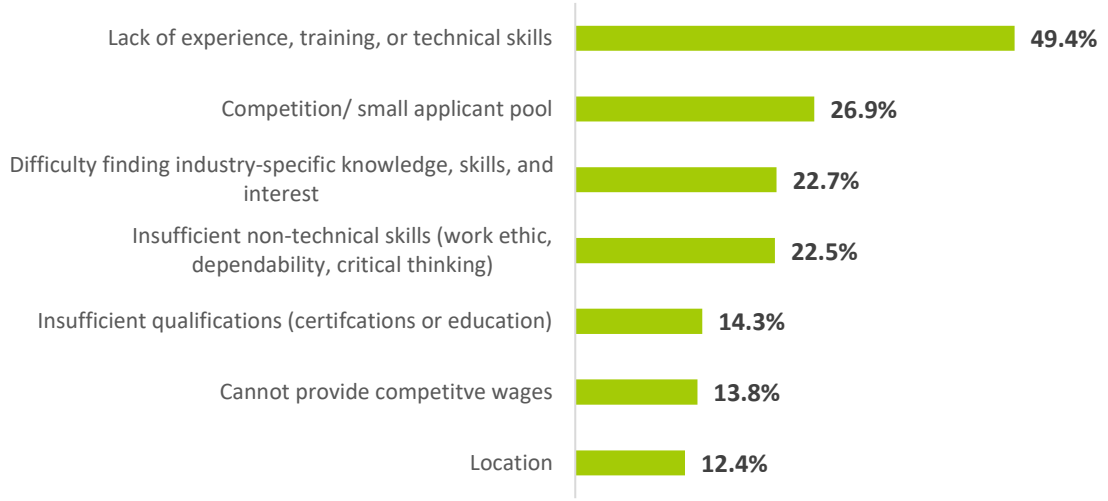
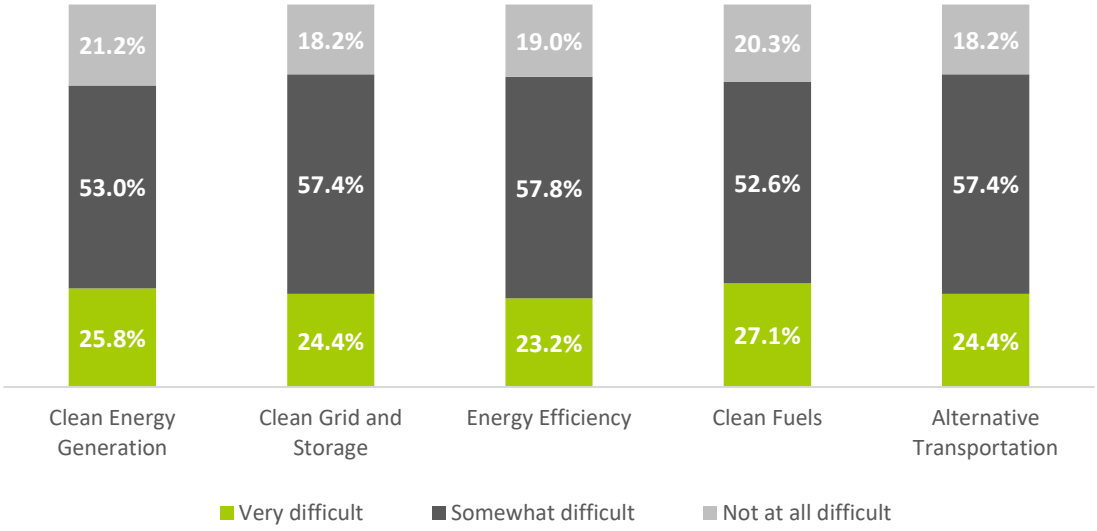


FIGURE 12. REASONS FOR HIRING DIFFICULTY, 2019



Hiring difficulty varied slightly by clean energy sector, with clean grid and storage (81.8 percent very and somewhat difficult) and alternative transportation employers (81.8 percent) indicating they had the most overall hiring difficulty between 2018 and 2019.

FIGURE 13. HIRING DIFFICULTY BY CLEAN ENERGY SECTOR, 2019



Clean Energy Demographics

Pennsylvania's clean energy economy was a source of jobs for Hispanic or Latinx and Veteran communities. The clean energy labor market has a higher proportion of these demographic subgroups compared to the statewide average. In Pennsylvania, 12.4 percent of clean energy workers were Hispanic or Latinx compared to only 6.1 percent of the statewide population. Similarly, 10.8 percent of clean energy workers in Pennsylvania were Veterans of the U.S. Armed Forces compared to a 5.2 percent statewide average. Above-average representation of Veterans in the clean energy industry was common and also observed in the nationwide average, where only 5.7 percent of the national labor force were Veterans of the U.S. Armed Forces, but nine percent of the national clean energy labor force were reported Veterans. It is possible that the high prevalence of Veterans in the clean energy industry is related to work experience, as Veterans who have made this transition note that the military provides a good transitional pathway into clean energy careers.[49]

TABLE 6. CLEAN ENERGY WORKFORCE DEMOGRAPHICS, 2019[50]

	Pennsylvania Clean Energy	Pennsylvania Overall	US Clean Energy	US Overall
Male	77.8%	52.1%	72.6%	53.0%
Female	22.2%	47.9%	27.4%	47.0%
Hispanic or Latinx	12.4%	6.1%	16.5%	17.6%
Not Hispanic or Latinx	87.6%	93.9%	83.5%	82.4%
American Indian or Alaska Native	1.1%	0.4%	1.4%	1.3%
Asian	5.7%	3.8%	8.2%	6.5%
Black or African American	9.9%	12.0%	8.4%	12.3%
Native Hawaiian or other Pacific Islander	0.8%	0.1%	1.0%	0.2%
White	77.5%	81.5%	73.1%	77.7%
Two or more races	5.1%	2.1%	7.9%	2.8%
Veterans	10.8%	5.2%	9.0%	5.7%
55 and over	17.2%	26.8%	13.6%	23.6%
Union	11.1%	12.0%	7.9%	6.2%

[49] *See generally:* https://energynews.us/2019/11/11/midwest/military-experience-provides-natural-transition-to-clean-energy-careers-veterans-say/

[50] Demographic data is pulled from the United States Energy and Employment Report 2020 (USEER 2020); the Bureau of Labor Statistics: Current Population Survey, Veterans News Release, and Union Membership Rates; as well as Emsi Population Demographics.

Conclusions

Pennsylvania's efforts to continue supporting clean energy growth are proving successful. Though the state remains a major producer of coal and petroleum products, supportive policies for renewable and clean energy resources, alternative transportation and fuels, and clean grid and storage technologies are helping the state shift towards a future of lower carbon emissions.

Strong year-over-year growth in both the solar and wind industries, particularly in spite of declining nationwide solar trends, signify strong in-state renewable growth and capacity potential. The state's manufacturing industry will likely continue to support both the energy efficiency and clean fuels sectors, perhaps even transitioning to support alternative transportation and clean grid and storage technology manufacturing as the rest of the nation begins to ramp up adoption of hybrid and electric vehicles, smart grid, microgrid, and storage technologies. With new goals and policies in place to advance the deployment of passenger electric and hybrid vehicles across the state, Pennsylvania is poised to see potential growth in these areas.

While the state's clean energy industry did suffer job losses due to the global COVID-19 pandemic, job growth can likely be expected following the COVID-19 recovery. As Pennsylvania and many other states across the nation continue to transition towards a clean and zero-carbon economy, the policies and incentives already in place will likely support the quick rebound of clean energy jobs compared to other sectors of the economy.

Appendix A: Clean Energy Technology List

A 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; Clean Grid and Storage; Energy Efficiency; Clean Fuels; and Alternative Transportation. These jobs also include supporting services such as consulting, finance, tax, and legal services related to energy.

CLEAN ENERGY GENERATION

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

CLEAN GRID & STORAGE

Electric Power Transmission and Distribution

- Smart Grid
- Microgrids
- Other Grid Modernization

Storage

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

ENERGY EFFICIENCY

- Traditional HVAC goods, control systems, and services
- High Efficiency HVAC and Renewable Heating and Cooling
    - ENERGY STAR Certified Heating Ventilation and Air Conditioning (HVAC), including boilers and furnaces with an AFUE rating of 90 or greater and air and central air conditioning units of 15 SEER or greater
    - Solar Thermal Water Heating and Cooling
    - Other Renewable Heating and Cooling (geothermal, biomass, heat pumps, etc.)

- ENERGY STAR® and Efficient Lighting
    - ENERGY STAR Certified Appliances, excluding HVAC
    - ENERGY STAR Certified Electronics (TVs, Telephones, Audio/Video, etc.)
    - ENERGY STAR Certified Windows and Doors
    - ENERGY STAR Certified Roofing
    - ENERGY STAR Certified Seal and Insulation
    - ENERGY STAR Certified Commercial Food Service Equipment
    - ENERGY STAR Certified Data Center Equipment
    - ENERGY STAR Certified LED Lighting
    - Other LED, CFL, and Efficient Lighting
- Advanced Building Materials/Insulation
- Other Energy Efficiency
    - Recycled Building Materials
    - Reduced Water Consumption Products and Appliances

CLEAN FUELS

- Other Ethanol/Non-Woody Biomass, including biodiesel
- Woody Biomass/Cellulosic Biofuel
- Other Biofuels
- Nuclear Fuel

ALTERNATIVE TRANSPORTATION

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

Appendix B: Research Methodology

EMPLOYMENT, HIRING, & DEMOGRAPHIC DATA

Data for the 2020 Pennsylvania Clean Energy Industry Report is taken from the US Energy and Employment Report (USEER). The survey was administered by phone and web. The phone survey was conducted by ReconMR, and the web instrument was programmed internally. Each respondent was required to use a unique ID in order to prevent duplication.

The 2020 USEER survey in Pennsylvania resulted in more than 6,850 calls, 1,450 mailed invite letters, and 1,800 emails to potential respondents. More than 450 business establishments participated in the survey. These responses were used to develop incidence rates among industries as well as to apportion employment across various industry categories in ways currently not provided by state and federal labor market information agencies. The margin of error is +/-4.59 percent at a 95 percent confidence level.

The full research methodology for USEER may be found at: https://www.usenergyjobs.org/

FULL-TIME EQUIVALENT JOBS

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

WAGE DATA

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

The technology-specific multiplier is a sum of the products of occupational group multipliers and the share of that occupational group's employment within total technology employment (as reported in the 2020 US Energy and Employment Report). Occupational group multipliers are the quotients of occupational group averages of technology-specific 5-digit SOC wages over the averages of their corresponding BLS-provided 5-digit SOC wages. As stated above, technology-specific 5-digit SOC wages are a product of BLS-provided 5-digit SOC wages and a technology-specific 2-digit SOC multiplier. These technology-specific 2-digit SOC multipliers are the quotients of adjusted 2-digit SOC wages over BLS-provided 2-digit SOC wages. The adjusted 2-digit SOC wages are four-fifths BLS-provided 2-digit SOC wages and one-fifth survey-produced 2-digit SOC wages Pennsylvania firms. The survey-produced 2-digit

SOC wages are averages of survey-produced 5-digit SOC salaries divided by 2080 (a year's working hours assuming full-time employment).

The geographic-specific multiplier is the quotient of the BLS 2-digit SOC wages in Pennsylvania over the national BLS provided 2-digit SOC wages. This allows the research team to capture the premium or discount that Pennsylvania has over the rest of the nation.

Appendix C: Clean Energy Jobs by County

The following table provides clean energy employment data by county in Pennsylvania for overall clean energy jobs and energy efficiency jobs. Employment estimates cannot be provided for the remaining clean energy technology sectors due to the

County Name	Total Clean Energy Jobs	Clean Energy Generation	Energy Efficiency
Adams County	486	174	268
Allegheny County	12,912	2,258	9,784
Armstrong County	167	21	117
Beaver County	924	436	405
Bedford County	255	14	189
Berks County	3,344	1,469	1,742
Blair County	786	57	549
Bradford County	193	9	138
Bucks County	5,259	944	3,704
Butler County	1,511	141	1,138
Cambria County	593	61	440
Cameron County	10	1	8
Carbon County	239	38	100
Centre County	1,035	217	741
Chester County	4,895	839	3,659
Clarion County	158	28	96
Clearfield County	296	27	183
Clinton County	216	28	113
Columbia County	283	43	198
Crawford County	282	70	167
Cumberland County	1,808	169	1,379
Dauphin County	2,239	481	1,530
Delaware County	3,354	450	2,505
Elk County	125	5	98
Erie County	1,590	250	1,094
Fayette County	469	35	307
Forest County	11	1	10
Franklin County	666	33	498
Fulton County	61	10	32
Greene County	235	9	178
Huntingdon County	142	19	96

Indiana County	373	41	262
Jefferson County	508	276	141
Juniata County	65	6	46
Lackawanna County	1,250	119	837
Lancaster County	4,564	905	3,246
Lawrence County	448	33	363
Lebanon County	612	82	404
Lehigh County	7,862	202	6,932
Luzerne County	1,497	155	1,165
Lycoming County	708	63	517
McKean County	149	13	119
Mercer County	490	21	353
Mifflin County	138	11	95
Monroe County	449	29	335
Montgomery County	9,265	1,211	7,084
Montour County	103	6	46
Northampton County	1,291	74	1,025
Northumberland County	402	45	227
Perry County	125	7	85
Philadelphia County	9,504	1,163	7,520
Pike County	106	21	71
Potter County	60	5	22
Schuylkill County	557	91	366
Snyder County	210	15	146
Somerset County	406	34	256
Sullivan County	24	10	14
Susquehanna County	109	11	83
Tioga County	234	15	130
Union County	181	78	102
Venango County	162	16	114
Warren County	99	10	58
Washington County	1,480	79	1,179
Wayne County	233	12	195
Westmoreland County	2,237	359	1,637
Wyoming County	115	14	78
York County	3,689	821	2,435
N/A	2,941	202	2,286
TOTAL	**97,186**	**14,594**	**71,443**

Appendix D: Clean Energy Wages

The following tables provide wages for clean energy occupations in Pennsylvania by each major clean energy sector as well as for three levels of experience—entry-, mid-, and senior-level positions.

CLEAN ENERGY GENERATION

SOC	DESCRIPTION	ENTRY-LEVEL	MEDIAN	SENIOR-LEVEL
11-1011	Chief Executives	$ 50.75	$ 105.47	$ 176.46
11-1021	General and Operations Managers	$ 33.20	$ 56.14	$ 109.23
11-9021	Construction Managers	$ 40.36	$ 49.19	$ 71.55
13-1199	Business Operations Specialists, All Other	$ 22.56	$ 36.29	$ 58.06
13-2011	Accountants and Auditors	$ 26.37	$ 33.68	$ 49.15
15-1122	Information Security Analysts	$ 32.36	$ 47.47	$ 67.96
15-1199	Computer Occupations, All Other	$ 27.01	$ 43.57	$ 62.85
17-2199	Engineers, All Other	$ 29.29	$ 53.07	$ 84.72
17-3019	Drafters, All Other	$ 17.52	$ 24.03	$ 34.10
17-3029	Engineering Technicians, Except Drafters, All Other	$ 19.16	$ 29.28	$ 42.09
17-3031	Surveying and Mapping Technicians	$ 14.51	$ 20.57	$ 31.60
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$ 26.31	$ 40.50	$ 73.33
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$ 14.92	$ 23.14	$ 30.99
43-5041	Meter Readers, Utilities	$ 13.84	$ 22.06	$ 36.07
43-5061	Production, Planning, and Expediting Clerks	$ 16.64	$ 26.01	$ 38.14
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$ 12.19	$ 17.90	$ 25.04
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$ 25.43	$ 35.88	$ 56.46
47-2011	Boilermakers	$ 22.95	$ 35.43	$ 43.64
47-2061	Construction Laborers	$ 14.32	$ 20.41	$ 31.82
47-2073	Operating Engineers and Other Construction Equipment Operators	$ 19.11	$ 27.25	$ 40.83
47-2111	Electricians	$ 20.10	$ 31.46	$ 45.91
47-2132	Insulation Workers, Mechanical	$ 18.54	$ 27.21	$ 43.07
47-2151	Pipelayers	$ 16.40	$ 21.98	$ 33.44
47-2152	Plumbers, Pipefitters, and Steamfitters	$ 19.58	$ 30.74	$ 45.46
47-2181	Roofers	$ 15.58	$ 22.79	$ 32.26
47-2211	Sheet Metal Workers	$ 16.96	$ 27.63	$ 41.87

47-2221	Structural Iron and Steel Workers	$ 19.67	$ 30.77	$ 45.49
47-2231	Solar Photovoltaic Installers	$ 9.48	$ 12.55	$ 16.21
47-3013	Helpers--Electricians	$ 11.92	$ 16.66	$ 23.21
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$ 11.84	$ 16.43	$ 22.78
47-4098	Miscellaneous Construction and Related Workers	$ 12.75	$ 15.66	$ 19.15
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$ 23.82	$ 33.94	$ 49.83
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	$ 25.30	$ 35.97	$ 49.54
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$ 20.30	$ 34.03	$ 47.06
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$ 19.40	$ 28.89	$ 39.43
49-9041	Industrial Machinery Mechanics	$ 22.18	$ 31.76	$ 40.44
49-9051	Electrical Power-Line Installers and Repairers	$ 25.16	$ 43.03	$ 52.53
49-9071	Maintenance and Repair Workers, General	$ 15.51	$ 23.25	$ 32.27
49-9081	Wind Turbine Service Technicians	$ 19.77	$ 28.22	$ 38.23
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$ 13.14	$ 17.87	$ 24.12
49-9099	Installation, Maintenance, and Repair Workers, All Other	$ 16.22	$ 23.86	$ 33.68
51-1011	First-Line Supervisors of Production and Operating Workers	$ 21.55	$ 29.84	$ 42.40
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$ 11.73	$ 17.22	$ 25.07
51-4121	Welders, Cutters, Solderers, and Brazers	$ 16.42	$ 21.34	$ 28.58
51-4199	Metal Workers and Plastic Workers, All Other	$ 13.25	$ 18.53	$ 25.99
51-8012	Power Distributors and Dispatchers	$ 41.72	$ 47.13	$ 55.87
51-8013	Power Plant Operators	$ 34.80	$ 43.42	$ 50.55
51-8099	Plant and System Operators, All Other	$ 26.40	$ 31.14	$ 38.75
51-9199	Production Workers, All Other	$ 11.58	$ 16.81	$ 25.37
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$ 14.19	$ 20.46	$ 30.56
53-7199	Material Moving Workers, All Other	$ 15.35	$ 21.29	$ 38.88

CLEAN GRID AND STORAGE

SOC	Description	Entry-level	Median	Senior-level
11-1011	Chief Executives	$ 48.91	$ 102.97	$ 179.14
11-1021	General and Operations Managers	$ 32.00	$ 54.81	$ 110.89
11-9021	Construction Managers	$ 36.67	$ 47.80	$ 72.97
13-2011	Accountants and Auditors	$ 25.62	$ 32.64	$ 48.29
15-1122	Information Security Analysts	$ 31.83	$ 46.43	$ 66.84
15-1199	Computer Occupations, All Other	$ 26.57	$ 42.62	$ 61.81
17-2199	Engineers, All Other	$ 22.97	$ 41.15	$ 68.44
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$ 24.87	$ 38.72	$ 70.73
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$ 14.92	$ 22.59	$ 31.51
43-5041	Meter Readers, Utilities	$ 14.27	$ 22.97	$ 38.40
43-5061	Production, Planning, and Expediting Clerks	$ 17.17	$ 27.09	$ 40.60
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$ 12.19	$ 17.65	$ 24.92
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$ 21.51	$ 30.71	$ 48.02
47-2011	Boilermakers	$ 23.59	$ 35.28	$ 45.66
47-2061	Construction Laborers	$ 14.72	$ 20.32	$ 33.30
47-2073	Operating Engineers and Other Construction Equipment Operators	$ 19.65	$ 27.14	$ 42.73
47-2111	Electricians	$ 20.67	$ 31.33	$ 48.04
47-2132	Insulation Workers, Mechanical	$ 19.06	$ 27.10	$ 45.07
47-2151	Pipelayers	$ 16.86	$ 21.89	$ 35.00
47-2152	Plumbers, Pipefitters, and Steamfitters	$ 20.13	$ 30.61	$ 47.58
47-2181	Roofers	$ 16.02	$ 22.70	$ 33.76
47-2211	Sheet Metal Workers	$ 17.43	$ 27.51	$ 43.82
47-2221	Structural Iron and Steel Workers	$ 20.22	$ 30.64	$ 47.61
47-3013	Helpers--Electricians	$ 12.43	$ 17.80	$ 25.79
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$ 12.35	$ 17.55	$ 25.31
47-4031	Fence Erectors	$ 12.50	$ 14.35	$ 17.35
47-4098	Miscellaneous Construction and Related Workers	$ 13.92	$ 16.02	$ 20.09
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$ 23.82	$ 33.19	$ 49.72
49-2095	Electrical and Electronics Repairers, Powerhouse, Substation, and Relay	$ 26.15	$ 37.02	$ 50.18
49-3042	Mobile Heavy Equipment Mechanics, Except Engines	$ 23.11	$ 27.92	$ 34.79
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$ 20.83	$ 35.60	$ 48.25
49-9041	Industrial Machinery Mechanics	$ 22.76	$ 33.22	$ 41.46
49-9051	Electrical Power-Line Installers and Repairers	$ 25.83	$ 45.02	$ 53.86
49-9071	Maintenance and Repair Workers, General	$ 15.91	$ 24.32	$ 33.09

49-9098	Helpers--Installation, Maintenance, and Repair Workers	$ 13.48	$ 18.70	$ 24.73
49-9099	Installation, Maintenance, and Repair Workers, All Other	$ 16.65	$ 24.96	$ 34.54
51-1011	First-Line Supervisors of Production and Operating Workers	$ 20.01	$ 29.28	$ 41.78
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$ 11.83	$ 16.67	$ 24.32
51-4121	Welders, Cutters, Solderers, and Brazers	$ 17.44	$ 22.84	$ 32.09
51-4199	Metal Workers and Plastic Workers, All Other	$ 14.08	$ 19.83	$ 29.18
51-8012	Power Distributors and Dispatchers	$ 40.83	$ 47.61	$ 54.84
51-8013	Power Plant Operators	$ 34.06	$ 43.86	$ 49.62
51-8099	Plant and System Operators, All Other	$ 25.84	$ 31.46	$ 38.03
51-9199	Production Workers, All Other	$ 11.85	$ 15.51	$ 26.07
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$ 13.52	$ 20.24	$ 28.43
53-7199	Material Moving Workers, All Other	$ 14.62	$ 21.06	$ 36.17

ENERGY EFFICIENCY

SOC	Description	Entry-level	Median	Senior-level
11-1011	Chief Executives	$ 48.17	$ 101.98	$ 173.47
11-1021	General and Operations Managers	$ 31.52	$ 54.28	$ 107.38
11-9021	Construction Managers	$ 37.28	$ 46.69	$ 69.56
13-1199	Business Operations Specialists, All Other	$ 21.50	$ 36.29	$ 56.74
13-2011	Accountants and Auditors	$ 25.62	$ 32.89	$ 48.75
15-1122	Information Security Analysts	$ 29.80	$ 43.53	$ 63.52
15-1199	Computer Occupations, All Other	$ 24.88	$ 39.96	$ 58.75
17-2199	Engineers, All Other	$ 25.04	$ 43.29	$ 64.12
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$ 23.50	$ 37.96	$ 69.36
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$ 14.67	$ 22.04	$ 30.63
43-5061	Production, Planning, and Expediting Clerks	$ 17.12	$ 28.38	$ 40.40
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$ 12.19	$ 17.47	$ 24.40
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$ 23.31	$ 33.79	$ 51.02
47-2011	Boilermakers	$ 23.19	$ 35.00	$ 44.32
47-2021	Brickmasons and Blockmasons	$ 19.36	$ 28.69	$ 41.54
47-2031	Carpenters	$ 17.79	$ 26.24	$ 40.78
47-2061	Construction Laborers	$ 14.47	$ 20.16	$ 32.32
47-2073	Operating Engineers and Other Construction Equipment Operators	$ 19.31	$ 26.92	$ 41.47
47-2081	Drywall and Ceiling Tile Installers	$ 16.95	$ 24.64	$ 40.91

47-2111	Electricians	$ 20.31	$ 31.08	$ 46.63
47-2131	Insulation Workers, Floor, Ceiling, and Wall	$ 15.44	$ 21.67	$ 31.07
47-2132	Insulation Workers, Mechanical	$ 18.74	$ 26.89	$ 43.75
47-2151	Pipelayers	$ 16.57	$ 21.72	$ 33.97
47-2152	Plumbers, Pipefitters, and Steamfitters	$ 19.79	$ 30.37	$ 46.18
47-2181	Roofers	$ 15.75	$ 22.52	$ 32.77
47-2211	Sheet Metal Workers	$ 17.13	$ 27.30	$ 42.53
47-2221	Structural Iron and Steel Workers	$ 19.88	$ 30.40	$ 46.21
47-3012	Helpers--Carpenters	$ 11.38	$ 16.46	$ 22.17
47-3013	Helpers--Electricians	$ 11.92	$ 16.73	$ 23.58
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$ 11.84	$ 16.50	$ 23.14
47-4031	Fence Erectors	$ 11.29	$ 14.13	$ 16.32
47-4098	Miscellaneous Construction and Related Workers	$ 12.58	$ 15.78	$ 18.89
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$ 22.23	$ 33.89	$ 48.48
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$ 20.02	$ 33.28	$ 47.34
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$ 19.13	$ 28.26	$ 39.67
49-9041	Industrial Machinery Mechanics	$ 21.88	$ 31.06	$ 40.69
49-9051	Electrical Power-Line Installers and Repairers	$ 24.82	$ 42.08	$ 52.85
49-9071	Maintenance and Repair Workers, General	$ 15.30	$ 22.74	$ 32.47
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$ 12.96	$ 17.48	$ 24.27
49-9099	Installation, Maintenance, and Repair Workers, All Other	$ 16.00	$ 23.33	$ 33.89
51-1011	First-Line Supervisors of Production and Operating Workers	$ 21.55	$ 31.48	$ 44.04
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$ 12.25	$ 17.22	$ 25.07
51-4121	Welders, Cutters, Solderers, and Brazers	$ 17.65	$ 22.84	$ 31.13
51-4199	Metal Workers and Plastic Workers, All Other	$ 14.24	$ 19.83	$ 28.30
51-9199	Production Workers, All Other	$ 10.80	$ 16.11	$ 24.86
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$ 12.89	$ 17.31	$ 24.12
53-7199	Material Moving Workers, All Other	$ 13.94	$ 18.01	$ 30.69

CLEAN FUELS

SOC	Description	Entry-level	Median	Senior-level
11-1011	Chief Executives	$ 48.22	$ 102.57	$ 177.02
11-1021	General and Operations Managers	$ 31.55	$ 54.60	$ 109.58
11-9021	Construction Managers	$ 39.13	$ 49.36	$ 70.60
13-1199	Business Operations Specialists, All Other	$ 21.50	$ 36.29	$ 57.27
13-2011	Accountants and Auditors	$ 25.62	$ 33.26	$ 48.00
15-1122	Information Security Analysts	$ 30.72	$ 44.35	$ 63.65
15-1199	Computer Occupations, All Other	$ 25.64	$ 40.71	$ 58.86
17-2199	Engineers, All Other	$ 28.93	$ 53.95	$ 85.62
17-3019	Drafters, All Other	$ 17.56	$ 23.74	$ 34.10
17-3029	Engineering Technicians, Except Drafters, All Other	$ 19.21	$ 28.92	$ 42.09
17-3031	Surveying and Mapping Technicians	$ 14.55	$ 20.32	$ 31.60
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$ 25.95	$ 40.18	$ 73.93
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$ 14.72	$ 22.04	$ 30.47
43-5061	Production, Planning, and Expediting Clerks	$ 16.71	$ 27.67	$ 39.03
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$ 12.19	$ 17.65	$ 24.24
47-1011	First-Line Supervisors of Construction Trades and Extraction Workers	$ 24.10	$ 34.05	$ 51.44
47-2061	Construction Laborers	$ 14.52	$ 19.63	$ 32.26
47-2073	Operating Engineers and Other Construction Equipment Operators	$ 19.39	$ 26.21	$ 41.40
47-2111	Electricians	$ 20.39	$ 30.26	$ 46.54
47-2151	Pipelayers	$ 16.63	$ 21.15	$ 33.91
47-2152	Plumbers, Pipefitters, and Steamfitters	$ 19.86	$ 29.56	$ 46.09
47-2181	Roofers	$ 15.81	$ 21.92	$ 32.71
47-2211	Sheet Metal Workers	$ 17.20	$ 26.58	$ 42.45
47-3013	Helpers--Electricians	$ 11.48	$ 17.01	$ 23.80
47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$ 11.41	$ 16.77	$ 23.36
47-5031	Explosives Workers, Ordnance Handling Experts, and Blasters	$ 17.59	$ 24.75	$ 33.57
47-5081	Helpers--Extraction Workers	$ 12.75	$ 18.05	$ 23.39
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$ 24.98	$ 34.14	$ 48.86
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$ 20.86	$ 34.68	$ 47.60
49-9041	Industrial Machinery Mechanics	$ 22.79	$ 32.36	$ 40.91
49-9071	Maintenance and Repair Workers, General	$ 15.93	$ 23.69	$ 32.65
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$ 13.50	$ 18.21	$ 24.40
49-9099	Installation, Maintenance, and Repair Workers, All Other	$ 16.67	$ 24.31	$ 34.08

51-1011	First-Line Supervisors of Production and Operating Workers	$ 21.30	$ 30.31	$ 43.86
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$ 12.21	$ 17.46	$ 25.54
51-4121	Welders, Cutters, Solderers, and Brazers	$ 17.56	$ 22.41	$ 30.26
51-4199	Metal Workers and Plastic Workers, All Other	$ 14.17	$ 19.45	$ 27.51
51-9199	Production Workers, All Other	$ 11.85	$ 16.72	$ 27.33
53-3031	Driver/Sales Workers	$ 11.97	$ 14.58	$ 24.49
53-3032	Heavy and Tractor-Trailer Truck Drivers	$ 18.93	$ 25.78	$ 32.70
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$ 14.61	$ 20.78	$ 28.96
53-7199	Material Moving Workers, All Other	$ 15.80	$ 21.62	$ 36.84

ALTERNATIVE TRANSPORTATION

SOC	Description	Entry-level	Median	Senior-level
11-1011	Chief Executives	$ 52.12	$ 105.97	$ 177.66
11-1021	General and Operations Managers	$ 34.10	$ 56.41	$ 109.97
13-1199	Business Operations Specialists, All Other	$ 21.87	$ 35.52	$ 58.58
13-2011	Accountants and Auditors	$ 25.62	$ 32.38	$ 48.48
15-1122	Information Security Analysts	$ 31.34	$ 45.50	$ 64.91
15-1199	Computer Occupations, All Other	$ 26.16	$ 41.77	$ 60.03
17-2199	Engineers, All Other	$ 29.05	$ 55.03	$ 84.42
17-3019	Drafters, All Other	$ 17.65	$ 24.74	$ 35.93
17-3029	Engineering Technicians, Except Drafters, All Other	$ 19.31	$ 30.15	$ 44.35
17-3031	Surveying and Mapping Technicians	$ 14.63	$ 21.18	$ 33.29
41-4011	Sales Representatives, Wholesale and Manufacturing, Technical and Scientific Products	$ 24.87	$ 38.88	$ 69.60
43-3031	Bookkeeping, Accounting, and Auditing Clerks	$ 14.92	$ 22.59	$ 30.99
43-5061	Production, Planning, and Expediting Clerks	$ 16.75	$ 29.74	$ 39.96
43-6014	Secretaries and Administrative Assistants, Except Legal, Medical, and Executive	$ 12.19	$ 17.83	$ 25.04
47-2061	Construction Laborers	$ 16.83	$ 23.96	$ 37.66
47-2073	Operating Engineers and Other Construction Equipment Operators	$ 22.47	$ 31.99	$ 48.32
47-2111	Electricians	$ 23.63	$ 36.94	$ 54.33
47-2132	Insulation Workers, Mechanical	$ 21.80	$ 31.95	$ 50.97
47-2152	Plumbers, Pipefitters, and Steamfitters	$ 23.02	$ 36.09	$ 53.80
47-2211	Sheet Metal Workers	$ 19.93	$ 32.44	$ 49.55
47-2221	Structural Iron and Steel Workers	$ 23.13	$ 36.13	$ 53.84
47-3013	Helpers--Electricians	$ 13.29	$ 16.94	$ 24.81

47-3015	Helpers--Pipelayers, Plumbers, Pipefitters, and Steamfitters	$ 13.20	$ 16.71	$ 24.35
49-1011	First-Line Supervisors of Mechanics, Installers, and Repairers	$ 22.86	$ 32.51	$ 47.41
49-3021	Automotive Body and Related Repairers	$ 13.30	$ 20.72	$ 33.91
49-3023	Automotive Service Technicians and Mechanics	$ 10.64	$ 18.72	$ 29.49
49-3031	Bus and Truck Mechanics and Diesel Engine Specialists	$ 14.75	$ 21.67	$ 31.48
49-3042	Mobile Heavy Equipment Mechanics, Except Engines	$ 20.73	$ 26.14	$ 33.26
49-9012	Control and Valve Installers and Repairers, Except Mechanical Door	$ 18.11	$ 28.86	$ 40.87
49-9021	Heating, Air Conditioning, and Refrigeration Mechanics and Installers	$ 17.30	$ 24.50	$ 34.24
49-9041	Industrial Machinery Mechanics	$ 19.78	$ 26.93	$ 35.12
49-9071	Maintenance and Repair Workers, General	$ 13.83	$ 19.72	$ 28.03
49-9098	Helpers--Installation, Maintenance, and Repair Workers	$ 11.72	$ 15.16	$ 20.95
49-9099	Installation, Maintenance, and Repair Workers, All Other	$ 14.47	$ 20.23	$ 29.25
51-1011	First-Line Supervisors of Production and Operating Workers	$ 20.01	$ 29.04	$ 41.78
51-2098	Assemblers and Fabricators, All Other, Including Team Assemblers	$ 11.38	$ 16.73	$ 25.07
51-4121	Welders, Cutters, Solderers, and Brazers	$ 17.20	$ 22.13	$ 30.36
51-4199	Metal Workers and Plastic Workers, All Other	$ 13.88	$ 19.22	$ 27.60
51-9199	Production Workers, All Other	$ 11.39	$ 16.34	$ 26.30
53-3031	Driver/Sales Workers	$ 11.73	$ 14.33	$ 25.47
53-3032	Heavy and Tractor-Trailer Truck Drivers	$ 18.56	$ 25.34	$ 34.02
53-7062	Laborers and Freight, Stock, and Material Movers, Hand	$ 11.08	$ 15.60	$ 23.69
53-7199	Material Moving Workers, All Other	$ 11.99	$ 16.23	$ 30.14