CLEAN JOBS, BETTER JOBS

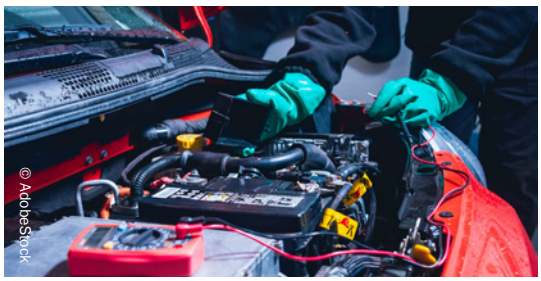
An examination of clean energy job wages and benefits









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ACORE
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ABOUT THIS REPORT

To understand the quality of employment opportunities in clean energy-related industries, E2 (Environmental Entrepreneurs), the American Council on Renewable Energy (ACORE), and the Clean Energy Leadership Institute (CELI) commissioned BW Research to analyze wages and benefits of occupations in clean energy industries in comparison to all occupations nationwide, sectors heavily impacted by the pandemic crisis, and other energy-related occupations.

This report analyzed clean energy wages, benefits and unionization rates across all five clean energy sectors (renewable energy generation, energy efficiency, clean fuels, clean vehicles, and grid modernization and storage) with detailed demographic data for 15 specific clean energy occupations, and how they compare with similar jobs in other industries. Also detailed in the report are state-specific wage findings for all 50 states and the District of Columbia.

Methodology

This report is based primarily on data and research from the U.S. Bureau of Labor Statistics (BLS) and the 2020 U.S. Energy and Employment Report. The national median hourly wage for all occupations, as well as the descriptions for specific occupations outlined in this report, are taken from the BLS May 2019 National Occupational Employment and Wage Estimates: https://www.bls.gov/oes/current/oes_nat.htm#00-0000.

Clean energy industry sector wages are extrapolated using both BLS May 2019 National Industry-Specific Occupational Employment and Wage Estimates and proprietary data from the 2019 and 2020 U.S. Energy and Employment Report data collection effort. Wages described in the individual occupational profiles are also extrapolated using both BLS May 2019 National Occupational Employment and Wage Estimates and the proprietary 2019 and 2020 USEER wage data. State overall clean energy wages are derived from a combination of Emsi Q3 2020 datarun and BLS May 2019 National Industry-Specific Occupational Employment and Wage Estimates. The median hourly wages for other industries in the U.S. are based on the BLS May 2019 National Industry-Specific Occupational Employment and Wage Estimates: https://www.bls.gov/oes/current/oessrci.htm.

National private sector employment benefits data in this report are taken from the Bureau of Labor Statistics: https://www.bls.gov/news.release/pdf/ebs2.pdf. All occupational employment benefits data for the clean energy occupations being profiled are specific to individuals working in the clean energy industry. Clean energy occupational benefits are derived from proprietary data sources based on the 2019 and 2020 U.S. Energy and Employment Report data collection effort.

Unionization rates for clean energy sectors are from the 2020 U.S. Energy and Employment Report dataset but are not available at the sub-sector level of granularity for all clean energy sub-sectors except the solar and wind industries.

Unionization rates for other industries in the U.S. are taken from the Bureau of Labor Statistics: https://www.bls.gov/news.release/union2.t03.htm.

All demographic, education, and training data in this report are taken from Emsi Q3 2020 datarun. Data was extracted on September 9th and 10th, 2020. With the exception of wind turbine technicians and solar photovoltaic installers, data are not specific to the clean energy industry, but representative of the overall occupational average across all industry sectors.

ABOUT E2

E2 (Environmental Entrepreneurs) is a national, nonpartisan group of business leaders, investors, and professionals from every sector of the economy who advocate for smart policies that are good for the economy and good for the environment. E2 members have founded or funded more than 2,500 companies, created more than 600,000 jobs, and manage more than $100 billion in venture and private equity capital. For more information about E2's reports and research into clean energy jobs, see e2.org/reports.

ABOUT ACORE

The American Council on Renewable Energy (ACORE) is a national nonprofit organization that unites finance, policy and technology to accelerate the transition to a renewable energy economy. Founded in 2001, ACORE is the focal point for collaborative advocacy across the renewable energy sector, supported by members spanning renewable energy technologies and constituencies. For more information, please visit www.acore.org.

ABOUT CELI

With programs operating in Washington, DC, San Francisco, and Chicago, the Clean Energy Leadership Institute (CELI) is a 501(c)(3) nonprofit dedicated to developing a new kind of energy leadership. We believe creating a diverse community of change-makers across sectors and disciplines will drive an equitable, decarbonized, and resilient energy ecosystem. To learn more about our trainings and programs, please visit cleanenergyleaders.org.

ABOUT BW RESEARCH PARTNERSHIP

BW Research Partnership is a full-service, economic and workforce research consulting firm with offices in Carlsbad, California and Wrentham, Massachusetts. It is the nation's leading provider of accurate, comprehensive energy and clean energy research studies, including the United States Energy and Employment Report (USEER), National Solar Jobs Census, wind industry analyses for the National Renewable Energy Laboratory and the Natural Resources Defense Council, and state-level clean energy reports for Massachusetts, New York, Illinois, Vermont, Iowa, Rhode Island, Florida, and Missouri, among others.

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INTRODUCTION

Clean energy jobs are now undeniably a major part of our economy.

At the end of 2019, more than 3.3 million Americans worked in clean energy occupations—renewable energy, energy efficiency, clean vehicles and fuels. That is more Americans who worked in clean energy than worked as schoolteachers, real estate agents, farmers or bankers—and nearly three times the number of Americans that work in fossil fuel companies.

As detailed in E2's annual Clean Jobs America reports and related state-specific reports, clean energy jobs are spread across a wide range of sectors, including construction, manufacturing, utilities, trade, and finance. They are found in every state, regardless of geology, geography, or politics.

As government leaders and policymakers in Washington, D.C. and in state capitals look to rebuild a better, more resilient and more equitable economy after the global coronavirus (COVID-19) related economic meltdown, identifying opportunities to create high-quality jobs will be essential.

Building on extensive work around energy employment data, BW Research Partnership (BW Research) was commissioned to delve deeper into the pay and benefits of specific clean energy occupations.

Three overarching findings of this report are both clear and especially significant amid current discussions surrounding how to rebuild the U.S. economy:

// **Median hourly wages for clean energy jobs overall are about 25 percent higher than the national median wage.**

// **Clean energy jobs are more likely to come with health care and retirement benefits than jobs across the rest of the private sector.**

// **Unionization rates for clean energy jobs are slightly higher than the rest of the private sector, with a few exceptions.**

For the purposes of this report, job quality is defined largely in terms of wages and the provision of employment benefits, such as health care and retirement contributions. However, additional metrics, including unionization rates, demographic distribution, and educational requirements are also included.

Overall, median salaries for clean energy jobs are much higher than jobs in sectors such as retail, service and accommodations, especially when it comes to entry-level wages and for Americans just entering the workforce. Clean energy job salaries are also comparable—in some cases better—than fossil fuel job salaries. Jobs in coal, natural gas and petroleum fuels pay about $24.37 an hour, for instance, while jobs in solar and wind pay about $24.85 an hour. Similarly, jobs in energy efficiency—the biggest part of America's energy sector—come with median salaries of about $24.44.

Clean energy occupations also had higher rates of health care coverage, and virtually all enjoyed comparable or better retirement benefits than the national average. Finally, the clean energy industries' 9 percent unionization rate is higher than the 6 percent unionization rate across the rest of the private sector, but varies by occupation.

While this analysis shows clear and consistent outperformance in the clean energy sector on key jobs quality metrics relative to the rest of the economy, as policymakers look toward rebuilding our economy, more can and should be done to ensure high-quality clean energy jobs are available to the full diversity of our workforce in the U.S.

What is a Clean Energy Job?

Most clean energy jobs are well-known occupations found across a variety of value chain activities including manufacturing, construction, wholesale trade, and professional services.

With the exception of clean energy-specific occupation titles like solar photovoltaic installers or wind turbine technicians, the vast majority of clean energy workers do not have "clean energy-specific" job titles.

Instead, clean energy workers are found across many traditional trades, including carpentry, plumbing and mechanical or electrical work. In short, many clean energy occupational titles are not new, previously non-existent positions. Most clean energy projects require the work of skilled tradespeople such as electricians, HVAC technicians, mechanics, welders, and assemblers and fabricators. These are individuals who have already acquired the needed skills and knowledge that are pivotal to modernizing the nation's grid infrastructure, producing electric vehicles and component parts, selling clean energy technologies, or installing and maintaining efficient lighting and HVAC systems. While such work may require additional training or certification, many of the fundamental skill sets remain unchanged.

THE DISPROPORTIONATE IMPACTS OF COVID-19

Since the onset of the COVID-19 pandemic, nearly all industry clusters across the nation have shed workers as a result of forced business shutdowns and social distancing measures. Weekly unemployment claims reached all-time highs, with cumulative numbers surpassing even the worst years of the Great Depression. As of September 2020, roughly 13.5 million individuals were on unemployment insurance.[1] Though this represents a decline from the more than 40 million unemployment claims at the peak of the pandemic-induced economic recession, the nationwide economy is still in shock.

Prior to the pandemic, the clean energy industry had seen annual employment growth for five consecutive years. At the end of 2019, there were more than 3.3 million clean energy workers nationwide—up from the more than 2.5 million clean energy jobs at the end of 2015.[2] Additionally, over 99 percent of U.S. counties were home to clean energy jobs at the end of 2019.

From March 2020 through August 2020, clean energy sector employment levels declined by 14 percent compared to pre-COVID-19 levels—a net loss of nearly 500,000 jobs.[3] Energy efficiency jobs were hit the hardest, with more than 345,000 workers in energy efficiency-related occupations filing for unemployment, as buildings and homes were made off limits due to social distancing and non-essential work orders. Other sectors experienced heavy job losses as well. Nearly 78,000 renewable energy workers filed for unemployment through August, as did about 35,000 clean vehicles workers and nearly 22,000 Americans who work in grid and storage related companies.[4]

At the same time, the economic shutdown has also affected ethnic and racial minorities more significantly across the nation. In April 2020, at the peak of the economic shutdown, six in 10 Hispanic Americans (61 percent) and four in 10 Black Americans (44 percent) reported that someone in their household had either lost a job or experienced wage losses due to COVID-19; this compares to only 38 percent of white Americans.[5]

When it came to job losses in clean energy, Hispanic and Latino workers suffered the most. The clean energy industry is about 14 percent Hispanic or Latino, but an estimated 25 percent of the job losses in the clean energy industry were Hispanic or Latino workers. All non-white racial and ethnic minorities constitute about 37 percent of the clean energy industry while representing 31 percent of job losses.[6] These figures indicate more needs to be done to address racial inequities in clean energy and the broader economy.

AN OPPORTUNITY TO BUILD BACK BETTER, FASTER

Moving forward, if done right, the clean energy economy can provide opportunities for an equitable nationwide economic recovery. Federal policy and stimulus initiatives can focus on ensuring that the economic recovery supports the creation of higher-wage employment opportunities that are accessible to all individuals across the country—better employment opportunities than many other jobs that were quickly lost during the economic downturn. Indeed, the clean energy industry has proven to respond with significant economic returns on targeted and strategic stimulus investments. Clean energy investments under the American Recovery and Reinvestment Act of 2009 resulted in 900,000 job-years from 2009 through 2015, as well as continued job growth across all clean energy technology sectors through the end of 2019.

E2's recent "Build Back Better, Faster" report identified the potential economic impacts today from a similar federal clean energy stimulus totaling $99.2 billion in targeted investments within the energy efficiency, renewable energy, and grid modernization sectors of the clean energy industry. The model finds that such investments would create 860,300 full-time direct, indirect, and induced jobs that would last for at least five years (a total of 4.3 million job-years), and $66 billion in annual GDP for five years—or $330 billion in total economic activity—more than triple the amount of the investments.[7]

The report that follows identifies the most common types of jobs that would be created from such a stimulus package.

Specifically, the report profiles the following 15 occupations, identifying hourly wages, unionization rates, health care and retirement benefits, demographics, and educational characteristics.

1. Wind turbine technicians
2. Solar photovoltaic installers
3. Clean energy technology welders, cutters, solderers, and brazers
4. Supervisors of production workers in clean energy fields
5. Clean energy product wholesale sales representatives
6. Clean energy plumbers, pipefitters, and steamfitters
7. Building efficiency insulation workers
8. Building efficiency HVAC mechanics, installers, and technicians
9. Clean energy construction laborers
10. Clean energy electricians
11. Clean energy electrical power-line installers and repairers
12. Clean energy project construction managers
13. Building efficiency carpenters
14. Clean transportation service mechanics and technicians
15. Clean energy product assemblers and fabricators

Over the last two decades, the nation's energy system has been trending toward decarbonization, and it is likely these trends will continue. Demonstrated by the sector's pre-pandemic employment growth, ability to create jobs quickly in every state and across a multitude of industries, and its higher wages than those most impacted by the economic recession, a clean energy-driven recovery presents a unique opportunity to boost America's workers and build our economy back better.

A clean energy-driven recovery presents a unique opportunity to boost America's workers and build our economy back better.

CLEAN ENERGY INDUSTRY OVERVIEW

OVERALL INDUSTRY WAGES AND UNIONIZATION RATES

In general, the clean energy industry—including clean energy generation, energy efficiency, clean grid and storage, clean fuels, and clean vehicles—supports a higher median hourly wage than the national average. Clean energy jobs overall provide a median hourly wage of $23.89 (Table 1); this is 25 percent higher than the national median wage of $19.14.

Specific clean energy sub-sectors like solar and wind support even higher wages, at $24.48 and $25.95, respectively. In fact, all clean energy sectors support above-average wages when compared to the national median hourly wage of $19.14. Of all clean energy sub-sectors, the wind energy industry supports the highest wage, with a premium of 36 percent over the national median wage; this is followed by grid modernization jobs, which support an hourly wage of $25.40—or 33 percent above the national median.

TABLE 1. WAGES AND UNIONIZATION RATES BY INDUSTRY, 2019

	2019 Median Hourly Wages[8]	% Above or Below the National Median	Unionization Rates[9]	Nationwide Employment, 2019[10]
U.S. TOTAL	**$19.14**	**–**	**6%**	**149,133,921**
CLEAN ENERGY INDUSTRIES OVERALL	**$23.89**	**25%**	**9%**	**3,355,419**
Renewable Energy Generation*	**$23.44**	**22%**	**6%**	**522,811**
Solar	$24.48	28%	4%	345,393
Wind	$25.95	36%	6%	114,774
Energy Efficiency	**$24.44**	**28%**		**2,378,893**
ENERGY STAR Appliances	$24.63	29%		142,272
Renewable Heating & Cooling	$24.91	30%	**10%**	129,998
Efficient Lighting	$24.21	26%		380,299
Traditional & High-Efficiency HVAC	$24.43	28%		1,034,666
Grid Modernization & Storage	**$25.07**	**31%**		**147,644**
Grid Modernization	$25.40	33%	**12%**	67,945
Storage	$24.82	30%		79,699
Clean Fuels (Advanced Biofuels)	**$19.55**	**2%**	**6%**	**39,704**
Clean Vehicles	**$22.20**	**16%**	**9%**	**266,368**
Other Industries				
Retail Trade	$13.16	-31%	4%	15,613,400
Accommodation	$11.64	-39%	7%	2,084,600
Food Services & Drinking Places	$11.48	-40%	1%	12,026,200
Arts, Entertainment, & Recreation	$13.88	-27%	7%	2,415,400

* Includes low-impact hydropower, combined heat and power, bioenergy, and geothermal in addition to wind and solar.

BETTER OPPORTUNITIES FOR IMPACTED WORKERS

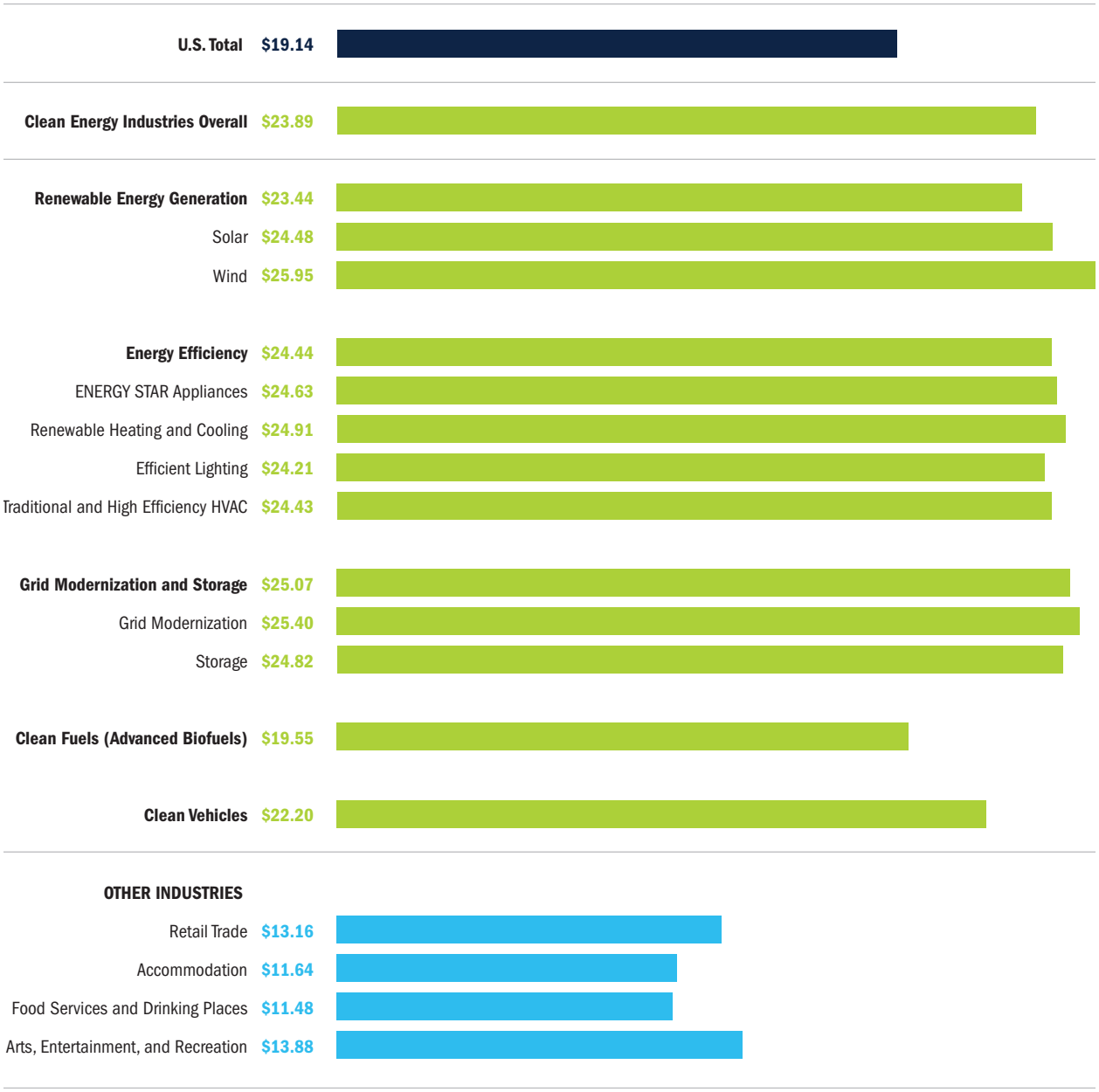
Clean energy wages are particularly high compared to other industry sectors in the United States, including many that suffered major job losses due to COVID-19. In general, retail trade, accommodations, food service, and entertainment and recreation all provide median hourly wages that are 27 to 40 percent lower than the national median hourly wage. These industries support wages that are roughly $11.50 to $13.90 an hour.

In addition to higher hourly wages, clean energy jobs have spread to nearly every county in America—making the industry particularly efficient for producing new and better employment opportunities for workers left jobless by the pandemic. As the nation looks to recover from COVID-19, government investments in clean energy would generate career opportunities with better wage and benefit opportunities for many unemployed due to the pandemic.

Regarding unionization rates, the grid modernization sector boasts the highest rate of unionization at 12 percent—six points above the national average. This is likely due to the sector's high concentration of construction workers, as well as its connection to utilities, which are often unionized. The construction industry accounts for about half of all grid modernization jobs, and at 12.6 percent, the overall construction industry has among the highest rates of unionization compared to other industry sectors like retail trade or food service.[11] The unionization rates for energy efficiency and clean vehicles are also higher than the national average of six percent.

It is important to note that clean energy jobs are more likely to support higher entry-level wages, often reaching parity at senior levels of experience. This is due to the fact that entry-level clean energy positions usually have higher skill or certification requirements, such as additional safety training or manufacturer-specific certifications. These additional skills and certifications tend to offer wage premiums. As clean energy workers rise in experience level, wages even out, as supervisory roles typically have lower demand compared to entry- or mid-level positions. However, these individuals also now have the skills and experience to move into other opportunities in related industries. As a result, clean energy jobs offer advancement pathways both within the clean energy industry and to other careers with similar skill requirements.

FIGURE 1. WAGES BY INDUSTRY, 2019



CLEAN ENERGY WAGES AT THE STATE LEVEL

In nearly every state across the country, the clean energy industry's median hourly wage is higher than the state-specific median hourly wages (see Table 2). This is particularly true for California, Louisiana, Massachusetts, New York, Oregon, and Texas—where the clean energy industry overall pays a premium that is at least 20 percent higher than the statewide median hourly wage. Clean energy workers earn wages 10 percent higher than the state median wage in 23 states, and 5 percent higher in 36 states.

In 37 states and the District of Columbia, the median hourly wage for clean energy workers is over $18.50 and in 25 states that number rises above $20.00. In 14 states, clean energy workers earn a $23.00 median hourly wage.

FIGURE 2: STATES RANKED BY CLEAN ENERGY MEDIAN HOURLY WAGE, 2019

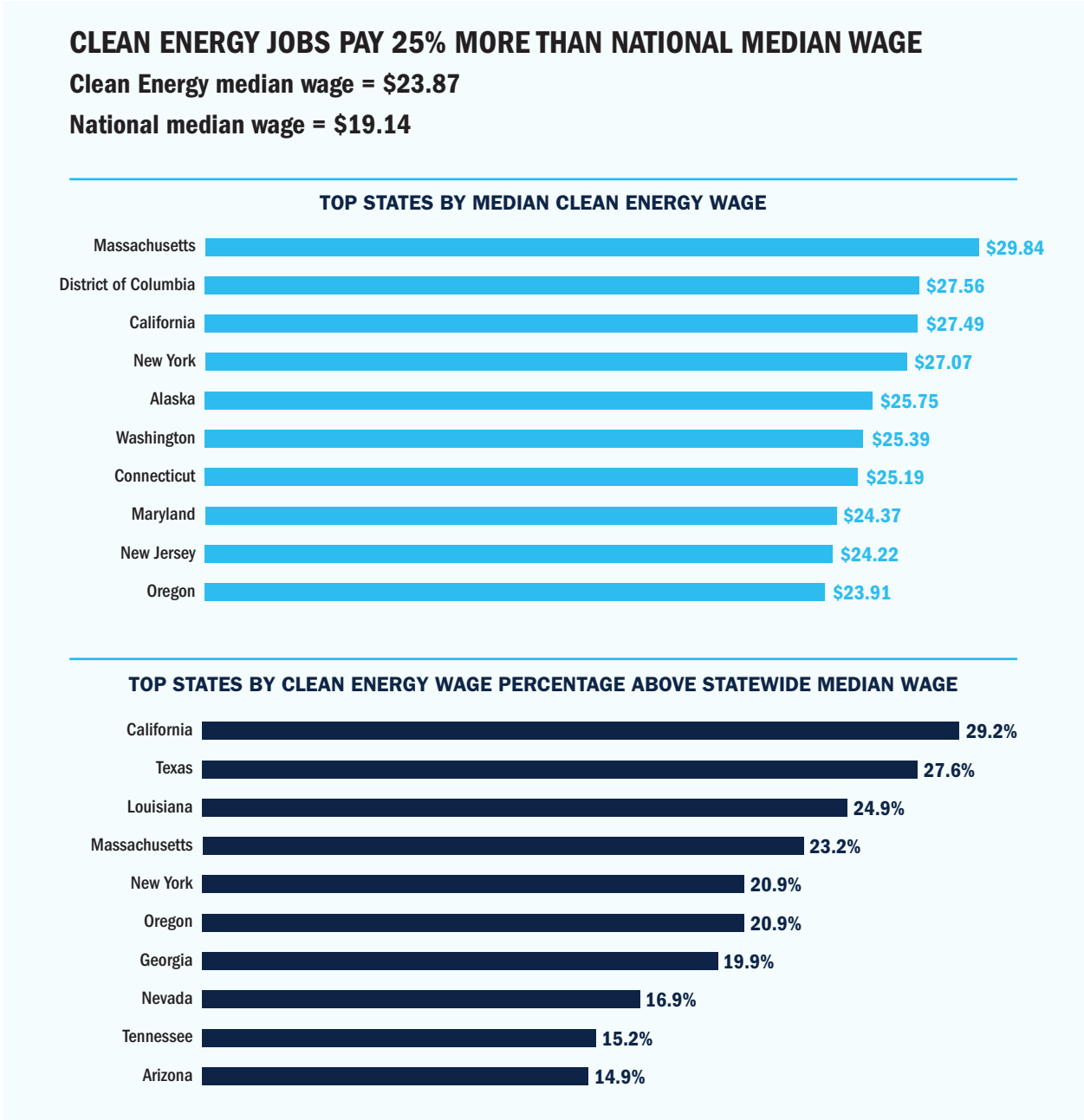


TABLE 2. STATE-LEVEL OVERALL CLEAN ENERGY WAGES, 2019

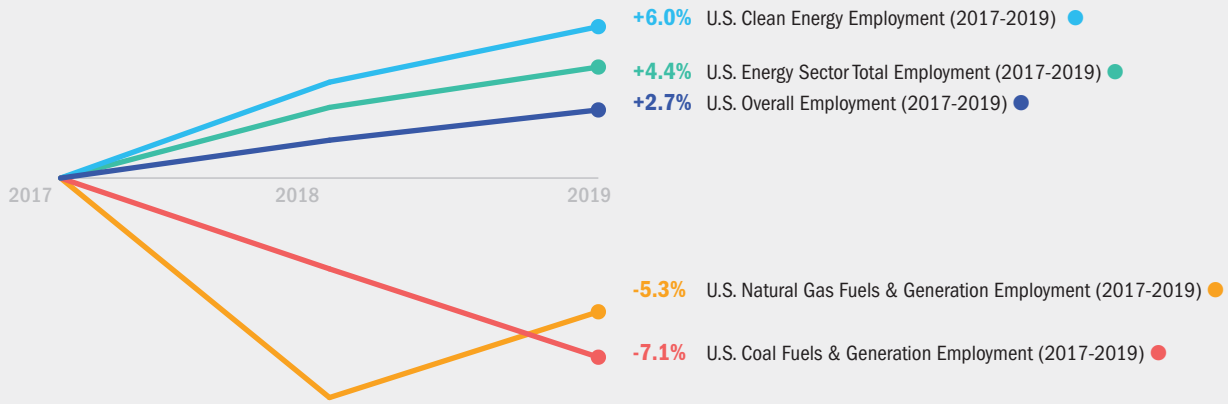
	State Clean Energy Wage, 2019	% Above/Below State-Specific Median Wage
Alabama	$18.56	**10.8%**
Alaska	$25.75	**10.3%**
Arizona	$21.27	**14.9%**
Arkansas	$16.71	**5.5%**
California	$27.49	**29.2%**
Colorado	$23.12	**8.5%**
Connecticut	$25.19	**8.4%**
Delaware	$22.44	**13.6%**
District of Columbia	$27.56	**-21.8%**
Florida	$19.13	**11.1%**
Georgia	$21.36	**19.9%**
Hawaii	$23.78	**11.3%**
Idaho	$17.91	**5.8%**
Illinois	$22.46	**13.1%**
Indiana	$17.37	**-2.3%**
Iowa	$17.93	**-2.8%**
Kansas	$18.67	**5.0%**
Kentucky	$17.92	**5.0%**
Louisiana	$20.98	**24.9%**
Maine	$18.22	**-1.4%**
Maryland	$24.37	**10.6%**
Massachusetts	$29.84	**23.2%**
Michigan	$19.93	**6.8%**
Minnesota	$22.44	**5.9%**
Mississippi	$14.69	**-2.2%**
Missouri	$18.97	**6.2%**

	State Clean Energy Wage, 2019	% Above/Below State-Specific Median Wage
Montana	$18.08	**3.9%**
Nebraska	$17.54	**-4.6%**
Nevada	$20.55	**16.9%**
New Hampshire	$23.02	**14.4%**
New Jersey	$24.22	**11.1%**
New Mexico	$18.95	**11.7%**
New York	$27.07	**20.9%**
North Carolina	$20.05	**12.8%**
North Dakota	$20.34	**-0.1%**
Ohio	$18.85	**1.2%**
Oklahoma	$17.50	**1.9%**
Oregon	$23.91	**20.9%**
Pennsylvania	$20.26	**5.7%**
Rhode Island	$21.33	**0.2%**
South Carolina	$17.98	**7.8%**
South Dakota	$16.15	**-3.2%**
Tennessee	$19.87	**15.2%**
Texas	$23.39	**27.6%**
Utah	$19.30	**5.5%**
Vermont	$18.81	**-4.8%**
Virginia	$21.84	**7.1%**
Washington	$25.39	**10.7%**
West Virginia	$17.91	**10.3%**
Wisconsin	$19.73	**4.5%**
Wyoming	$19.14	**-4.4%**

Comparing Energy Sector Wages, Growth

Clean energy jobs are growing faster than any other segment of the energy sector, accounting for about half of all net new energy sector job growth the past three years.[12] Many jobs in renewable energy technologies, energy efficiency, grid modernization and storage also pay better than a majority of fossil fuels occupations—including those in mining, drilling and fracking.

FIGURE 3: JOB GROWTH RATES BY ENERGY SECTOR, 2017-2019



The majority of fossil fuel related jobs are in fuel extraction, including coal, gas and petroleum. Median wages for fossil fuel extraction-related jobs in coal, gas and petroleum—including mining, fracking and drilling—were about $24.37 per hour last year, according to Bureau of Labor Statistics data. Median wages for solar and wind energy jobs are about $24.85, with the median wage for wind jobs reaching almost $26.00 per hour. Jobs in energy efficiency and grid modernization and storage also come with higher median wages than fossil fuel jobs (see chart below).

Median wages for jobs at power plants and utilities that burn fossil fuels are about $33.31 per hour, however, these jobs typically require higher education and training than many clean energy jobs. These jobs are also considerably less common than clean energy jobs, and are more likely to be unionized. Nuclear engineering and other nuclear-related jobs pay the highest wages across the entire energy sector, in part because they typically have the highest education and training requirements. They also are some of the least common energy sector jobs, with limited opportunities for future growth.

It's important to note that along with having better wages than (non-generation) fossil fuels jobs, clean energy jobs offer more opportunities to more Americans in more places. Clean energy jobs are available in every state and in 99 percent of U.S. counties[13]—regardless of geology, geography or politics. Moreover, wind turbine technicians and solar PV installers are expected to be the first- and third-fastest growing jobs in the country over the next decade, according to BLS,[14] while coal, oil and other traditional energy jobs are expected to continue to decline.

TABLE 3. WAGE RATES AND NATIONWIDE EMPLOYMENT, 2019

Other Energy Sectors	Median Hourly Wages, 2019	Nationwide Employment, 2019
Fossil Fuel Sector Overall	**$25.99**	**1,190,183**
Fossil Fuel	**$24.37**	**966,895**
Coal	$25.26	75,443
Natural Gas	$24.43	275,924
Petroleum/Oil	$24.22	615,528
Fossil Fuel Generation	**$33.31**	**214,245**
Coal	$33.64	79,711
Natural Gas	$34.02	121,812
Petroleum/Oil	$24.49	12,722
Nuclear Fuels	$25.44	9,406
Nuclear Generation	$41.32	60,916

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CLEAN ENERGY OCCUPATIONAL PROFILES

WIND TURBINE TECHNICIANS

JOB DESCRIPTION

Wind turbine technicians are engaged in the installation and repair of wind turbines and their component parts. They are responsible for ensuring wind turbines run efficiently and effectively. Technicians also perform any additional maintenance on the turbine's electrical, mechanical, and hydraulic systems. Unlike other occupations which span multiple clean energy technology sectors, wind turbine technicians are employed exclusively within the renewable energy generation sector.

While some wind turbine technicians may be involved in the building of new wind turbines, most of the work is concentrated in the operation and maintenance of the structures and components. Wind turbines are typically monitored electronically; when an issue is detected, wind turbine technicians travel to the sites to work on repairs. Typical tasks include inspecting components and lubricating parts. Preventative and routine maintenance and servicing for wind turbines typically occurs one to three times per year.

These maintenance and inspection positions are increasingly important as wind generation capacity continues to rise in the United States. In 2019 alone, the wind industry added more than 9,100 megawatts (MW) of new wind capacity. To date, the nation is home to more than 60,000 wind turbines across 41 states and two U.S. territories; six states have more than 20 percent of their electricity generated from wind turbines.[15] With U.S. electricity production moving increasingly toward renewable and clean resources like wind, over the next several years positions such as these are expected to be in demand.[16] Wind turbine technicians are projected to be among the fastest-growing positions over the next decade.[17]

WAGES & BENEFITS

An entry-level wind turbine technician working in the renewable energy generation industry earns $19.15 per hour, which is 49 percent higher compared to the overall entry-level wage for installation, maintenance, and repair occupations. Wind turbine service technicians also earn about three dollars more per hour—a 14 percent premium—compared to the median wage for all installation, maintenance, and repair occupations and just slightly higher than the overall senior-level hourly wage.

Entry-level wages for a wind turbine technician are 49 percent higher than entry-level wages for other installation, maintenance or repair occupations.

TABLE 4. WIND TURBINE TECHNICIAN COMPARATIVE WAGES, 2019[18]

	Entry-level	Median	Senior-level
Installation, Maintenance, & Repair Occupations Overall	$12.86	$22.42	$38.24
Wind Turbine Technicians	$19.15	$25.44	$38.53

Wind turbine service technicians are also more likely to receive employment benefits, such as health care and retirement contributions compared to both the overall national average and the average across all installation, maintenance, and repair occupations.

Roughly eight in 10 wind turbine service technicians receive either partial or full health care benefits from their employer while three-quarters receive some form of retirement contribution, a respective 14 and eight percentage points above the national private sector average.

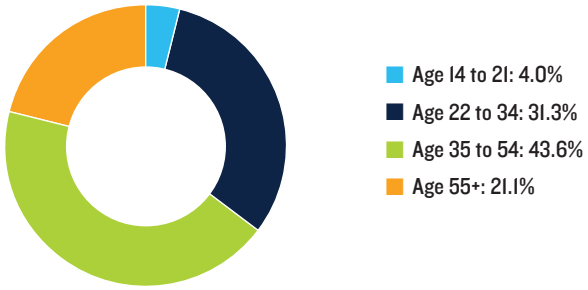
TABLE 5. WIND TURBINE TECHNICIAN EMPLOYMENT BENEFITS, 2019[19]

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Installation, Maintenance, & Repair Occupations National Average	77%	65%
Wind Turbine Technicians	83%	75%

DEMOGRAPHICS

The majority, roughly 65 percent, of wind turbine service technicians are 35 years of age or older, and 21 percent are over the age of 55. This indicates that about two in 10 wind turbine service technicians will in the coming years likely be nearing retirement.

FIGURE 4. WIND TURBINE TECHNICIAN DEMOGRAPHICS, AGE, 2019[20]



About seven in 10 wind turbine service technicians are white and the vast majority—roughly 95 percent—are men. Two in 10 wind turbine service technicians are Hispanic or Latino.

FIGURE 5. WIND TURBINE TECHNICIAN DEMOGRAPHICS, ETHNICITY, 2019

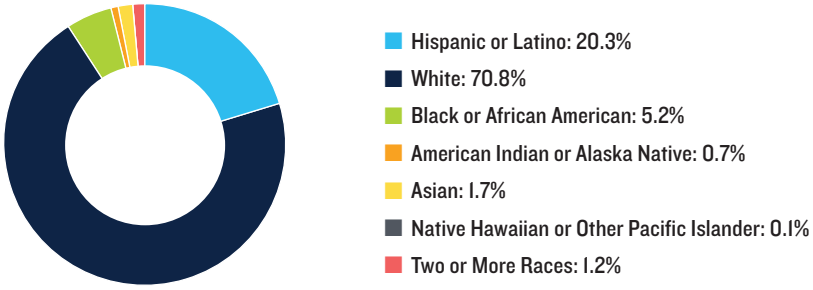
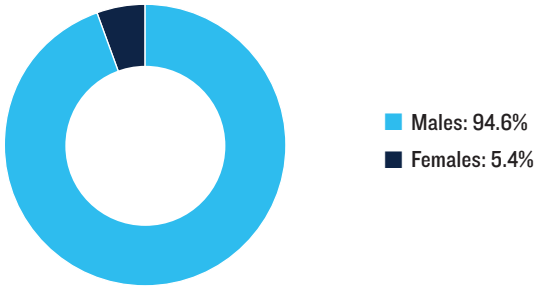


FIGURE 6. WIND TURBINE TECHNICIAN DEMOGRAPHICS, GENDER, 2019



Education, Training, & Certifications

Wind turbine service technicians typically learn their trade by attending a technical school or community college, where they are able to earn certificates in wind energy technology. Some wind turbine service technicians may complete an Associate's degree if they choose to, though it is not usually a requirement to enter the workplace.

In addition to educational coursework, wind turbine technicians often receive long-term on-the-job training related to specific turbines; much of this training is manufacturer-specific, but other avenues include internships or apprenticeships with a wind turbine servicing contractor.

There are typically no mandatory wind turbine technician-specific certifications, though certifications in other areas of work, such as workplace electrical safety, tower climbing, OSHA, first aid, and self-rescue, may be required or preferred by employers.

TABLE 6. WIND TURBINE TECHNICIANS EDUCATION & TRAINING, 2019[21]

Typical Entry Level Education	Typical On-The-Job Training
Postsecondary non-degree award	Long-term on-the-job training

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SOLAR PHOTOVOLTAIC INSTALLERS

JOB DESCRIPTION

Solar photovoltaic (PV) installers are employed within the renewable energy generation sector of the clean energy economy. Their job is to assemble, install, and maintain solar PV systems on roofs, other structures and on land. Tasks may include measuring, cutting, assembling, and bolting structural framing and solar modules. Additionally, installers may perform minor electrical work to ensure the system functions properly, such as determining current requirements in a solar PV electrical circuit and connecting wiring between solar systems and module arrays.

Over the last decade, installed solar capacity has risen sharply in the U.S., with an estimated average annual growth rate of 49 percent. While business restrictions and shelter-in-place orders resulted in slight declines in quarterly installed capacity for the first half of 2020—particularly for residential and commercial installations—almost nine gigawatts (GW) of new utility PV power-purchase agreements were announced in the second quarter of the year. To date, there are 62 GW of contracted utility PV projects in the pipeline.[22] As businesses begin to reopen and the nation recovers from the economic recession, installed capacity will likely continue to grow, increasing the demand for solar PV installers in the workforce. Solar installers are also projected to be among the fastest-growing positions over the next decade.[23]

WAGES & BENEFITS

At the entry-level of work experience, solar photovoltaic installers on solar projects (without a license) earn an 11 percent premium over the national entry-level wage for all construction and extraction occupations. For mid- and senior-level experienced solar PV installers, the hourly wages are lower than overall construction and extraction occupations. However, solar PV installers who have an electrician license earn more than the overall average for construction and extraction occupations across both the entry- and mid-level of experience. At the senior-level, licensed PV installers earn more than non-licensed installers.[24]

TABLE 7. SOLAR PHOTOVOLTAIC INSTALLERS COMPARATIVE WAGES, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Solar Photovoltaic Installers (w/Electrician License)	$17.27	$25.69	$35.07
Solar Photovoltaic Installers	$15.19	$21.58	$30.71

About 80 percent of solar installers receive either full or partial health care coverage from their employers.

Solar PV installers are more likely to receive health care benefits compared to the overall national private sector average and the overall average for all construction occupations. About eight in 10 solar PV installers receive either full or partial health care coverage from their employers.

Solar PV installers are also more likely to receive retirement benefits compared to the overall construction average, but slightly less likely compared to the overall national private sector average. Sixty-five percent of solar PV installers receive some form of retirement contributions from their employer. These health care and retirement benefits are paid for almost exclusively by contractors working in projects, and comparable data for residential solar installation is more difficult to obtain.[25]

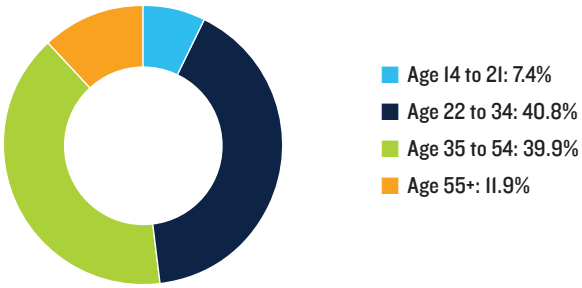
TABLE 8. SOLAR PHOTOVOLTAIC INSTALLERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Solar Photovoltaic Installers	79%	65%

DEMOGRAPHICS

There is a healthy representation of younger individuals in this occupational group. Almost half (48 percent) are under the age of 35 and only 12 percent are nearing retirement age.

FIGURE 7. SOLAR PHOTOVOLTAIC INSTALLERS DEMOGRAPHICS, AGE, 2019[26]



Solar PV installers are also slightly more diverse; only 55 percent of this occupational group is white and roughly a third are Hispanic or Latino. However, the workforce is largely male, as 96 percent of solar PV installers are men.

FIGURE 8. SOLAR PHOTOVOLTAIC INSTALLERS DEMOGRAPHICS, ETHNICITY, 2019

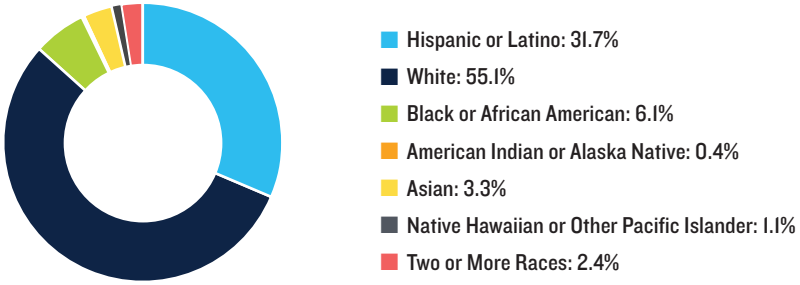
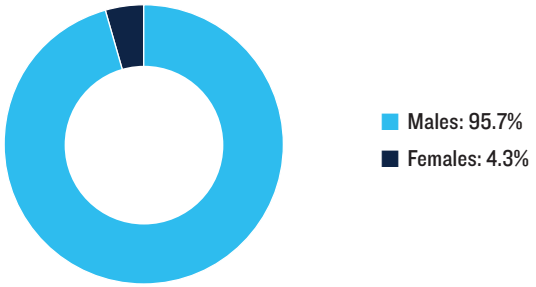


FIGURE 9. SOLAR PHOTOVOLTAIC INSTALLERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

The highest level of education required for job entry is typically a high school diploma or equivalent. Some installers may opt to take courses at a community college or trade school in order to learn more, while some candidates may enter the field with online training only. Web courses are most suitable for jobseekers who already have prior experience in the construction trades, such as electricians.

Many work tasks may be learned through on-the-job training and by working with experienced PV installers. Specific training modules may also be available through internships, apprenticeships, or manufacturer-specific courses on products.

While there is no specific required certification to become a PV installer, several organizations—such as the Electronics Technicians Association International (ETA), the North American Board of Certified Energy Practicioners (NABCEP), and Roof Integrated Solar Energy Inc. (RISE)—all offer certifications for PV installers.

TABLE 9. SOLAR PHOTOVOLTAIC INSTALLERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Moderate-term on-the-job training

CLEAN ENERGY TECHNOLOGY WELDERS, CUTTERS, SOLDERERS, AND BRAZERS

JOB DESCRIPTION

Welders, cutters, solderers, and brazers use a variety of techniques to join metal components or to fill holes, indentations, or seams of fabricated metal products. Their work applies to all technology sectors of the clean energy industry. Although welding and related tasks are not typically thought of as clean energy jobs, these occupations will be increasingly important to the construction and maintenance of clean energy infrastructure, as well as the manufacture of clean energy technologies and component parts over the coming years.

Welders are needed to support the construction of transmission lines, the manufacture and maintenance of wind turbines and equipment, as well as the construction or retrofit of energy-efficient residential, commercial, and industrial buildings. In general, with the nation's aging infrastructure and as the U.S. continues to build out its clean energy infrastructure over the next several years, welders are expected to see increased demand. Furthermore, with much of this workforce reaching retirement age, and with many young adults often choosing a four-year college degree over studying a vocational trade, these jobs are not being replaced fast enough. In fact, the American Welding Society projected that there would be a shortage of more than 400,000 skilled welders by 2024.[27]

WAGES & BENEFITS

Overall, welders, cutters, solderers, and brazers in the clean energy industry earn a premium across all levels of work experience compared to the national occupational average. Across all clean energy technology sectors, welders earn a premium over the entry- and mid-level hourly wages for production occupations overall.

At the senior-level of experience, welders working in grid modernization and storage, energy efficiency, clean fuels, and clean vehicles earn more per hour than the overall hourly wage for senior-level production positions.

In general, welders within the energy efficiency and grid modernization and storage sectors tend to earn the most per hour compared to other clean energy technology sectors.

TABLE 10. WELDERS, CUTTERS, SOLDERERS, AND BRAZERS WAGES, 2019

	Entry-level	Median	Senior-level
Production Occupations Overall	$11.14	$17.31	$30.41
Welders, Cutters, Solderers, & Brazers Overall	$14.17	$20.43	$30.89
Welders, Cutters, Solderers, & Brazers in Clean Energy	$16.95	$22.48	$31.94
Welders, Cutters, Solderers, and Brazers by Clean Energy Sector			
Renewable Energy Generation	$15.86	$21.05	$29.46
Grid Modernization & Storage	$16.83	$22.51	$33.05
Energy Efficiency	$17.17	$22.78	$32.42
Clean Fuels	$16.95	$22.09	$31.17
Clean Vehicles	$16.61	$21.82	$31.27

Welders working in the clean energy economy are also more likely to receive health care and retirement benefits compared to the national private sector average, as well as the overall national average for all production occupations.

About nine in 10 welders, cutters, solderers, and brazers working across the clean energy technology sectors receive health care and retirement benefits from their employers, a respective 24 and 22 percentage points above the national private sector average.

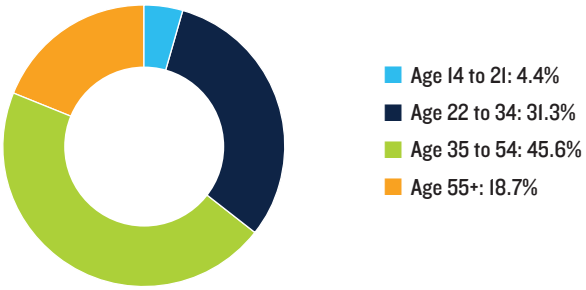
TABLE 11. WELDERS, CUTTERS, SOLDERERS, AND BRAZERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Production Occupations National Average	81%	73%
Clean Energy Technology Welders, Cutters, Solderers, & Brazers	93%	89%

DEMOGRAPHICS

About two in 10 welders, cutters, solderers, and brazers are over the age of 55 and thus nearing retirement in the coming years. Another 46 percent are between the ages of 35 and 54, and roughly a third of the workforce is under the age of 35.

FIGURE 10. WELDERS, CUTTERS, SOLDERERS, AND BRAZERS DEMOGRAPHICS, AGE, 2019[28]



Two-thirds of welders, cutters, solderers, and brazers across the U.S. are white, 19 percent are Hispanic or Latino, and eight percent are Black or African American. The majority (94 percent) are male.

FIGURE 11. WELDERS, CUTTERS, SOLDERERS, AND BRAZERS DEMOGRAPHICS, ETHNICITY, 2019

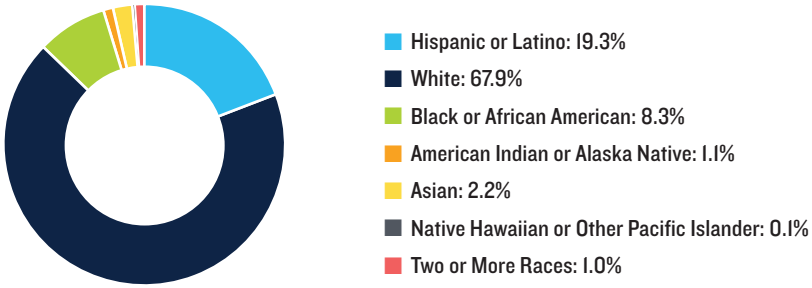
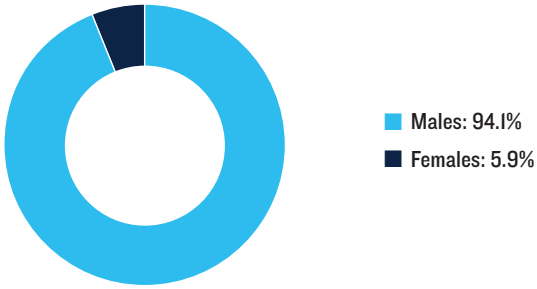


FIGURE 12. WELDERS, CUTTERS, SOLDERERS, AND BRAZERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

A high school diploma or equivalent alongside technical training, either on-the-job or through apprenticeships combined with classroom lessons, are required for any individual seeking to embark on this career path.

There are several certifications available for this occupation, including the following from the American Welding Society and the International Code Council: Certified Welder, Certified Radiographic Interpreter, Certified Associate Welding Inspector, and Certified Welding Supervisor—these are considered core certifications. Advanced or specialty certifications include the Senior Certified Welding Inspector, Certified Welding Engineer, Structural Welding Special Inspector, and Certified Robotic Arc Welding Operators and Technicians. Some states may require an occupational license to work in this field.

TABLE 12. WELDERS, CUTTERS, SOLDERERS, AND BRAZERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Moderate-term on-the-job training

SUPERVISORS OF PRODUCTION WORKERS IN CLEAN ENERGY FIELDS

JOB DESCRIPTION

Supervisors of production workers are valuable to all technology sectors of the clean energy economy. In the United States, clean energy manufacturing accounted for almost 547,000 jobs—or 16 percent of the clean energy workforce in the nation at the end of 2019.[29] U.S. clean energy manufacturers are engaged in the production of wind turbines, ENERGY STAR®-certified appliances, heating and cooling products, and lighting fixtures, as well as hybrid and electric vehicles and component parts, batteries, and smart meters. Production supervisors manage and coordinate the activities of production and operation workers, including inspectors, precision workers, machine setters and operators, assemblers, fabricators, and plant and system operators. They work in both the industrial manufacturing of clean energy technologies, as well as in the development of more energy-efficient manufacturing processes.

In the United States, there are roughly 500 manufacturing facilities that specialize in wind component parts[30] and 2,000 manufacturers of ENERGY STAR-certified products.[31] As the demand for clean energy technologies continues to grow both nationally and globally, U.S. clean energy manufacturers are poised to meet this demand, and production supervisors will become increasingly important in the growing clean energy economy.

Roughly 500 U.S. manufacturing facilities specialize in wind component parts and 2,000 U.S. factories manufacture ENERGY STAR-certified products.

WAGES & BENEFITS

In general, entry- and mid-level supervisors of production workers that are working in the clean energy industry—across nearly all technology sectors—earn more than the hourly wage for supervisors of production workers overall. Compared to the overall hourly wages for all production occupations, supervisors of production workers in clean energy fields earn a premium across the board.

Individuals working in the energy efficiency sector earn the most compared to all other clean energy technology sectors.

TABLE 13. SUPERVISORS OF PRODUCTION WORKERS WAGES BY TECHNOLOGY SECTOR AND EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Production Occupations Overall	$11.14	$17.31	$30.41
Supervisors of Production Workers Overall	$17.66	$29.48	$48.17
Supervisors of Production Workers in Clean Energy	$20.59	$31.23	$47.30
Supervisors of Production Workers by Clean Energy Sector			
Renewable Energy Generation	$20.38	$29.66	$45.45
Grid Modernization & Storage	$18.94	$29.11	$44.79
Energy Efficiency	$20.86	$32.00	$48.15
Clean Fuels	$20.14	$30.12	$47.00
Clean Vehicles	$18.94	$28.87	$44.79

Supervisors of production workers in clean energy fields are significantly more likely to receive employment benefits compared to the national private sector average and the overall average for all production workers. Nearly all (96 percent) receive full or partial health care coverage and about nine in 10 (88 percent) receive retirement benefits.

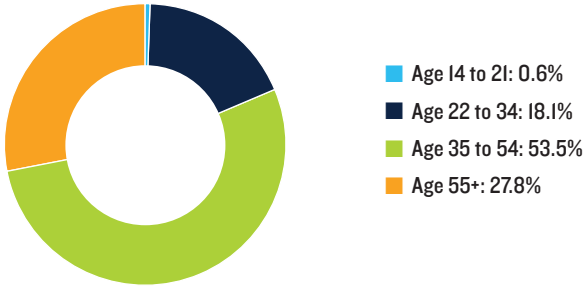
TABLE 14. SUPERVISORS OF PRODUCTION WORKERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Production Occupations National Average	81%	73%
Supervisors of Production Workers in Clean Energy	96%	88%

DEMOGRAPHICS

The majority of individuals in this occupation (54 percent) are between the ages of 35 to 54; this is not surprising as production worker supervisors likely require a few years of work experience in the field before moving up to a supervisorial position. Almost three in 10 (28 percent) are over the age of 55 and likely nearing retirement.

FIGURE 13. SUPERVISORS OF PRODUCTION WORKERS DEMOGRAPHICS, AGE, 2019[32]



Seventy-one percent of individuals in this occupation are white, 14 percent are Hispanic or Latino, and about 10 percent are Black or African American. Eight in 10 are men.

FIGURE 14. SUPERVISORS OF PRODUCTION WORKERS DEMOGRAPHICS, ETHNICITY, 2019

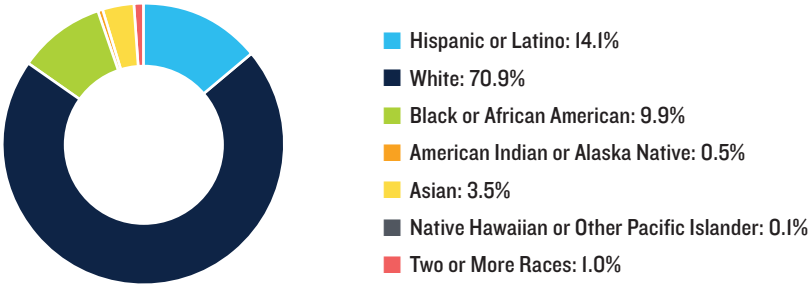
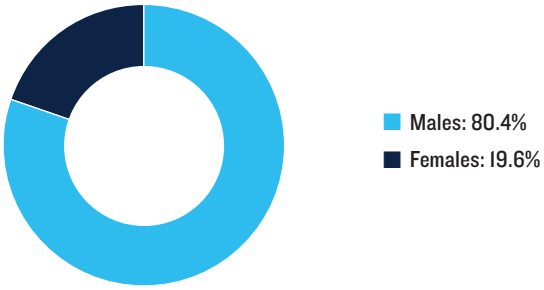


FIGURE 15. SUPERVISORS OF PRODUCTION WORKERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Individuals beginning in this career typically have a high school diploma or equivalent and five years or less of work experience. There is not usually on-the-job training for this position. Some individuals may choose to pursue a degree, in which case coursework in an operations management and supervision program may be useful.

There are no specific required certifications needed for this position though several are offered through multiple organizations, such as the American Welding Society, the National Institute for Metalworking Skills, the IPC Association Connecting Electronics Industries, and more.

TABLE 15. SUPERVISORS OF PRODUCTION WORKERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	None

CLEAN ENERGY PRODUCT WHOLESALE SALES REPRESENTATIVES

JOB DESCRIPTION

For the purposes of this report, clean energy sales representatives work solely in wholesale trade. These individuals sell goods for both wholesalers and manufacturers and are expected to have a well-rounded understanding of their clean energy products, markets, services, and technologies. Clean energy-specific knowledge is particularly important, as these individuals must be able to present information to customers about the energy efficiency or environmental impacts of products, as well as research and convey information about the tax benefits and government rebates associated with clean energy products.

Sales representatives are found across all technology sectors of the clean energy industry. With a growing clean energy manufacturing base in the U.S. and increased demand for clean energy goods and services, clean energy sales jobs are expected to grow.

WAGES & BENEFITS

Clean energy wholesale sales representatives earn more than the overall national sales occupational wages and wholesale sales representatives in general at all levels of experience. At the entry- and mid-level of experience in particular, wholesale sales representatives working in the clean energy industry earn more than double the hourly wages for all sales occupations.

Sales representatives within the renewable energy generation and clean fuels sector earn the highest premiums compared to other clean energy technology sectors.

TABLE 16. WHOLESALE SALES REPRESENTATIVES WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
National Sales Occupations Overall	$9.41	$14.24	$38.95
Wholesale Sales Representatives Overall	$15.30	$30.29	$63.90
Wholesale Sales Representatives in Clean Energy	$21.21	$37.73	$68.53
Wholesale Sales Representatives by Clean Energy Sector			
Renewable Energy Generation	$23.16	$39.74	$71.76
Grid Modernization & Storage	$21.94	$38.03	$69.26
Energy Efficiency	$20.71	$37.29	$67.94
Clean Fuels	$22.86	$39.44	$72.34
Clean Vehicles	$21.94	$38.17	$68.17

Wholesale sales representatives for clean energy products are more likely to receive health care and retirement benefits compared to both the overall national private sector and sales occupations averages.

Eighty-seven percent of clean energy product sales representatives receive full or partial health care coverage from their employer, and three-quarters receive some form of retirement contributions.

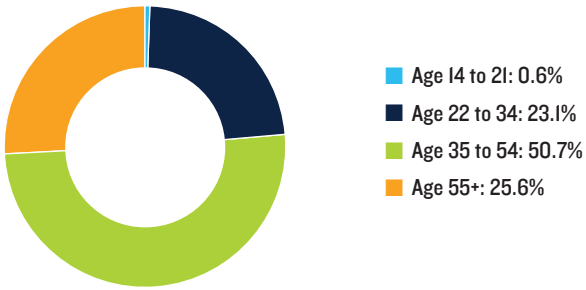
TABLE 17. WHOLESALE SALES REPRESENTATIVES EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Sales Occupations National Average	54%	68%
Clean Energy Product Wholesale Sales Representatives	87%	75%

DEMOGRAPHICS

More than three-quarters (76 percent) of individuals in this occupation are at least 35 years of age or older. Just over a quarter (26 percent) are over 55 and nearing retirement age.

FIGURE 16. WHOLESALE SALES REPRESENTATIVES DEMOGRAPHICS, AGE, 2019[33]



There are more women in this occupation compared to other jobs in the clean energy economy, particularly in construction. About three in 10 (29 percent) of individuals in this occupation are women.

Eight in 10 individuals are white, while nine percent and four percent are Hispanic or Latino and Black or African American, respectively.

FIGURE 17. WHOLESALE SALES REPRESENTATIVES DEMOGRAPHICS, ETHNICITY, 2019

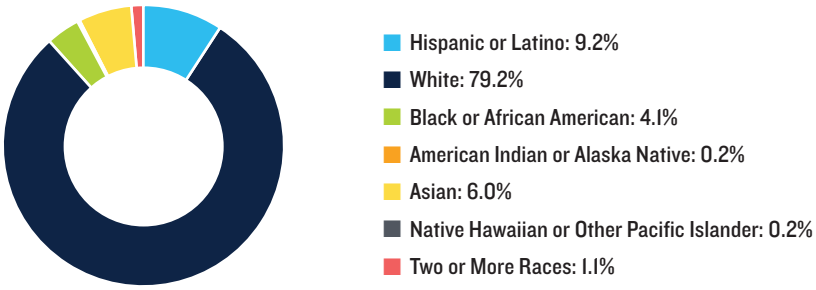
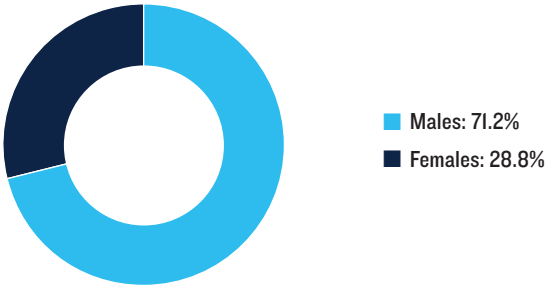


FIGURE 18. WHOLESALE SALES REPRESENTATIVES DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Due to the technical knowledge and expertise required of wholesale sales representatives, the required level of education upon entry is typically a Bachelor's degree—often in an area of study related to the products being sold.

Previous sales experience and specific knowledge in the technologies and products these individuals will be working with are valuable to jobseekers choosing a career path in clean energy product sales. New sales representatives may be required to complete company training programs in order to become familiar with the products, customer base, and sales strategies. On-the-job training may also consist of joining sales calls with experienced representatives.

Certification is voluntary, but the Manufacturers' Representatives Education Research Foundation does offer a Certified Sales Professional (CSP) credential.

TABLE 18. WHOLESALE SALES REPRESENTATIVES EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
Bachelor's degree	Moderate-term on-the-job training

© GettyImages

CLEAN ENERGY PLUMBERS, PIPEFITTERS, AND STEAMFITTERS

JOB DESCRIPTION

Plumbers, pipefitters, and steamfitters work with pipe systems that carry water, steam, air, or other liquids and gases. These individuals perform many tasks that are vital to the functioning of the clean energy economy. They install and test fixtures, appliances, or equipment designed to reduce water and energy consumption, including gray water systems or geothermal heating and cooling systems. Plumbers also contribute to the clean energy economy by calculating cost savings for water- or energy-efficient appliances.

These jobs are expected to be in high demand, similar to welders, as much of the skilled trades workforce is nearing retirement and the nation's aging infrastructure is in need of revitalization and rebuilding.[34] Within the clean energy industry, plumbers, pipefitters, and steamfitters are most likely found in the energy efficiency sector but may also be employed in grid modernization, renewable energy generation, and clean fuels. In the energy efficiency space, these individuals are likely involved in the energy-efficient retrofitting of homes, public, and commercial buildings or the installation and maintenance of clean heating and cooling systems; in fact, plumbers are essential to the construction of new buildings. In other sectors of the clean energy economy, plumbers may be key to the building of new renewable resource-fueled power plants or the retrofitting and decommissioning of older power plants.

WAGES & BENEFITS

Entry-level plumbers, pipefitters, and steamfitters across all clean energy technology sectors earn a higher hourly wage compared to the overall entry-level hourly wage for construction and extraction occupations.

In the clean energy industry, plumbers, pipefitters, and steamfitters are often paid higher-than-average hourly wages at the entry- and mid-level.

TABLE 19. PLUMBERS, PIPEFITTERS, AND STEAMFITTERS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Plumbers, Pipefitters, & Steamfitters Overall	$15.71	$26.52	$46.72
Plumbers, Pipefitters, & Steamfitters in Clean Energy	$18.60	$29.10	45.83
Plumbers, Pipefitters, and Steamfitters by Clean Energy Sector			
Renewable Energy Generation	$18.05	$28.81	$44.67
Grid Modernization & Storage	$18.53	$28.66	$46.76
Energy Efficiency	$18.76	$29.22	$46.09
Clean Fuels	$18.29	$27.71	$45.33

Plumbers, pipefitters, and steamfitters working in the clean energy industry are more likely to receive health care benefits compared to the national private sector average and the overall construction industry average. About eight in 10 (79 percent) workers receive full or partial health care coverage, 10 points above the national private sector average.

Clean energy plumbers, pipefitters, and steamfitters are more likely to receive retirement benefits compared to the overall construction occupational average, but slightly less likely than the overall private sector average. Sixty-eight percent of clean energy plumbers, pipefitters, and steamfitters receive some contributions from their employers to a retirement plan.

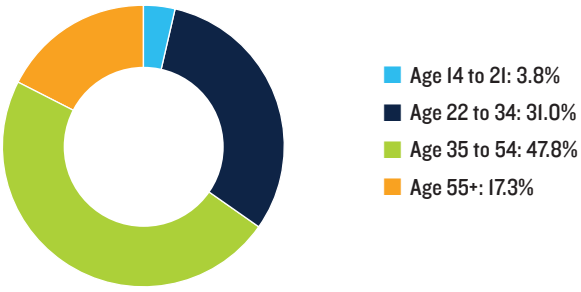
TABLE 20. PLUMBERS, PIPEFITTERS, AND STEAMFITTERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Clean Energy Plumbers, Pipefitters, & Steamfitters	79%	68%

DEMOGRAPHICS

The majority of workers in this occupational group (65 percent) are 35 years of age or older, and 17 percent are nearing retirement age. Just under a third are between the ages of 22 and 34.

FIGURE 19. PLUMBERS, PIPEFITTERS, AND STEAMFITTERS DEMOGRAPHICS, AGE, 2019[35]



Almost three-quarters (72 percent) of plumbers, pipefitters, and steamfitters are white, while 19 percent are Hispanic or Latino, and six percent are Black or African American. The vast majority (98 percent) of workers are men.

FIGURE 20. PLUMBERS, PIPEFITTERS, AND STEAMFITTERS DEMOGRAPHICS, ETHNICITY, 2019

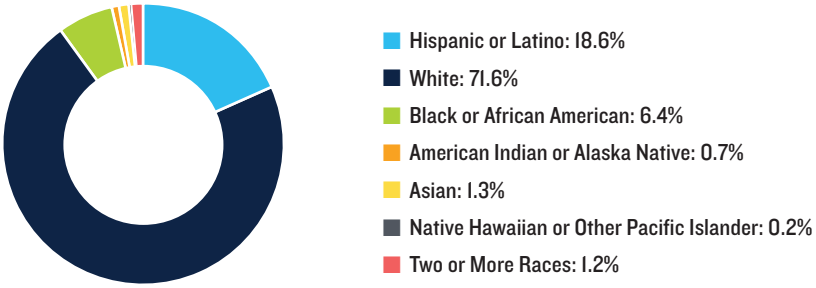
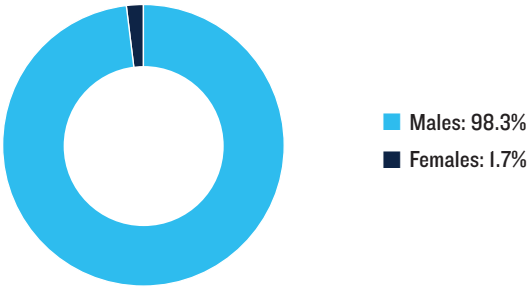


FIGURE 21. PLUMBERS, PIPEFITTERS, AND STEAMFITTERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

The typical level of education required to enter this career path is a high school diploma or equivalent, with technical and hands-on training completed through a formal apprenticeship or vocational college program. Most plumbers, pipefitters, and steamfitters learn their trade through some type of on-the-job training, though some may start off by attending courses at a technical or trade school. Technical schools offer courses including pipe system design, safety, and tool use. Welding courses may be necessary for some pipefitters and steamfitters, and plumbers must also be knowledgeable of state-specific standards, such as the California Green Building Standards Code (CALGreen); these types of codes and regulations affect the construction of new projects.

Upon apprenticeship completion, individuals must pass a code exam in order to obtain a plumbing certificate. If plumbers choose to become self-employed contractors, they must pass another exam in order to obtain a plumbing contractor's license through the U.S. Department of Consumer Affairs, Contractors State License Board. Most states require pipefitters and steamfitters to be licensed. These requirements vary, but the majority require workers to have two to five years of work experience in addition to passing an examination before individuals may work independently.

TABLE 21. PLUMBERS, PIPEFITTERS, AND STEAMFITTERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Apprenticeship

BUILDING EFFICIENCY INSULATION WORKERS

JOB DESCRIPTION

Insulation workers line and cover floors, ceilings, and walls with insulating materials such as fiberglass, mineral wool, cellulose, or foam. These individuals are pivotal to increasing the energy efficiency of residential, commercial, and industrial buildings across the nation, as proper insulation can reduce a building's overall energy use for heating and cooling. Insulation workers must be able to read blueprints and specifications to identify the amount of materials required to properly insulate a home or office building, prepare insulation surfaces, use tools to measure and cut materials to fit into walls or surfaces, and seal or protect the insulation materials from moisture.

With the availability of financial incentives for energy efficiency retrofits and upgrades across state and local governments, utilities, and manufacturers, there will likely continue to be growing demand for building efficiency improvements and increased energy cost savings over the years. To capture energy savings, skilled workers are needed to properly install energy efficiency equipment and materials.[36] In general, the construction trades are facing a shortage of skilled workers, as previously described for plumbers and welders. With much of the labor force soon reaching retirement age and the need to rebuild or retrofit the nation's aging building infrastructure, these demands are expected to increase the need for more insulation workers.

WAGES & BENEFITS

Building efficiency insulation workers earn more per hour at the entry- and mid-level of experience compared to insulation workers overall, a respective 19- and 10-percent wage premium.

Compared to construction and extraction occupations overall, insulation workers in the energy efficiency industry earn a premium over the entry-level wage, though hourly wages are lower at the mid- and senior-level of experience.

TABLE 22. INSULATION WORKERS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Insulation Workers Overall	$12.43	$19.41	$33.11
Insulation Workers in Energy Efficiency	$14.85	$21.38	$32.66

Building efficiency insulation workers are more likely to receive health care benefits compared to the national private sector and construction occupational averages. Eight in 10 building efficiency insulation workers receive health care benefits.

These individuals are also more likely to receive retirement contributions from their employer compared to the overall average.

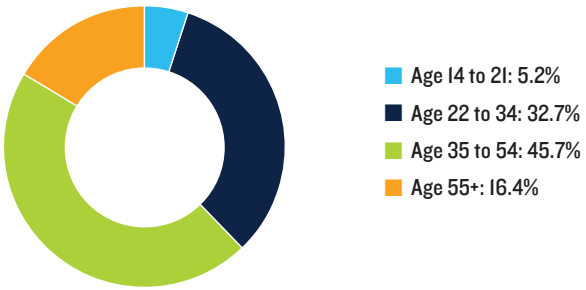
TABLE 23. INSULATION WORKERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Building Efficiency Insulation Workers	80%	69%

DEMOGRAPHICS

Sixty-two percent of this occupational group are 35 years of age or older, and a third are between the ages of 22 and 34.

FIGURE 22. INSULATION WORKERS DEMOGRAPHICS, AGE, 2019[37]



At about 26 percent, there is a higher proportion of Hispanic or Latino workers in this occupation compared to other clean energy occupations. Sixty-four percent of individuals in this occupational group are white, while seven percent are Black or African American. The majority of workers are also men (91 percent).

FIGURE 23. INSULATION WORKERS DEMOGRAPHICS, ETHNICITY, 2019

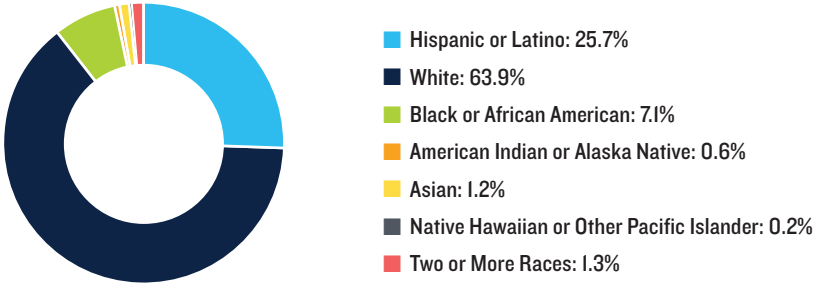
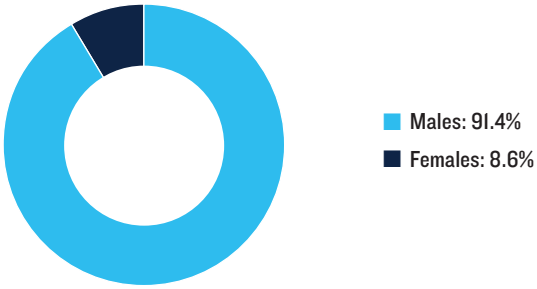


FIGURE 24. INSULATION WORKERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Most insulation workers typically learn through informal on-the-job training, though mechanical insulators often complete formal apprenticeships. Such apprenticeship programs cover first aid, math, and construction techniques. States have varying hourly requirements of on-the-job training for this occupation; once they reach required training milestones, insulation workers can obtain a certification.

Certification is especially important for workers who come into contact with asbestos; these individuals must obtain certification through the U.S. Environmental Protection Agency. Some states also require asbestos training programs.

TABLE 24. INSULATION WORKERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
No formal educational credential	Short-term on-the-job training

BUILDING EFFICIENCY HVAC MECHANICS, INSTALLERS, AND TECHNICIANS

JOB DESCRIPTION

HVAC workers install, service, or repair heating and air conditioning systems in residential, commercial, and industrial buildings. These individuals are employed within the energy efficiency sector of the clean energy economy and, similar to insulation workers, are also pivotal to the improvement of building energy efficiency and energy cost savings. With growing demand for improved building efficiency, HVAC mechanics, installers, and technicians are needed to update old HVAC systems to new ENERGY STAR-rated systems.

Similar to insulation workers, this occupation is likely to grow in the future as the nation's building infrastructure is updated and retrofitted for improved energy efficiency. To capture energy savings, skilled workers are needed to properly install energy efficiency equipment and materials.[38]

WAGES & BENEFITS

Across all levels of experience, building efficiency HVAC mechanics, installers, and technicians earn a premium over the hourly wages of both overall installation, maintenance, and repair occupations as well as the overall HVAC mechanic, installer, and technician hourly wages.

HVAC workers in the energy efficiency sector are also more likely to receive employment benefits compared to national averages. Eighty-two percent of individuals received health care benefits, compared to the 69 percent national average and 77 percent average for installation, maintenance, and repair occupations overall.

Seventy-one percent of building efficiency HVAC mechanics, installers, and technicians received some form of retirement contributions from their employer, compared to the 67 percent national average and 65 percent average for the overall occupational group.

TABLE 25. HVAC MECHANICS, INSTALLERS, AND TECHNICIANS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Installation, Maintenance, & Repair Occupations Overall	$12.86	$22.42	$38.24
HVAC Mechanics, Installers, & Technicians Overall	$14.72	$23.43	$37.46
HVAC Mechanics, Installers, & Technicians in Energy Efficiency	$19.72	$28.32	$39.60

TABLE 26. HVAC MECHANICS, INSTALLERS, AND TECHNICIANS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Installation, Maintenance, & Repair Occupations National Average	77%	65%
Building Efficiency HVAC Mechanics, Installers, & Technicians	82%	71%

DEMOGRAPHICS

Almost half (48 percent) of HVAC mechanics, installers, and technicians are between the ages of 35 and 54, while 18 percent are over the age of 55 and likely nearing retirement. About three in 10 HVAC mechanics, installers, and technicians (31 percent) are between the ages of 22 and 34.

Three-quarters (75 percent) of HVAC mechanics, installers, and technicians are white and 15 percent are Hispanic or Latino. The vast majority of individuals in this occupational group are men (99 percent).

FIGURE 25. HVAC MECHANICS, INSTALLERS, AND TECHNICIANS DEMOGRAPHICS, AGE, 2019[39]

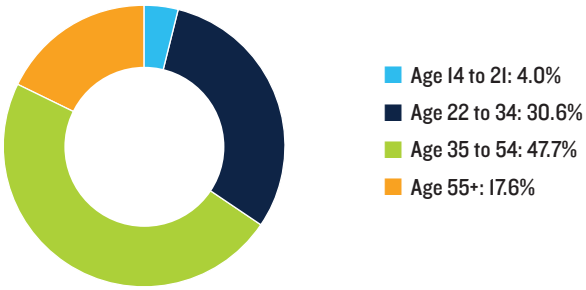


FIGURE 26. HVAC MECHANICS, INSTALLERS, AND TECHNICIANS DEMOGRAPHICS, ETHNICITY, 2019

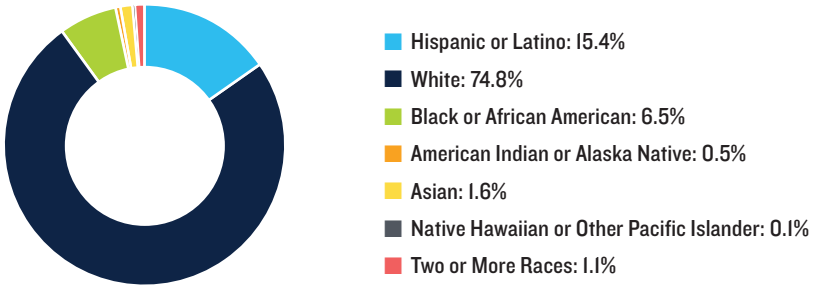
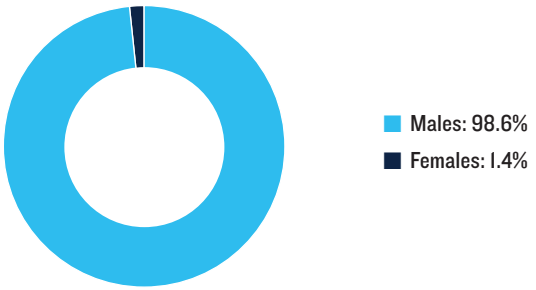


FIGURE 27. HVAC MECHANICS, INSTALLERS, AND TECHNICIANS DEMOGRAPHICS, GENDER, 2019

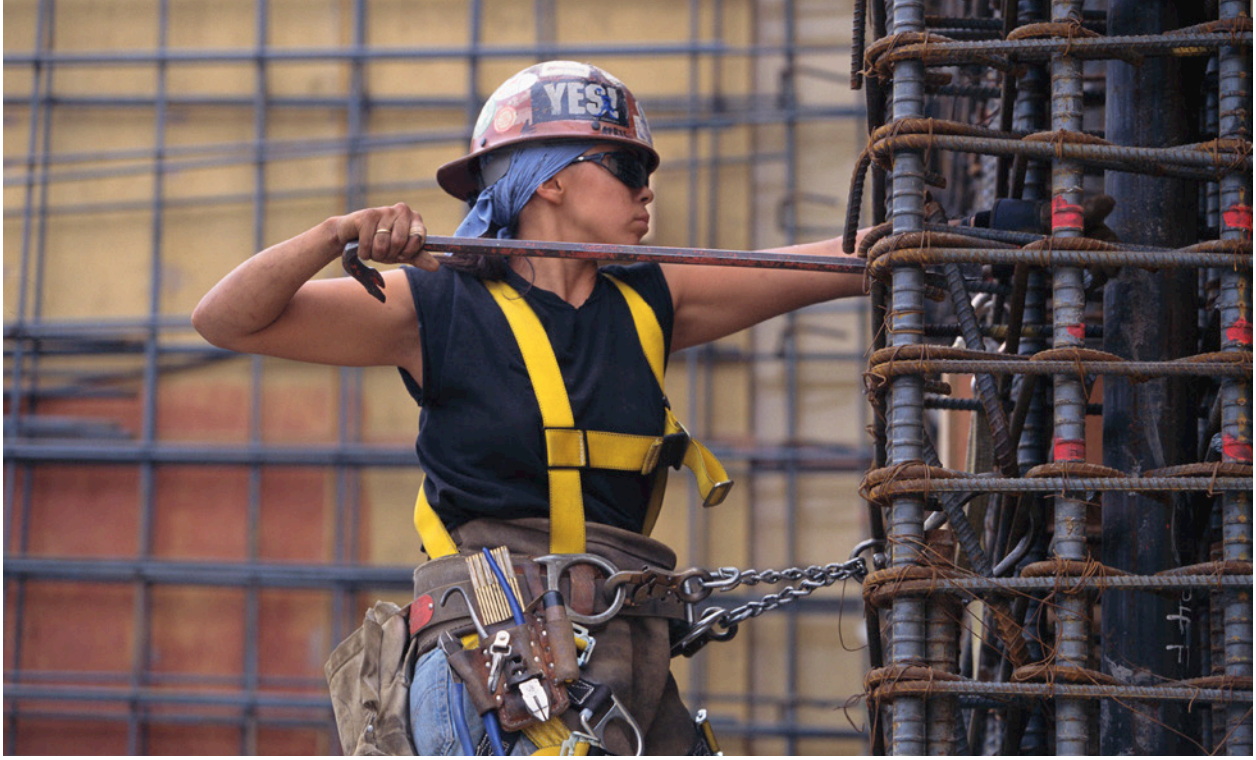


EDUCATION, TRAINING, & CERTIFICATIONS

Due to the complexity of HVAC systems, most employers typically require potential job candidates possess a postsecondary non-degree award or have at least completed an apprenticeship. While it is possible to gain on-the-job training to enter this field, apprenticeships or vocational training and coursework greatly increase employment opportunities. Some states and localities require technicians to be licensed prior to beginning work.

TABLE 27. HVAC MECHANICS, INSTALLERS, AND TECHNICIANS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
Postsecondary non-degree award	Long-term on-the-job training



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CLEAN ENERGY CONSTRUCTION LABORERS

JOB DESCRIPTION

Construction laborers support nearly all activities at a construction site. Most tasks involve physical labor, such as cleaning and preparation of job sites, digging trenches, setting braces to support the sides of excavations, erecting scaffolding, and cleaning rubble, debris, and other waste materials. Construction laborers typically also support other trades workers at construction sites.

These workers are vital to the clean energy economy, particularly as much of the nation's building infrastructure is aging and in need of retrofitting or rebuilding. In fact, the so-called "green" construction industry has been growing steadily over the last several years. In 2015, it was estimated that the green nonresidential construction market was worth around $120 billion to $145 billion.[40] Large projects, including the construction of new hospitals, office spaces or federal buildings, are contributing to this boom in green building infrastructure; however, green construction is not only limited to commercial and industrial spaces, but also includes residential construction projects.

Construction laborers may be found in nearly all technology sectors of the clean energy economy, as they provide support for many types of clean energy construction projects. These individuals will continue to be increasingly important as the U.S. moves toward building infrastructure that is equipped with materials and technologies that improve energy efficiency, grid connectivity, energy storage capacities, and the use of clean and renewable sources of electricity.

WAGES & BENEFITS

At the entry- and mid-level experience, construction laborers in the clean energy industry make more than overall wages for construction laborers across all industries. Entry-level construction laborers in grid modernization and storage earn more compared to other clean energy technology sectors.

Construction laborers working in the clean energy industry are also more likely to receive employment benefits from their employer compared to the overall average for construction occupations. Seventy-nine percent receive either full or partial health care coverage, and 66 percent receive some form of retirement contribution.

TABLE 28. CONSTRUCTION LABORERS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Construction Laborers Overall	$11.96	$17.72	$32.65
Construction Laborers in Clean Energy	$14.25	$19.50	$32.18
Construction Laborers by Clean Energy Sector			
Renewable Energy Generation	$13.74	$19.25	$31.21
Grid Modernization & Storage	$14.11	$19.15	$32.68
Energy Efficiency	$14.28	$19.52	$32.21
Clean Fuels	$13.92	$18.51	$31.68

TABLE 29. CONSTRUCTION LABORERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Clean Energy Construction Laborers	79%	66%

Construction laborers who work on clean energy projects are more likely to receive health benefits than laborers on other job sites (79 percent vs 69 percent).

DEMOGRAPHICS

Forty-three percent of workers are between the ages of 35 and 54, while 14 percent are over the age of 55. Just over a third of construction laborers are between the ages of 22 and 34.

There is a higher proportion of Hispanic or Latino workers in this occupational group compared to other clean energy occupations. Roughly a third (32 percent) of construction laborers are Hispanic or Latino. Fifty-six percent are white and almost nine percent are Black or African American. The vast majority of workers are men (95 percent).

FIGURE 28. CONSTRUCTION LABORERS DEMOGRAPHICS, AGE, 2019[41]

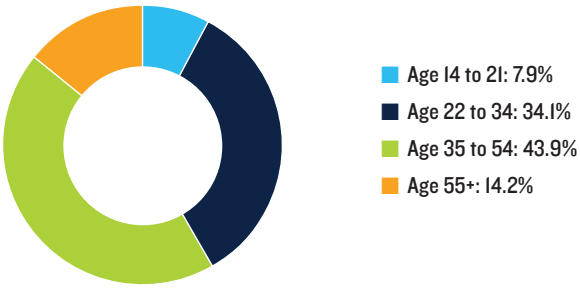


FIGURE 29. CONSTRUCTION LABORERS DEMOGRAPHICS, ETHNICITY, 2019

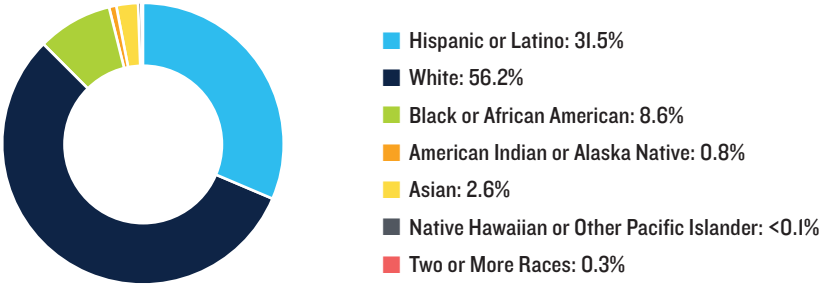
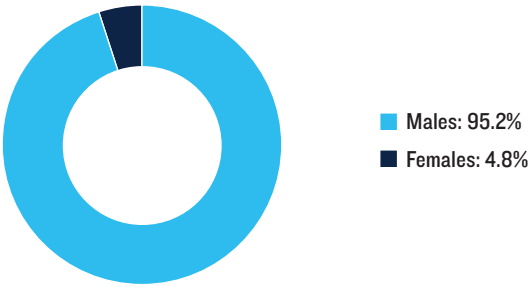


FIGURE 30. CONSTRUCTION LABORERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Construction laborers are not required to have any formal educational credential, though a high school diploma or equivalent is useful to attaining employment in this job. Most skills are learned through on-the-job training, though there are apprenticeship programs that are available and provide more thorough training.

Construction laborers performing more complex tasks may choose to acquire certification in different areas of expertise. Certifications are offered through the American Welding Society and the American Concrete Institute for Welding and Concrete Finishing.

TABLE 30. CONSTRUCTION LABORERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
No formal educational credential	Short-term on-the-job training

CLEAN ENERGY ELECTRICIANS

JOB DESCRIPTION

Electricians install, maintain, and repair electrical wiring, control systems, equipment, and fixtures. These individuals ensure that electrical work is in accordance with all relevant codes and standards. Electricians are typically not only knowledgeable about electrical components and systems, but also have some understanding of building construction.

Electricians are important across all technology sectors of the clean energy economy. These workers are needed to install renewable energy generation systems, such as solar photovoltaic or wind turbine installations. Additionally, an electrician with familiarity of building energy systems is vital to the energy efficiency sector, as these individuals install LED and other efficient lighting technologies or ENERGY STAR products. Electricians typically install smart meters for grid modernization projects while automotive electricians are trained to work with the newer electrical systems in hybrid and electric cars, trucks, and buses.

Depending on training and experience, electricians have multiple and varied career paths across the clean energy industry's technology sectors. The demand for electricians within the clean energy economy will likely continue to grow alongside the increased deployment of clean energy technologies.

WAGES & BENEFITS

Electricians working in the clean energy industry earn higher hourly wages compared to the overall construction and extraction occupations. At the entry- and mid-level of experience, clean energy electricians earn more per hour compared to all electricians across all industry sectors.

In general, electricians working in the clean vehicles sector of the clean energy industry earn the highest premium.

TABLE 31. ELECTRICIANS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Electricians Overall	$16.06	$27.01	$46.43
Electricians in Clean Energy	$19.01	$29.64	$45.55
Electricians by Clean Energy Sector			
Renewable Energy Generation	$18.45	$29.34	$44.39
Grid Modernization & Storage	$18.94	$29.19	$46.47
Energy Efficiency	$19.18	$29.76	$45.80
Clean Fuels	$18.70	$28.22	$45.05
Clean Vehicles	$21.16	$34.03	$52.16

Entry-level electricians who work in clean energy-related occupations earn about $2.55 more per hour than electricans who work in other fields.

Clean energy electricians are more likely to receive health care benefits compared to the national private sector average and the average across all construction occupations. Seventy-nine percent of clean energy electricians receive either partial or full health care coverage from their employer.

Sixty-seven percent of clean energy electricians receive retirement benefits; this is comparable to the overall national private sector average, but higher than the average for all construction occupations.

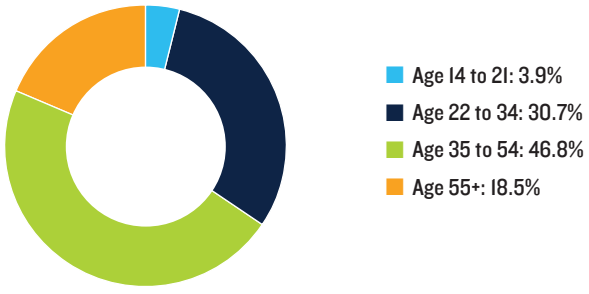
TABLE 32. ELECTRICIANS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Clean Energy Electricians	79%	67%

DEMOGRAPHICS

Just under half of electricians in the U.S. (47 percent) are between the ages of 35 and 54. About two in 10 (19 percent) workers are over the age of 55, and roughly a third (31 percent) are between the ages of 22 and 34.

FIGURE 31. ELECTRICIANS DEMOGRAPHICS, AGE, 2019[42]



Almost three-quarters of electricians (74 percent) are white, 16 percent are Hispanic or Latino, and six percent are Black or African American. The vast majority of electricians across the nation are male (97 percent).

FIGURE 32. ELECTRICIANS DEMOGRAPHICS, ETHNICITY, 2019

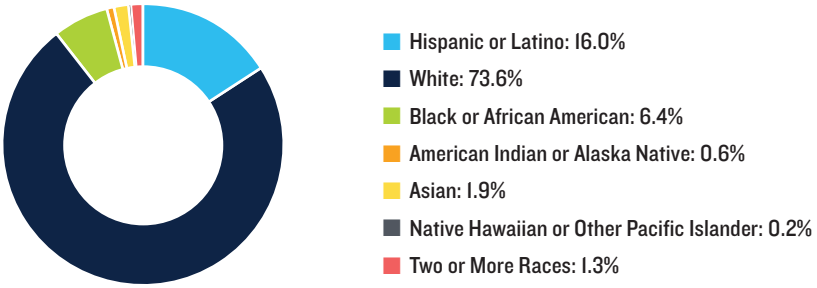
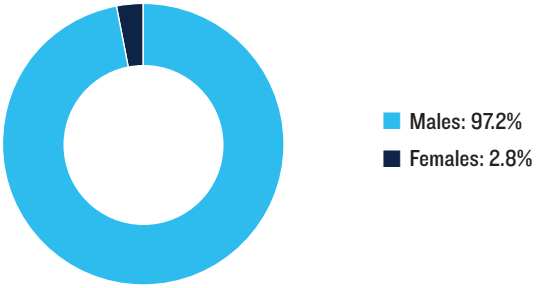


FIGURE 33. ELECTRICIANS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Electricians typically require at most a high school diploma or equivalent to enter the labor force. Some electricians may opt to attend a technical trade school and take courses related to circuitry, safety practices, and basic electrical information. Graduates of these programs may receive credits toward apprenticeship training.

The majority of electricians learn their trade through a four to five-year apprenticeship program. Apprentices receive 2,000 hours of paid on-the-job training for each year of the program.

Most states require electricians to pass a test and receive a license, though requirements vary by state. Requirements may be found via the National Electrical Contractor Association. Some electricians must have to take continuing education courses to maintain their licensure.

In addition to a license, electricians may opt to obtain other certifications to demonstrate competencies in specialty areas, such as solar photovoltaics, electrical generating, or lighting systems.

TABLE 33. ELECTRICIANS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Apprenticeship

CLEAN ENERGY ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS

JOB DESCRIPTION

Electrical power-line installers and repairers install, repair, and maintain the cables or wires used in electrical power distribution systems; they also inspect and test power lines, cables, and other equipment, including transformers, circuit breakers, and switches. With regards to the clean energy economy, these individuals help build and maintain the nation's growing smart grid and renewable electricity generation infrastructure.

These jobs are expected to grow as cities expand and communities create new housing developments or office parks. The increased complexity of the nation's energy grid makes these jobs more valuable, as power-line installers are vital to ensuring renewable electricity generation sources are connected to the grid.

WAGES & BENEFITS

Entry-level power-line installers and repairers in the clean energy industry earn a respective 33 percent and 93 percent hourly wage premium compared to all electrical power-line installers and repairers across all industries, as well as the overall installation, maintenance, and repair occupations.

In general, clean energy electrical power-line installers and repairers earn more per hour than the national average. This is especially true for individuals working within the grid modernization and storage sector of the clean energy economy.

TABLE 34. ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Installation, Maintenance, & Repair Occupations Overall	$12.86	$22.42	$38.24
Electrical Power-Line Installers & Repairers Overall	$18.66	$34.86	$49.76
Electrical Power-Line Installers & Repairers in Clean Energy	$24.81	$42.01	$52.44
Electrical Power-Line Installers and Repairers by Clean Energy Sector			
Renewable Energy Generation	$24.51	$41.45	$52.01
Grid Modernization & Storage	$25.13	$43.34	$53.31

Entry-level power line workers with clean energy training earn about 30 percent more than those who don't specialize in clean energy.

Clean energy electrical power-line installers and repairers are also more likely to earn employment benefits compared to the national private sector average and the average across all installation, maintenance, and repair occupations.

Eighty-six percent of individuals receive full or partial health care coverage, and 78 percent receive some form of retirement contribution from their employers.

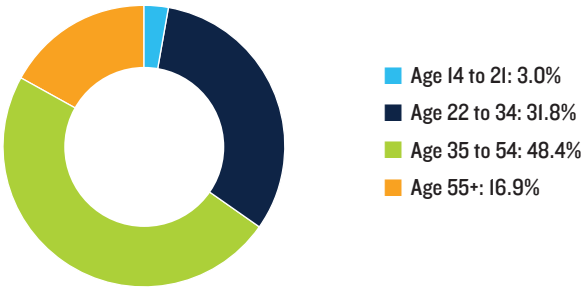
TABLE 35. ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Installation, Maintenance, & Repair Occupations National Average	77%	65%
Clean Energy Electrical Power-Line Installers & Repairers	86%	78%

DEMOGRAPHICS

Just under half (48 percent) of individuals in this occupational group are between the ages of 35 and 54, while 17 percent are 55 years of age or older. About a third (32 percent) are between the ages of 22 and 34.

FIGURE 34. ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS DEMOGRAPHICS, AGE, 2019[43]



The majority of workers are white (81 percent). About 10 percent are Hispanic or Latino and seven percent are Black or African American. The vast majority are men (98 percent).

FIGURE 35. ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS DEMOGRAPHICS, ETHNICITY, 2019

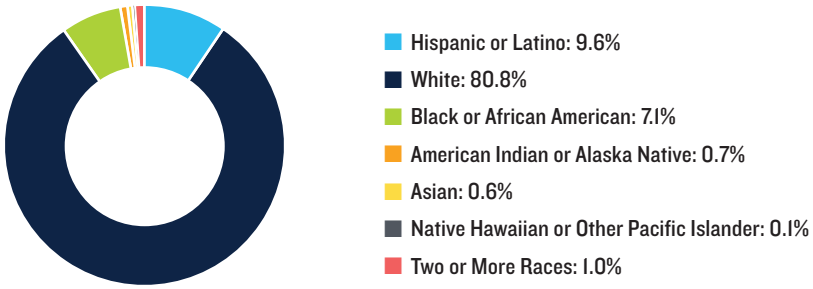
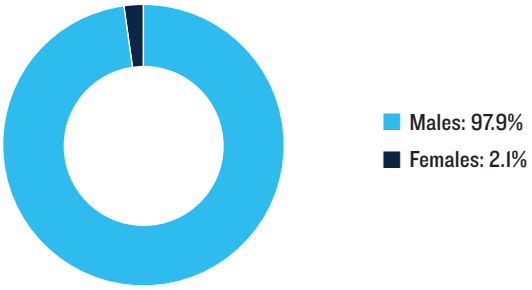


FIGURE 36. ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Individuals interested in this career path must possess at least a high school diploma or equivalent. Training for this job usually occurs through an apprenticeship program, though individuals may also attend a trade or vocational school and obtain a postsecondary certificate.

There are no required licenses or certifications, though several associations, such as IBEW—NECA Electrical Training Alliance, offer certifications in several specialty areas. Two common core certifications include the Cable Splicing Certification and the Instrumentation Certification.

TABLE 36. ELECTRICAL POWER-LINE INSTALLERS AND REPAIRERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Long-term on-the-job training

CLEAN ENERGY PROJECT CONSTRUCTION MANAGERS

JOB DESCRIPTION

Construction managers plan, direct, and coordinate the construction and maintenance of buildings, facilities, and systems. Managers are involved in the conceptual development of a construction project and are in charge of overseeing its organization, scheduling, budgeting, and implementation. This occupational group also includes managers in specialized construction trades, like carpentry or plumbing. Construction managers are important to many clean energy projects, including green or energy-efficient building development, renewable electricity generation power plant construction, biofuel processing facilities construction, or utility grid modernization project development.

As with other jobs in the construction trades, construction managers are expected to see employment growth in the future with more clean energy construction projects on the horizon across the nation.

WAGES & BENEFITS

Across all levels of experience, construction managers in the clean energy industry earn a premium over the hourly wages for overall construction and extraction occupations. Compared to construction managers across all industries, entry-level clean energy project construction managers earn 29 percent more per hour. Entry-level wages for this occupational group are especially high in the renewable energy generation sector.

TABLE 37. CONSTRUCTION MANAGERS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Construction Managers Overall	$26.99	$45.80	$79.23
Construction Managers in Clean Energy	$34.69	$46.23	$69.50
Construction Managers by Clean Energy Sector			
Renewable Energy Generation	$37.26	$48.41	$71.06
Grid Modernization & Storage	$33.90	$47.06	$72.43
Energy Efficiency	$34.46	$45.97	$69.22
Clean Fuels	$36.14	$48.58	$70.14

Ninety-one percent of clean energy project construction managers receive full or partial health care coverage from their employers, significantly higher than the overall national private sector average and the construction occupational average.

Seventy-seven percent of individuals receive retirement benefits—10 to 20 percentage points higher than the overall averages.

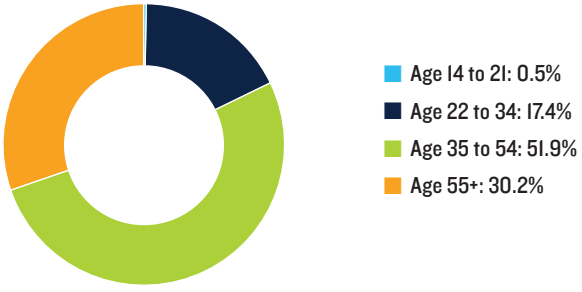
TABLE 38. CONSTRUCTION MANAGERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Clean Energy Project Construction Managers	91%	77%

DEMOGRAPHICS

A significant portion of individuals in this occupational group are nearing retirement age. About three in 10 clean energy project construction managers are 55 years of age or older; 52 percent are between the ages of 35 and 54.

FIGURE 37. CONSTRUCTION MANAGERS DEMOGRAPHICS, AGE, 2019[44]



The majority of construction managers across the nation are men (82 percent), followed by Hispanic or Latino (10 percent), and Black or African American (three percent). There is a slightly larger share of women in this position compared to other construction-related trades. Eleven percent of construction managers are women, and 89 percent are men.

FIGURE 38. CONSTRUCTION MANAGERS DEMOGRAPHICS, ETHNICITY, 2019

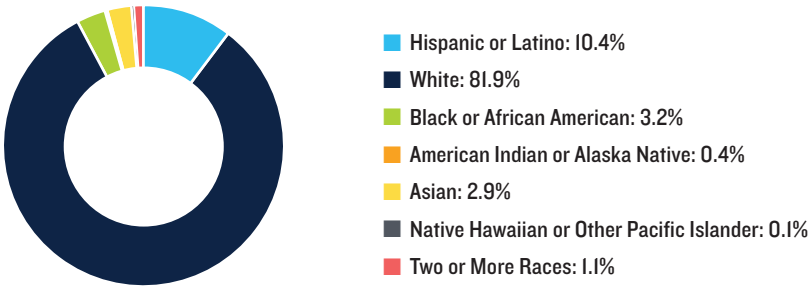
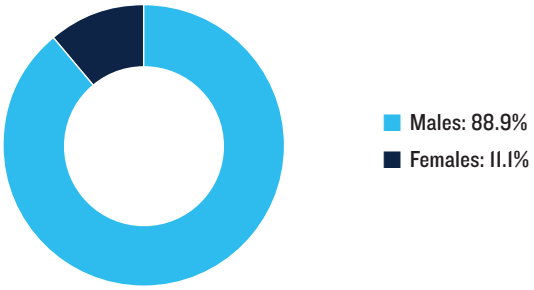


FIGURE 39. CONSTRUCTION MANAGERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Construction managers typically possess a Bachelor's degree, learning management techniques through on-the-job training. Larger construction firms often prefer individuals with both experience in the construction industry and a Bachelor's degree in a construction-related field. However, some individuals with a high school diploma and several years of experience may be hired as construction managers. Though there are varied ways to enter this occupation, due to the increasingly complex nature of building construction, employers are placing greater emphasis on specialized education.

Certification is not required but is valuable for this occupation. A Certified Construction Manager (CCM) certification is available from the Construction Management Association of America upon passing a technical exam and reaching the minimum requirement for years of work experience. The American Institute of Constructors also awards the Associate Constructor (AC) and Certified Professional Constructor (CPC) certifications.

Some states require licensure for construction managers.

TABLE 39. CONSTRUCTION MANAGERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
Bachelor's degree	Moderate-term on-the-job training

BUILDING EFFICIENCY CARPENTERS

JOB DESCRIPTION

Carpenters construct, install, or repair structures made of wood, such as concrete forms and building frameworks; other tasks include installing, repairing, or erecting rafters, stairways, windows, door frames, hardwood floors, cabinets, siding, and drywall insulation. These individuals are employed within the energy efficiency sector of the clean energy economy and are especially important to the energy efficent building space, as their knowledge of building design and construction supports the development of new energy efficient building development projects, such as hospitals, retail spaces, offices, and other commercial or residential buildings.

Carpenters have an important role not only in improving building energy efficiency, but also in reducing waste for building construction projects. In addition to reducing overall material use and waste, carpentry design is important to the insulation of buildings, as special techniques can increase the amount of spacing between framing members, allowing for more insulation to be added, and thus increasing the energy efficiency of buildings. To capture energy savings, skilled workers are needed to properly install energy efficiency equipment and materials.[45]

WAGES & BENEFITS

Building efficiency carpenters earn more per hour at the entry- and mid-level of experience compared to both overall construction and extraction occupations and carpenters in general across all industries.

TABLE 40. CARPENTERS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Construction & Extraction Occupations Overall	$13.66	$22.80	$41.26
Carpenters Overall	$14.51	$23.24	$40.72
Carpenters in Energy Efficiency	$17.33	$25.60	$40.17

Carpenters working in the energy efficiency industry are more likely to receive health care benefits. Seventy-three percent receive full or partial coverage from their employer, compared to the 69 percent private sector average and 68 percent overall construction occupational average.

Sixty-three percent of building efficiency carpenters also receive retirement contributions from their employer; this is higher than overall construction occupations but slightly lower than the national private sector average.

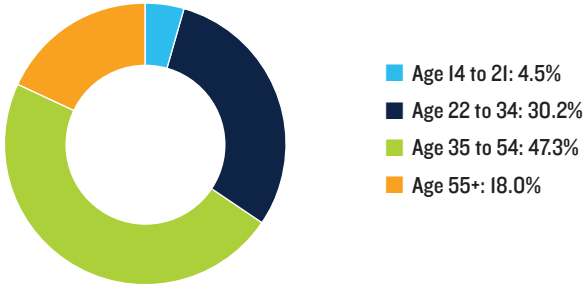
TABLE 41. CARPENTERS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Construction Occupations National Average	68%	57%
Building Efficiency Carpenters	73%	63%

DEMOGRAPHICS

Almost two in 10 (18 percent) carpenters in the U.S. are nearing retirement age, while 47 percent are between the ages of 35 and 54. Three in 10 carpenters are between the ages of 22 and 34.

FIGURE 40. CARPENTERS DEMOGRAPHICS, AGE, 2019[46]



A quarter of carpenters in the U.S. are Hispanic or Latino and five percent are Black or African American. The majority of carpenters are white (65 percent), and the vast majority are male (97 percent).

FIGURE 41. CARPENTERS DEMOGRAPHICS, ETHNICITY, 2019

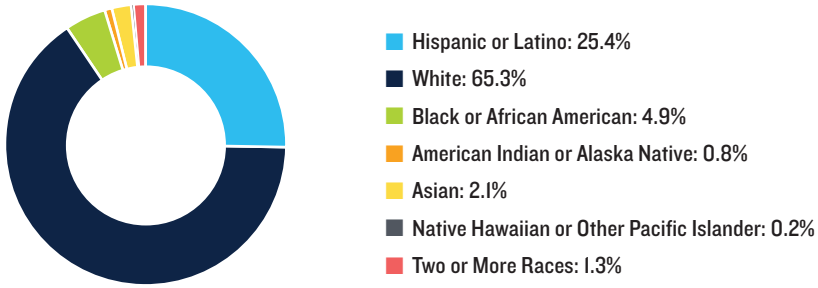
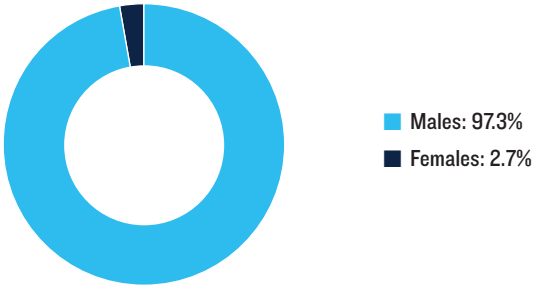


FIGURE 42. CARPENTERS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

The typical level of educational attainment for carpenters is a high school diploma or equivalent with skill sets learned through apprenticeship programs and on-the-job training. Some carpenters may learn their skills through working under the supervision of more experienced carpenters. Formal apprenticeships last from three to four years and combine technical classroom training with real world, on-the-job work experience.

There are no required certifications, but there are several voluntary certifications available through the Door and Hardware Institute, National Association of Home Builders, National Association of the Remodeling Industry, and National Wood Floor Association.

TABLE 42. BUILDING EFFICIENCY CARPENTERS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Apprenticeship

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CLEAN TRANSPORTATION SERVICE MECHANICS AND TECHNICIANS

JOB DESCRIPTION

Service mechanics and technicians for clean automobiles, buses, or trucks are in charge of diagnosing, maintaining, and repairing electric, hybrid electric, plug-in hybrid, natural gas, and hydrogen or fuel-cell vehicles and their component parts. These individuals are especially valuable to the clean energy economy, as many traditional automotive mechanics and technicians are unable to work on these new clean vehicle technologies. In particular, while electric vehicles share some component parts with traditional gas-powered cars, the different powertrains require additional training in order to service them properly. In fact, a study found that 97 percent of auto mechanics are unqualified to work on electric cars.[47]

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 sixfold.[48] The number of alternative fuel vehicles (AFVs) across federal agencies is also increasing; since 2010, the federal AFV fleet grew by 26 percent to roughly 223,000 vehicles in 2018.[49]

With the growing number of alternative fuel vehicles on the roads, transportation service mechanics and technicians with the skillsets to work on these new technologies will be increasingly important in years to come.

WAGES & BENEFITS

At the entry-level of work experience, automotive service mechanics and technicians working within the alternative clean vehicles industry earn respective hourly wage premiums of 24 percent and 13 percent compared to automotive service mechanics and technicians overall, as well as all installation, maintenance, and repair occupations.

TABLE 43. AUTOMOTIVE SERVICE MECHANICS AND TECHNICIANS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Installation, Maintenance, & Repair Occupations Overall	$12.86	$22.42	$38.24
Automotive Service Mechanics & Technicians Overall	$11.73	$20.24	$33.11
Automotive Service Mechanics & Technicians in Clean Vehicles	$14.57	$21.49	$31.65

Clean vehicle service mechanics and technicians are more likely to receive health care and retirement benefits compared to the national private sector average and the average for all installation, maintenance, and repair occupations. Eighty-six percent receive health care benefits, and 72 percent receive retirement benefits.

TABLE 44. AUTOMOTIVE SERVICE MECHANICS AND TECHNICIANS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Installation, Maintenance, & Repair Occupations National Average	77%	65%
Clean Vehicle Service Mechanics & Technicians	86%	72%

DEMOGRAPHICS

Six in 10 automotive service mechanics and technicians are 35 years of age or older. About a third are between the ages of 22 and 34.

The majority of workers are white (70 percent), followed by Hispanic or Latino (18 percent), and Black or African American (seven percent). The vast majority are men (98 percent).

FIGURE 43. AUTOMOTIVE SERVICE MECHANICS AND TECHNICIANS DEMOGRAPHICS, AGE, 2019[50]

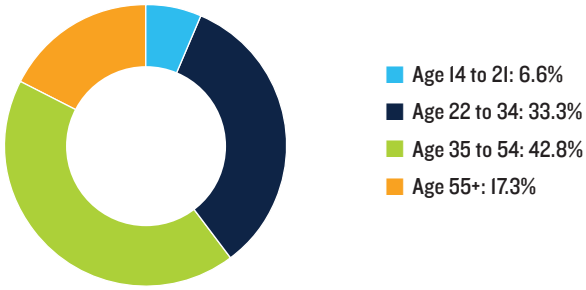


FIGURE 44. AUTOMOTIVE SERVICE MECHANICS AND TECHNICIANS DEMOGRAPHICS, ETHNICITY, 2019

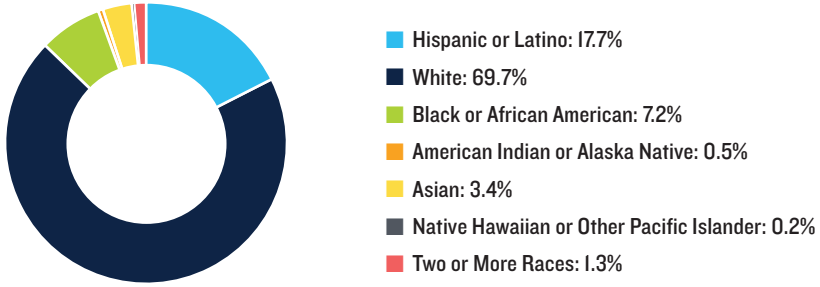
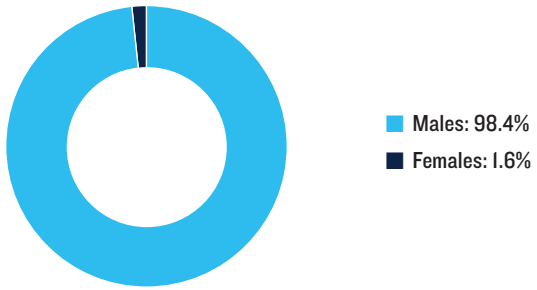


FIGURE 45. AUTOMOTIVE SERVICE MECHANICS AND TECHNICIANS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Automotive service mechanics and technicians are typically required to have graduated from an Associate's degree program in automotive maintenance and repair. Additionally, it is valuable to have experience and on-the-job training. Though not always required, an Automotive Service Excellence (ASE) certification is the most common certification for this occupation.

Due to the specific nature of working with electrical vehicles, however, Tesla launched a separate automotive training program in 2018 in order to train the next generation of electric car technicians.[51]

TABLE 45. AUTOMOTIVE SERVICE MECHANICS AND TECHNICIANS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
Postsecondary non-degree award	Short-term on-the-job training

CLEAN ENERGY PRODUCT ASSEMBLERS AND FABRICATORS

JOB DESCRIPTION

Assemblers and fabricators of clean energy technologies are responsible for assembling finished products as well as their component parts. Most assemblers and fabricators are found in the manufacturing industry, which makes them valuable across all technology sectors of the clean energy economy. The U.S. has particular strengths in wind turbine and ENERGY STAR product manufacturing, with regional concentrations of clean vehicle and component parts manufacturing as well. More should be done to grow the domestic renewable manufacturing supply chain jobs. With appropriate policy, as the demand for these products and services increases across the nation, clean energy product assemblers and fabricators could see increased labor market demand in years to come and support growth in domestic manufacturing.

WAGES & BENEFITS

At $12.27 per hour, entry-level assemblers and fabricators working in the clean energy industry earn 15 percent more compared to assemblers and fabricators across all industries and 10 percent more than the overall entry-level wage for all production occupations.

TABLE 46. ASSEMBLERS AND FABRICATORS WAGES BY TECHNOLOGY SECTOR & EXPERIENCE LEVEL, 2019

	Entry-level	Median	Senior-level
Production Occupations Overall	$11.14	$17.31	$30.41
Assemblers & Fabricators Overall	$10.78	$15.55	$24.73
Assemblers & Fabricators in Clean Energy	$12.35	$16.91	$24.85
Assemblers and Fabricators by Clean Energy Sector			
Renewable Energy Generation	$11.90	$16.60	$24.36
Grid Modernization & Storage	$11.99	$16.08	$23.63
Energy Efficiency	$17.17	$22.78	$32.42
Clean Fuels	$12.37	$16.83	$24.82
Clean Vehicles	$11.55	$16.13	$24.36

Assemblers and fabricators working in the clean energy industry are more likely to receive health care and retirement benefits compared to the national private sector and overall production occupational averages. Eighty-six percent receive full or partial health care coverage, and 80 percent receive retirement contributions from their employers.

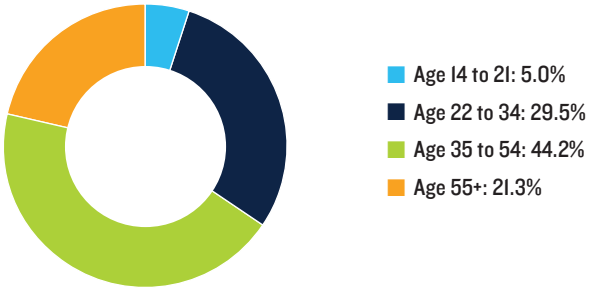
TABLE 47. ASSEMBLERS AND FABRICATORS EMPLOYMENT BENEFITS, 2019

	Health Care Benefits	Retirement Benefits
Overall National Private Sector Average	69%	67%
Production Occupations National Average	81%	73%
Clean Energy Product Assemblers & Fabricators	86%	80%

DEMOGRAPHICS

Two in 10 (21 percent) assemblers and fabricators in the U.S. are nearing retirement age, and 44 percent are between the ages of 35 and 54. About three in 10 are between the ages of 22 and 34.

FIGURE 46. ASSEMBLERS AND FABRICATORS DEMOGRAPHICS, AGE, 2019[52]



Of clean energy occupations profiled in this report, clean energy product assemblers and fabricators has the highest share of Black or African American workers, at 19 percent.

Hispanic or Latino individuals comprise 16 percent of the occupational group, and white individuals account for 57 percent of workers.

There are also more women compared to the other occupations profiled. About four in 10 assemblers and fabricators across the nation are women.

FIGURE 47. ASSEMBLERS AND FABRICATORS DEMOGRAPHICS, ETHNICITY, 2019

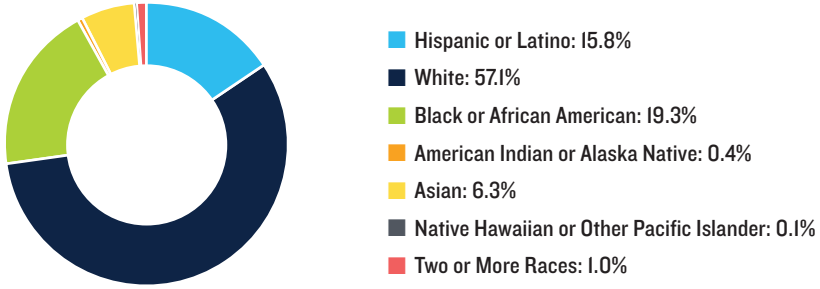
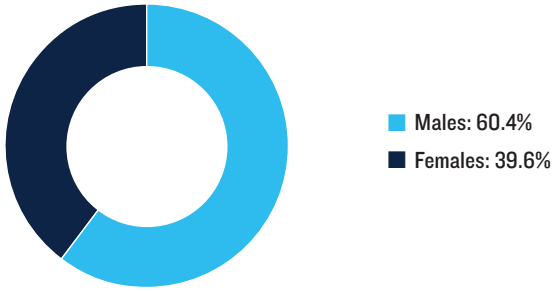


FIGURE 48. ASSEMBLERS AND FABRICATORS DEMOGRAPHICS, GENDER, 2019



EDUCATION, TRAINING, & CERTIFICATIONS

Education levels and qualifications may vary by industry and employer for this occupation, though a high school diploma or equivalent is typically sufficient for entrance into this career path. On-the-job training and work experience are needed for more advanced assembly work.

Some employers may require specialized training or an Associate's degree for specialized work with electrical, electronic, and aircraft or motor vehicle products. The Fabricators and Manufacturers Association International (FIMA) offers certifications and training programs on fabrication, coil processing, and other topics. Certifications are not required but valuable nevertheless and help with career path advancement.

For assemblers and fabricators working with electronics, employers may require certifications in soldering. The Association Connecting Electronics Industries offers certification programs related to electronic assembly and soldering.

TABLE 48. ASSEMBLERS AND FABRICATORS EDUCATION & TRAINING, 2019

Typical Entry Level Education	Typical On-The-Job Training
High school diploma or equivalent	Moderate-term on-the-job training

ENDNOTES

1 https://www.dol.gov/ui/data.pdf.

2 Clean Jobs America: https://www.e2.org/wp-content/uploads/2016/03/CleanJobsAmerica_FINAL.pdf and https://e2.org/wp-content/uploads/2020/04/E2-Clean-Jobs-America-2020.pdf.

3 https://bwresearch.com/covid.

4 https://e2.org/reports/clean-jobs-covid-economic-crisis-august-2020.

5 Pew Research Center. Financial and health impacts of COVID-19 vary widely by race and ethnicity. May 2020. https://www.pewresearch.org/fact-tank/2020/05/05/financial-and-health-impacts-of-covid-19-vary-widely-by-race-and-ethnicity.

6 https://e2.org/wp-content/uploads/2020/05/Clean-Energy-Jobs-April-COVID-19-Memo-FINAL.pdf.

7 https://e2.org/reports/build-back-better-faster-how-federal-clean-energy-stimulus-can-restart-americas-economy.

8 The national occupational median hourly wage for all occupations is taken from the Bureau of Labor Statistics, May 2019 National Occupational Employment and Wage Estimates: https://www.bls.gov/oes/current/oes_nat.htm#00-0000. Clean energy sector wages are extrapolated using both public and proprietary data sources based on the 2020 United States Energy and Employment Report data collection effort. Median hourly wages for other industries in the U.S. are based on the Bureau of Labor Statistics, May 2019 National Industry-Specific Occupational Employment and Wage Estimates: https://www.bls.gov/oes/current/oessrci.htm.

9 Unionization rates for clean energy sectors are from the 2020 United States Energy and Employment Report dataset but are not available at the sub-sector level of granularity for all clean energy sub-sectors except the solar and wind industry. Unionization rates for other industries in the U.S. are taken from the Bureau of Labor Statistics: https://www.bls.gov/news.release/union2.t03.htm.

10 U.S. Energy & Employment Report 2020 (www.usenergyjobs.org) and Clean Jobs America 2020 (www.e2.org/cleanjobsamerica).

11 https://www.bls.gov/news.release/union2.t03.htm.

12 U.S. Energy and Employment Reports, 2017-2019. Available at www.usenergyjobs.org.

13 E2, Clean Jobs America 2020, April 2020. Available at https://e2.org/reports/clean-jobs-america-2020.

14 Bureau of Labor Statistics, Occupational Outlook Handbook, Fastest Growing Occupations 2019-29, Updated: September 1, 2020. Available at https://www.bls.gov/ooh/fastest-growing.htm.

15 American Wind Energy Association, Wind Facts at a Glance: https://www.awea.org/wind-101/basics-of-wind-energy/wind-facts-at-a-glance.

16 https://www.bls.gov/ooh/fastest-growing.htm.

17 https://www.bls.gov/ooh/fastest-growing.htm.

18 All national wage data in this table and for the remainder of this report are taken from the Bureau of Labor Statistics, Occupational Employment and Wage Estimates, May 2019. The entry-level wages are at the 10th percentile while senior-level wages are at the 90th percentile. Comparisons to major occupational groups such as “installation, maintenance, and repair occupations”, “production occupations”, “sales occupations”, or “construction and extraction occupations” are based on which occupational group the clean energy occupation being profiled falls under. For example, wind turbine technicians are classified under the Standard Occupational Classification (SOC) system as installation, maintenance, and repair occupations (SOC 49-0000), while welders, cutters, solderers, and brazers are classified under production occupations (SOC 51-0000).

19 National private sector employment benefits data in this table and for the remainder of the report are taken from the Bureau of Labor Statistics: https://www.bls.gov/news.release/pdf/ebs2.pdf. All occupational employment benefits data for the clean energy occupations being profiled are specific to individuals working in the clean energy industry.

20 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020. With the exception of wind turbine technicians and solar photovoltaic installers, demographic data is not specific to the clean energy industry, but representative of the overall occupational average across all industry sectors.

21 Education and training data in this table and the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 10, 2020. This data is not specific to the clean energy industry, but representative of the occupational average across all industry sectors.

22 https://www.seia.org/research-resources/solar-market-insight-report-2020-q3.

23 https://www.bls.gov/ooh/fastest-growing.htm.

24 Requirements for licensing vary by state.

25 B. Jones, P. Philips, and C. Zabin, *The Link Between Good Jobs and a Low-Carbon Future: Evidence from California’s Renewable Portfolio Standard, 2002-2015*, July 2016, at 11-12.

26 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

27 Tradesmen International, Addressing a Welder Shortage in the Construction Industry: https://www.tradesmeninternational.com/construction-management/welder-shortage/#:~:text=According%20the%20American%20Welding%20Society,under%20the%20age%20of%2035.

28 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

29 https://e2.org/wp-content/uploads/2020/04/E2-Clean-Jobs-America-2020.pdf.

30 https://www.energy.gov/eere/wind/wind-manufacturing-and-supply-chain.

31 https://www.energystar.gov/about/origins_mission/energy_star_overview/about_energy_star_products#:~:text=In%202019%2C%20approximately%202%2C000%20manufacturers,residential%20and%20commercial%20product%20categories.

32 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

33 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

34 https://www.polkmechanical.com/plumber-shortage.

35 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

36 Workforce Issues and Energy Efficiency Programs: A Plan for California's Utilities, 2014. https://laborcenter.berkeley.edu/workforce-issues-and-energy-efficiency-programs-a-plan-for-californias-utilities.

37 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

38 Workforce Issues and Energy Efficiency Programs: A Plan for California's Utilities, 2014. https://laborcenter.berkeley.edu/workforce-issues-and-energy-efficiency-programs-a-plan-for-californias-utilities.

39 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

40 https://www.bls.gov/green/construction.

41 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

42 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

43 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

44 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

45 Workforce Issues and Energy Efficiency Programs: A Plan for California's Utilities, 2014. https://laborcenter.berkeley.edu/workforce-issues-and-energy-efficiency-programs-a-plan-for-californias-utilities.

46 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

47 https://cleantechnica.com/2018/12/10/97-of-auto-mechanics-cant-work-on-electric-cars-new-report-concludes.

48 U.S. Department of Energy. Alternative Fuels Data Center. Data accessed 10 March 2020.

49 U.S. Department of Energy. Office of Energy Efficiency and Renewable Energy, Federal Fleet Management Program. Federal Automotive Statistical Tool. Last updated 29 March 2019. Data accessed 17 March 2020.

50 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.

51 https://electrek.co/2018/03/26/tesla-start-automotive-training-program.

52 All demographic data in this figure and for the remainder of the report are taken from Emsi Q3 2020. Data was extracted on September 9, 2020.