



10TH ANNUAL

NATIONAL SOLAR JOBS CENSUS 2019

FEBRUARY 2020

ABOUT



The Solar Foundation

The Solar Foundation® is a national 501(c)(3) nonprofit organization whose mission is to accelerate adoption of the world's most abundant energy source. Through its leadership, research, and capacity building, The Solar Foundation creates transformative solutions to achieve a prosperous future in which solar and solar-compatible technologies are integrated into all aspects of our lives. In 2010, The Solar Foundation conducted its inaugural *National Solar Jobs Census*, establishing the first comprehensive solar jobs baseline and verifying that the solar industry is having a positive impact on the U.S. economy. Using the same rigorous, peer-reviewed methodology, The Solar Foundation has conducted an annual *Census* in each of the past 10 years to analyze trends and track changes over time.

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 clean energy research studies, including the *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, and Florida, among others.

ACKNOWLEDGEMENTS

We extend our gratitude to all The Solar Foundation's organizational and individual sponsors. Without their support, the tenth annual *National Solar Jobs Census* would not have been possible.

The Solar Foundation and BW Research Partnership would also like to thank all the solar employers who participated in the survey. Your responses were critical in providing us with accurate and timely data.

Thanks to the Energy Futures Initiative and the National Association of State Energy Officials for their assistance providing solar + storage employment data. A report from these organizations, forthcoming in 2020, will include jobs numbers across other energy industries as well as the solar employment data from this *National Solar Jobs Census*.

Unless otherwise indicated, all solar jobs data for 2010-2018 derive from The Solar Foundation's *National Solar Jobs Census* report series, available at SolarJobsCensus.org.

Special thanks to our institutional sponsors, including Energy Foundation, Tilia Fund, McKnight Foundation, the California Energy Commission, D.C. Department of Energy & Environment, and Virginia Department of Mines, Minerals, and Energy.

Thanks to The Solar Foundation's individual members for their support, including Silver Members Jonathan Abe, Daniel Dus, Mark Joyce, William Hopkins, Chikoma Kazunga, Nicholas Lutsey, James Mendelsohn, and Rhoda Springer, along with all others who provided generous donations to The Solar Foundation.

Additional thanks to our Bronze and Member level organizational sponsors. For a complete list of supporters, visit SolarJobsCensus.org.

The lead author on this report is Ed Gilliland, Senior Director at The Solar Foundation. Additional authors include Mary Van Leuven, Dave Golembeski, and Avery Palmer. The Solar Foundation thanks Susan DeVico and Sam Boykin for their assistance with communications and outreach, and Top Shelf Design for designing the report layout. Report reviewers were Justin Baca, Shawn Rumery, Rachel Goldstein, Ryan Young, and Mitchell Schirch.

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Please cite this publication when referencing this material as:

"The Solar Foundation, *National Solar Jobs Census 2019*,
February 2020, available at
<http://www.SolarJobsCensus.org>."

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TESTIMONIALS

There's no doubt about it: The solar industry is a major employer and an increasingly important part of our economy. It would benefit lawmakers to remember the hundreds of thousands of Americans who now work in solar in every state in our country as they consider policies that can keep these good-paying jobs growing for a long time to come."

– Bob Keefe, Executive Director, E2 (Environmental Entrepreneurs)

"The outlook for solar in America has never been brighter. The 2020s are beginning with record installations, stellar job totals, and strong workforce diversification. Q CELLS could not be prouder to be a leading U.S. solar manufacturer during these exciting times."

– Scott Moskowitz, Q CELLS, Director of Market Intelligence and Public Affairs

"With solar development continuing to gain momentum, as more utilities and businesses commit to clean energy goals, rural and urban communities across the nation are realizing the economic development potential of including solar into their clean energy mix. As a result, recruiting, training and retaining a robust skilled workforce has been a growing priority for us and others in our industry. Thanks to the efforts

by our team to refine and expand our workforce development programs, we're introducing new workers to promising careers in solar construction. It's an exciting time in solar!" – **Scott Canada, Senior Vice President of McCarthy Building Companies Solar Energy and Storage group**

"It's exciting to see employment in the solar industry continue to grow, which we see as part of a long term secular shift to renewable energy. We are humbled to support the growth of this market by making solar easier and cheaper to design and sell." – **Samuel Adeyemo, Co-founder of Aurora Solar Inc.**

"Nautilus Solar is excited to contribute to America's solar jobs expansion with community solar projects under development and construction across the country. In Maryland, we are making a difference in LMI communities with the addition of nine community solar projects that will make affordable solar accessible to low-to-moderate income households. We're proud that these projects are contributing to Maryland's overall growth in solar jobs and support job training programs that benefit local communities." – **Laura Stern, Co-CEO, Nautilus Solar Energy**

"The solar industry is an American success story, and NEXTracker is proud to contribute to American solar jobs growth as the world's leading solar tracking company. As the new decade begins, we look forward to building the pipeline of new solar projects that will help revitalize local economies and put even more people to work." – **Bruce Ledesma, President, NEXTracker**

"As innovation enables the mainstreaming of solar, we're met with a progressively diverse customer base that needs to be matched by an equally diverse workforce. This drives us to hire forward-thinking contributors with a range of skills and experiences to deliver even more intelligent solar, storage and energy services to businesses and homeowners nationwide." – **Tom Werner, SunPower CEO and Chairman of the Board**

"U.S. Bank does all of its tax investing through its subsidiary, U.S. Bancorp Community Development Corporation. As the name would suggest, our group is heavily focused not just on the return to shareholders but the economic and social returns to the communities we serve. That is why we find jobs impact data to be so compelling and we are grateful to play a small but meaningful role in what has been an amazing economic success story all across the country." – **Dan Siegel, Senior Vice President, U.S. Bank**

"As one of the leading providers of renewable energy, RWE has ambitious plans for continuous investment in solar energy. Our expertise, skill and experience allows us to proudly contribute to the exciting opportunities that lie ahead in this fast-growing business."

– **Silvia Ortin, COO Onshore Wind and Solar PV Americas, RWE Renewables**

"With a diverse workforce, Sunnova strives to find the best and brightest team members to provide excellent service to its customers, solve the technology and service challenges of an evolving industry, and support long-term growth and profitability as a leader in the residential solar energy space. We look forward to contributing to future solar job growth."

– **William J. (John) Berger, Chief Executive Officer, Sunnova Energy International Inc.**

"As we continue to build toward our Solar Decade goals, we need to remain focused on increasing diversity within the solar industry. The solar industry has jobs and growth potential for everyone, and through united recruitment and training efforts, we'll continue to provide more opportunities for more Americans."

– **George Hershman, President of Swinerton Renewable Energy and Chair of the Solar Energy Industries Association (SEIA)**





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EXECUTIVE SUMMARY

10th Annual *National Solar Jobs Census*

The Solar Foundation's *National Solar Jobs Census 2019* is the tenth annual report on current employment and workforce trends in the U.S. solar industry, nationwide and state by state. Based on a rigorous survey of U.S. companies, this report represents the most comprehensive analysis of solar labor market trends in the United States.

As of November 2019, the solar industry employs nearly 250,000 solar workers, representing a growth of 2.3%, or 5,643 jobs, since 2018. This growth contrasts with job losses in 2017 and 2018 but continues the seven years of well-documented growth from 2010 to 2016. Annual data from the *National Solar Jobs Census* has found that since 2010, solar employment has grown 167%, from just over 93,000 to 249,983 jobs in all 50 states, the District of Columbia, and Puerto Rico.

The most important reason for the growth in solar jobs from 2018 to 2019 was a significant increase in the capacity of solar installations over the previous year. This industry expansion can be attributed to several factors, including:

- ◆ **Declining solar costs.** As solar installation costs continue to decline, more projects provide favorable returns on investment, even in states with lower electricity rates.
- ◆ **The phaseout of the federal investment tax credit.** Since 2019 was the last year the full 30% investment tax credit was available, there was a rush to install solar, especially in the residential solar market segment which has a shorter development cycle.
- ◆ **Waning concerns about the impacts of Section 201 tariffs.** The impact of the Section 201 tariffs on imported panels and cells has been largely mitigated by lower global prices on those components.

SOLAR JOB TRENDS IN 2019

This report includes up-to-date information on solar jobs by state, industry sector, and within demographic groups, as well as employer predictions on future job growth. Other major findings on the U.S. solar workforce, as of November 2019, are as follows:

- ◆ **31 states saw solar job growth in 2019, including many states with emerging solar markets.** States that experienced significant gains in employment included Florida (+1,843 jobs), Georgia (+1,102), Utah (+1,062), New York (+1,011), and Texas (+649).

The most important reason for the growth in solar jobs from 2018 to 2019 was a significant increase in the capacity of solar installations over the previous year.



The states that experienced the largest job reductions between 2018 and 2019 include California (-2,583 jobs), Tennessee (-496), Michigan (-293), Minnesota (-267), and Washington (-264). California, home to about 40% of U.S. solar capacity, still has by far the most solar jobs nationwide.

- ◆ Solar installation companies reported that about 16,000 jobs, or 10% of the total at installation companies, focused on battery storage. Separately, within firms where battery storage is the primary focus, there were 14,638 jobs directly linked to solar.*
- ◆ As solar energy has taken hold in the United States, the job market has expanded rapidly over the past decade. In the five-year period between 2014 and 2019, solar employment increased 44% overall, adding 76,000 jobs, which is about five times faster than job growth in the overall U.S. economy. Since 2010, solar employment has grown 167%, from just over 93,000 to nearly 250,000 jobs.
- ◆ Solar represents about 2.6% of overall U.S. electricity generation, yet it employs almost twice as many workers as the coal industry. In the energy sector, only the oil/petroleum and natural gas industries have more employment than solar.†
- ◆ Demand-side sectors (comprised of the installation and project development sector, and the wholesale trade and distribution sector) make up 77% of overall solar industry employment, while manufacturing represents 14% of the total. Operations and maintenance comprise just under 5%, and the “other” sector, which includes engineering, legal, and financing firms, represents just under 5%.
- ◆ About 162,000 solar jobs, or 65% of the total, are in the installation and project development sector. Of these, 56% are focused on the residential market segment, 25% focus on non-residential, and 19% are utility-scale.
- ◆ Respondents to the *Solar Jobs Census* survey predicted that total U.S. solar industry employment would reach about 269,500 jobs by the end of 2020, a 7.8% increase year over year.

* The 14,638 solar related workers at battery storage companies are not included in the solar jobs total, but will be listed in the forthcoming U.S. Energy and Employment Report (USEER), to be published by the Energy Futures Initiative and the National Association of State Energy Officials.

† Based on a comparison with 2018 data for other energy industries, the latest year of complete data available. See National Association of State Energy Officials and Energy Futures Initiative, *The 2018 U.S. Energy and Employment Report*, May 2018, <https://www.usenergyjobs.org/>.



THE U.S. SOLAR WORKFORCE

- ◆ In 2019, women represented 26% of the solar workforce, Latino or Hispanic workers represented 17%, Asian workers comprised 9%, and black or African American workers comprised 8%. The percentage of solar workers who are veterans was 8%. These figures are similar to what the *National Solar Jobs Census* reported for 2018.
- ◆ Twenty-six percent of solar establishments overall and 33% of installation companies reported that it was “very difficult” to find qualified candidates to fill open positions, the same reported difficulty hiring as 2018.
- ◆ Solar establishments required experience for 45% of their new hires, lower than the 60% of establishments that required experience in 2018. The proportion of new hires requiring bachelor’s degrees (28%) was higher than the 21% reported 2018.
- ◆ Solar industry wages remain competitive with similar industries and above the national median wage (\$18.58) for all occupations.¹ The median reported wage for non-electrician photovoltaic (PV) installers is \$16.00 for entry-level workers and \$23.00 for mid-level workers. The median reported wage for electrician PV installers is \$20.00 for entry-level workers and \$28.00 for mid-level workers.

*Between **2014** and **2019**,
solar jobs grew **five times faster**
than the overall economy.*

KEY FINDINGS

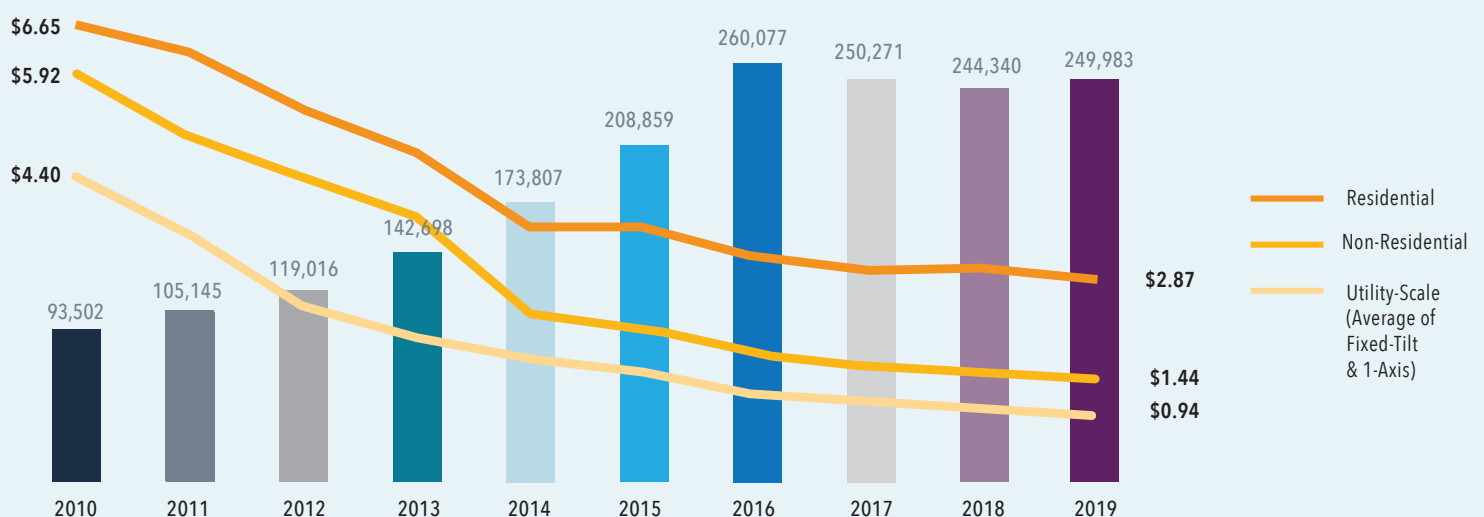
The *National Solar Jobs Census 2019* is The Solar Foundation's tenth annual review of employment in the U.S. solar energy industry, nationwide and state by state. It represents the most comprehensive and rigorous analysis of solar labor market trends in the United States. This report provides original data on the solar industry's role as a job creator and economic engine over the past decade, along with detailed information on the U.S. solar workforce.

The *National Solar Jobs Census 2019* includes data gathered between October and November 2019 from known and potential solar energy establishments or locations.* The combined survey effort included approximately 66,900 phone calls and over 47,000 emails. Information was gathered from 2,766 establishments, of which 1,859 completed or substantially completed the survey. This level of sampling rigor provides a margin of error of +/- 2.27% for the national jobs data.†

For its top-line numbers, the *National Solar Jobs Census* applies a rigorous test in counting solar jobs across

Figure 1

INSTALLED SOLAR PV COSTS BY SEGMENT COMPARED TO SOLAR EMPLOYMENT GROWTH, 2010-2019



Note: Puerto Rico was not included in solar jobs count prior to 2018. Price Data Source: SEIA/Wood Mackenzie Power and Renewables.

Sources: The Solar Foundation, *National Solar Jobs Census*; Wood Mackenzie, Limited, and the Solar Energy Industries Association, U.S. Solar Market Insight.

* An establishment or location is where work is performed, such as a small firm with one office or a branch office of a larger firm.

† For more information on the *National Solar Jobs Census* methodology, see Appendix C, p 52.



the United States. Since 2010, The Solar Foundation has defined a solar job as one held by a worker spending at least 50% of his or her time on solar-related work. Census findings have consistently shown that roughly 90% of these workers (91.4% in 2019) spend 100% of their time on solar-related work.

As of November 2019, the solar industry supports 249,983 jobs at 28,422 locations in all 50 states, the District of Columbia, and Puerto Rico. This represents an increase of 2.3%, or 5,643 more jobs, since the 2018 *Solar Jobs Census*.^{*} This growth is a rebound from the decline in solar jobs over the previous two years, following seven years of steady job growth from 2010 to 2016. Since 2010, the solar industry has grown dramatically in both jobs and added capacity as installation costs have plummeted (Figure 1). Solar employment grew by 167% from 2010 to 2019, adding 156,481 jobs. The 13 GW in installations expected in 2019 is almost 14 times the 849 MW installed in 2010.[‡]

In 2019, there were an additional 94,549 workers who spent less than half their time on solar-related work, for a total of 344,532 workers who spent all or part of their time on solar. This represents a 2.7% increase from 2018, and a 14.8% increase from 2015.[†]

The increase in solar jobs during 2019 corresponds with a growth in solar installations over the previous year. The most recent *U.S. Solar Market Insight*[®] report found the United States added about 7.1 GW of new installed solar capacity through Q3 2019, 10% above the total for the same period in 2018. This growth reflects an increase in both residential rooftop installations and utility-scale development.

Several factors supported this growth. First, the federal solar investment tax credit (ITC) was scheduled to drop from 30% to 26% on January 1, 2020. Particularly for residential solar, that meant there was a rush to install panels before the end of the year, generating more jobs. For utility-scale projects, which have a longer development cycle, there was also a rush to get projects started to qualify for the full tax credit. These projects may not be completed until 2020 or later, which will likely drive additional job growth in future years.³

In 2018, one of the key factors behind the decline in solar jobs was the impact of the Section 201 tariffs imposed on solar modules and cells in February of that year. Starting in early 2017 when the trade petition was pending, developers opted to delay many utility-scale projects due to industry uncertainty, supply shortages, and increasing module prices. Ultimately, the delays resulted in less installed capacity than previously expected in 2018 and a corresponding loss in jobs.⁴

^{*} The National Solar Jobs Census began collecting jobs data for Puerto Rico in the 2018 report. The National Solar Jobs Census 2018 reported 242,343 solar jobs in all 50 states and the District of Columbia, and 244,340 jobs with Puerto Rico included.

[†] This solar jobs data, along with jobs totals for other energy industries, will be listed in the forthcoming U.S. Energy Employment Report, to be published by the Energy Futures Initiative and the National Association of State Energy Officials.

Once the tariffs were established, however, the industry was able to factor the impacts into their business plans and the pipeline of projects began to build up again, though at a slower rate than had been expected prior to initiation of the trade dispute. Policy changes in China also reduced demand for solar panels, decreasing global prices and mitigating the impact of the tariffs. With less uncertainty over the tariffs and the rush to begin construction to capture the full 30% ITC, the utility-scale solar market was much more active in 2019, requiring additional solar workers to begin or complete these projects.

Third, declining costs and prices continue to drive demand. The cost of solar energy continued to decline in 2019, making solar a competitive choice for residential consumers, corporate purchasers, and utilities across the country, even in traditionally underperforming markets where electricity prices are low. Without subsidies, utility-scale solar is now cost competitive with new fossil fuel generators in many locations, and even competitive with many existing fossil fuel power plants.⁵

Today, there is an urgent need to accelerate solar energy development to meet goals for climate change mitigation, energy cost savings, resilience, and economic development. While the job growth in 2019 is good news, the solar industry still faces headwinds such as the phaseout of the federal ITC, continuing uncertainty

around tariffs, and state and local policies and practices that delay or discourage solar development. Solar energy has the potential to expand even more dramatically in the new decade, but this will require policy support at the federal and state levels. A comprehensive strategy to support renewable energy growth and address climate change is vital to our future.*

SOLAR JOBS BY STATE

In 2019, solar jobs grew in 31 states, led by Florida, Georgia, Utah, and New York (Table 1). Other states with emerging solar markets such as Texas, Illinois, and Virginia experienced major job gains, while the state with the most established market, California, lost jobs. Florida, the top state for solar job growth, saw expanded installations for both residential and utility-scale solar. Utilities such as Florida Power & Light and Tampa Bay Electric Company are aggressively building utility-scale projects.⁶ For the residential sector, the new availability of solar leasing in Florida has allowed installers to offer an attractive financing option already available to consumers in other large solar markets.⁷

The Southeastern United States is one of the bright spots in this year's *Census*, with strong job growth driven by utility-scale expansion as well as new manufacturing jobs (see Spotlight, p 42). A net total of more than 3,700 jobs was added across the region, with eight of 13 Southeastern states experiencing job growth. Outside of that region, Texas is gearing up for its solar markets to expand even more in the next few years, especially in utility-scale development. Despite the state's low electricity rates, over a quarter of the U.S. corporate renewable energy deals in 2019 were for Texas projects, of which 80% were for solar.⁸

California remains by far the nation's largest solar jobs market, with 74,255 jobs in 2019 and about 40% of cumulative U.S. solar capacity.[†] While solar jobs declined in the state by 3.4% (a loss of 2,583 jobs), this was well below the 13.6% and 11.1% declines in 2017 and 2018, respectively. This is one indication that California's residential market is rebounding. Following the catastrophic fires in both 2018 and 2019, more households are looking to solar PV systems combined with storage to maintain electricity when utility companies cut power for safety reasons (see box, p 28).

Table 1

TOP 10 STATES WITH SOLAR JOBS GROWTH

STATE	2018 Jobs	2019 Jobs	% Increase in Jobs 2018-2019	Jobs Added 2018-2019
Florida	10,358	12,202	17.8%	1,843
Georgia	3,696	4,798	29.8%	1,102
Utah	6,045	7,107	17.6%	1,062
New York	9,729	10,740	10.4%	1,011
Texas	9,612	10,261	6.7%	649
Illinois	4,879	5,513	13.0%	634
Virginia	3,890	4,489	15.4%	599
Indiana	3,114	3,600	15.6%	486
Louisiana	2,950	3,352	13.6%	402
Hawaii	2,120	2,484	17.2%	364

* The Solar Energy Industries Association has set a goal for solar to reach 20% of U.S. electricity generation by 2030, which would require an annual growth rate of 18% and an average installation of 39 GW each year. See Solar Energy Industries Association, "The Solar+ Decade 2020-2030: Leading the Energy Transition," September 2019, https://www.seia.org/sites/default/files/2019-09/SEIA_Solar%2B_Decade_Roadmap_FINAL.pdf.

† Although California lost jobs in 2017, 2018, and 2019, it grew by a staggering 24,500 jobs in 2016, representing almost half of the 51,000 new solar jobs added nationwide in 2016.

SOLAR JOBS BY STATE



State policies also support California residential solar growth. Beginning in 2020, most new single-family homes will be required to include solar (see *Census In-Depth*, p 40). Despite the strengthening of residential demand, job growth has been limited because installers have reduced sales staff for door-to-door canvassing. Also, the nonresidential segment was stymied by interconnection delays and policy uncertainty, resulting in the net loss in solar jobs.⁹

Massachusetts, another state with an established solar market, experienced a 1.9% gain after losing jobs in the two previous years. However, policy uncertainty is still curtailing nonresidential development in Massachusetts.¹⁰ In Midwestern states, the picture was more mixed in 2019. Strong job growth in Illinois reflects the industry's rapid expansion after the passage of the Future Energy Jobs Act. However, jobs were down in Minnesota, where growth in past years had been driven

by the state's landmark community solar program, which has since seen signs of slower growth.¹¹ Michigan and Missouri also lost jobs, while there was a modest increase in Ohio and neighboring Pennsylvania.

Puerto Rico had 1,949 solar jobs in 2019, a 2.4% decline from 2018. Since the 2017 hurricanes, there has been increased interest in solar and battery storage to bolster the island's sustainability and resilience. The need for grid reliability was only reinforced after a series of earthquakes hit the island in late 2019 and 2020.*

A table listing solar jobs in all 50 states, the District of Columbia, and Puerto Rico, along with the gains or losses from 2018, can be found in Appendix A (p 46). In March 2020, The Solar Foundation will release more detailed state jobs data, as well as local data for counties, metropolitan areas, and federal and state congressional districts.

* The Solar Foundation has launched a new program, the Puerto Rican Solar Business Accelerator, to foster the expansion of Puerto Rico's solar industry and workforce. More information can be found at <https://www.thesolarfoundation.org/puerto-rico/>.

McCarthy Building Companies

McCarthy's Training Within Industries: Proven Strategies for Building a National Solar Workforce



With a utility-scale project pipeline that's larger than ever before, solar companies are faced with the prospect of hiring and training hundreds of workers in very short periods of time. McCarthy Building Companies, a top construction firm that has built over 2.7 GW of solar in the past decade, is taking on this challenge using a framework that dates back to World War II.

Known as Training Within Industries (TWI), McCarthy views it as a tried-and-true approach that is already helping the company meet its training and recruitment goals. First created in the 1940s by the U.S. Department of War, TWI is designed to train inexperienced workers for moderately complex tasks. For McCarthy, it provides an effective way to bring new hires on board with no experience in solar, while improving the quality, timeliness, and efficiency of each project. "It's a way to formalize the process and provide an organized training experience for new hires, helping workers learn foundational skills that are transferable to new projects," says Scott Canada, Senior Vice President and Business Leader of the Renewable Energy & Storage Group.

So far, McCarthy has used TWI at select projects with encouraging results, and plans to roll it out across its entire solar portfolio in 2020. McCarthy expects this approach will help meet the demands of today's fast-paced solar markets. "We'll have nine to 10 months to build a solar project and we need a few hundred people to be trained very quickly," Canada says. "If we're going to be successful, we need to be more effective at quickly bringing people into this industry and growing their capability."

OPTIMIZING RECRUITMENT AND TRAINING

A successful training program begins with recruitment. For entry-level hires, McCarthy looks for qualities like mechanical aptitude, work ethic, the ability to do outdoor work, and a regard for teamwork and safety. McCarthy prides itself on hiring a large majority of employees from the local communities



Training Within Industries

is designed to train inexperienced workers for moderately complex tasks.

where solar is being built, and experience in solar can be helpful but isn't required. To make the hiring more effective, McCarthy has started to formally train its team leaders on best practices for conducting interviews. "Making that interview step more effective has been key in making the local hire process go well," Canada says.

Another important part of the TWI process is "training the trainers." At the beginning of a project, managers work with foremen and superintendents to establish a set of procedures for training new hires. Once the entry-level employees are on board, training follows a specific, guided process. A supervisor shows an employee how to do a task three separate times. Then, the employee has to demonstrate at least three times that they are able to do the task.

From there, supervisors monitor an employee's progress and check in frequently to make sure the work is going well. For each major task, they give employees a grade between 1 (beginner level) and 5 (capable of teaching the task to others). These grades provide a structured way for employees to advance on the job and get promotions, Canada says. "It allows us to transfer people between job tasks and easily transfer them to the next project."

While this approach might almost seem like common sense, it marks a departure from the more informal training methods still used on many construction projects. It's more rigorous and time-intensive than simply

McCarthy Building Companies

*McCarthy's
Training Within
Industries:
**Proven
Strategies**
for Building a
National Solar
Workforce*

watching a supervisor do a job and then saying “okay, I got this,” Canada says. Moreover, the construction industry has traditionally relied on apprenticeships that teach workers a trade over a period of years. This may not be an option for solar projects where workers are needed immediately.

Adopting the TWI method has required a considerable culture shift among project teams. “You’re trying to change a bunch of habits that have been established over hundreds of years in the construction industry,” Canada says. However, it has already led to measurable improvements. McCarthy found it reduced training time on most projects by 25%, reduced labor hours by over 25%, and reduced the learning curve from three weeks to one week. Improved training has also resulted in fewer quality control issues and led to more efficient performance.

TWI IN ACTION: HAZLEHURST, GEORGIA

One recent project where McCarthy put TWI into practice was Hazlehurst III, a 55 MWdc solar installation in central Georgia, developed, owned, and operated by Silicon Ranch Corporation, one of the nation’s largest independent solar power producers and the U.S. solar platform for Shell. This project offered a meaningful economic opportunity for a region that has struggled with high unemployment, exacerbated when the nearby Husqvarna outdoor equipment manufacturer closed in 2019 and about 1,200 employees lost their jobs.

The Hazlehurst project required nearly 300 local workers. Most of the new hires did not have a background in solar or even construction, and included people with experience in retail, restaurants, or warehouses. Using the TWI method, McCarthy trained employees to perform the tasks on-site, with the goal to make them effective within a day and fully productive in about a week.

“We’ll start out with very small parts and pieces, and once they get comfortable with that we go on to expand their knowledge base,” says McCarthy Project Director Matt McMullan. “We’re not focused on training a person who’s only capable of fastening a bolt or putting on one part of a tracker, but we want well-rounded individuals that can be flexible and can be used as necessary across multiple parts of the installation.”



Silicon Ranch has found TWI to be an effective way to recruit a quality workforce and provide economic benefits for the community.

"As the long-term owner and operator of our entire portfolio, Silicon Ranch is deeply committed to being a good citizen in the communities we serve and to investing in the well-being of our fellow citizens," says Silicon Ranch CEO and Co-Founder Reagan Farr. "We seek to use local service providers and hire from the local labor pool as much as possible, and we are proud to partner with McCarthy to execute this vision. We're excited to bring the experience of locals trained through McCarthy's Training Within Industry platform to bear on multiple solar construction projects as our portfolio continues to grow, and to see the platform benefit communities across the country."

EMPOWERING COMMUNITIES AND STRENGTHENING THE WORKFORCE

McCarthy will be using the TWI method in solar projects totaling 850 MW that are planned for 2020. One of these is the Assembly Solar Plant in Michigan, developed by Ranger Power. This 228 MWdc project will be the largest solar plant in the state requiring over 200 craft workers and 100 general laborers to complete.

Local leaders are enthusiastic about the project's impact on the community, and in particular the impact on jobs. "Overall it's a huge win for our economy," says Justin Horvath, President and CEO of the Shiawassee Economic Development Partnership. "This project will bring in new dollars to support local businesses and property taxes to support essential government services, and it's providing well-paying jobs to hundreds of people in Shiawassee County."

For McCarthy, the benefits of the TWI approach extend beyond the impact on the community and the company's bottom line. They've also found it helps improve relationships between managers, foremen, and employees.

"It definitely shows our craft workforce that we care a lot about them, and it's driving them to be more engaged in their job and feel better about their work," Canada says. "It's about viewing the workforce as an equal partner, and making sure they get a lot out of the work as they help us become a successful business."



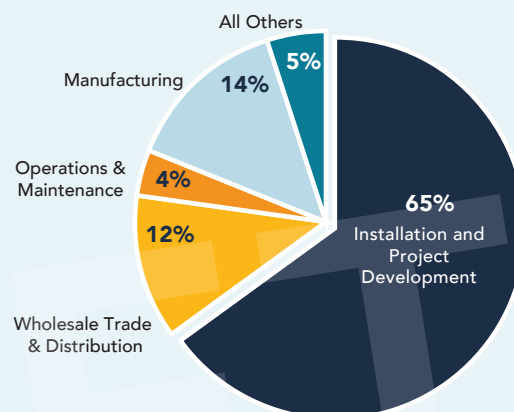
SOLAR JOBS BY SECTOR

The *National Solar Jobs Census* also reports on jobs by industry sectors: installation (including project development), wholesale trade and distribution, manufacturing, operations and maintenance (O&M), and the “other” category.* In 2019, demand-side sectors (installation and project development combined with wholesale trade and distribution) made up almost 77% of overall solar industry employment (Figure 2). In contrast, the manufacturing sector comprises only 14% of U.S. solar jobs, and O&M and the “other” sectors each comprise just under 5%.

The installation and project development sector was responsible for most of the job gains between 2018 and 2019. This sector grew by about 7,000 jobs to a total of 162,126, representing 4.5% growth (Table 3). Meanwhile, the manufacturing sector grew by just under 700

Figure 2

SOLAR EMPLOYMENT BY SECTOR



jobs, while the wholesale trade and distribution sector grew just over 550 jobs and the “other” category lost 1,000 jobs.†

* The jobs per industry sector are calculated based on the type of solar establishment, rather than an individual employee's work activities. For example, a sales representative at a solar installation establishment would be classified within the installation sector.

† The main types of firms included in the “other” category include research & development and related services, consulting, engineering, finance, legal, and other professional and support services. Until 2018, the “other” category also included O&M. “Other” jobs have likely declined due to survey participants’ increased awareness of the Solar Jobs Census and the categories they could choose from, allowing them to more accurately delineate their work to a specific sector category.

D.C.’S NATION-LEADING RENEWABLES MANDATE TO SPUR SOLAR GROWTH

In March 2019, a new mandate went into effect requiring Washington, D.C. to achieve 100% renewable energy by 2032, one of the most ambitious clean energy targets nationwide.¹² The law includes a solar carveout which requires 10% of the District’s electricity to be produced from local solar generation by 2041. The rest of the power can be purchased through renewable energy credits (RECs).

This 100% clean energy target is a growing trend across America as cities, counties, and states seek to transition to a clean energy economy. As of November 2019, more than 200 cities and counties, 11 states, Puerto Rico, and D.C. have set a 100% commitment to clean energy, together representing one in every three Americans.¹³

The District Department of Energy and Environment (DOEE) is implementing the mandate through its Solar for All program, which provides the benefits of locally generated solar energy to low- and moderate-income households. This program mandates that the District reduce the electricity bills by 50% for 100,000 low-income households by 2032, through either the installation of a rooftop solar installation or participation in a community solar project.¹⁴ In the Spring of 2019, DOEE announced plans to install over 7 MW of local solar capacity in partnership with the DC Sustainable Energy Utility, the current administrator of the Solar for All program.¹⁵

Thanks to these supportive policies, the District expects to see a 53% increase in local solar capacity year over year, both for residential and non-residential installations.¹⁶ This will have an impact on solar jobs not only in D.C. but also in neighboring Maryland and Virginia, where some of the installation companies may be located. In 2019, while the District lost 40 jobs year-over-year, Maryland and Virginia both gained jobs at the rate of 8% and 15%, respectively. Overall, these three jurisdictions gained approximately 900 solar jobs.

TEXAS PRIMED FOR LARGE-SCALE SOLAR MARKET GROWTH

A new 100 MW project in Texas developed by **RWE Renewables** adds to the company's burgeoning portfolio of U.S. solar projects, with about 10 GW of renewable energy in the development pipeline. RWE is an international developer of wind, solar, and battery storage facilities with a combined capacity of more than 9 GW. The company's West of the Pecos project, completed in January, utilizes nearly 350,000 solar modules and spans over 700 acres in Reeves County, Texas.¹⁷ It enabled approximately 200 jobs during construction.

Today, there are over 3.4 GW of installed solar capacity in Texas, a growth of 2.3 GW from only four years ago.¹⁸ Over the next five years, Texas is poised to be the top state for large-scale solar development with about 14 GW coming online.¹⁹ Texas is particularly conducive to large-scale solar due to the significant land available, a strong solar resource (especially in west Texas), and the compatibility of the state's wind and solar generation allowing efficient use of existing transmission infrastructure.²⁰ These attributes along with several market factors are leading the state to large-scale solar market dominance.

One of the biggest market factors is the state's energy-only ERCOT market, which has proven to be exceedingly attractive for solar developers that are able to take advantage of peak Texas energy prices.²¹ Electricity demand growth, corporate renewable energy goals, and the phaseout of the investment tax credit will also be key drivers spurring the massive expansion of large-scale solar in Texas.²²

The *Solar Jobs Census* further breaks down the installation and project development sector into market segments: residential, non-residential, and utility-scale (Table 2). Although utility-scale represents the largest segment for installed capacity, it has considerably fewer jobs than the other two segments. The utility-scale sector has higher labor productivity, and greater economies of scale due to the relatively low transaction costs per unit of capacity deployed.*

Table 2
INSTALLATION AND PROJECT DEVELOPMENT JOBS BY SEGMENT

	Employment	%
Residential	90,953	56.1%
Non-residential	39,721	24.5%
Community Solar	11,025	6.8%
Other Non-residential	28,696	17.7%
Utility-scale	31,452	19.4%
Total	162,126	

Table 3
SOLAR EMPLOYMENT BY SECTOR

Sector	2018 Employment	2019 Employment	Change in Employment 2018-2019	% Total Employment	% Growth 2018 - 2019	% Growth 2010 - 2019
Installation and Project Development	155,157	162,126	6,969	64.9%	4.5%	269%
Wholesale Trade and Distribution	29,243	29,798	555	11.9%	1.9%	154%
Operations & Maintenance	11,164	11,583	419	4.6%	3.8%	n/a
Manufacturing	33,726	34,423	697	13.8%	2.1%	38%
All Others	13,053	12,053	-1,000	4.8%	-7.7%	-7%
Overall	244,340	249,983	5,643		2.3%	167%

Note: There was no sector-level data available for Puerto Rico prior to 2019, but Puerto Rico is included in overall 2018 and 2019 employment

* Our 2018 analysis found the residential sector created 38.7 jobs per MW installed, compared to 21.9 jobs for the non-residential sector and 3.3 jobs for utility scale. See The Solar Foundation, *National Solar Jobs Census 2018*, February 2019, <http://www.solarjobsensus.org>.



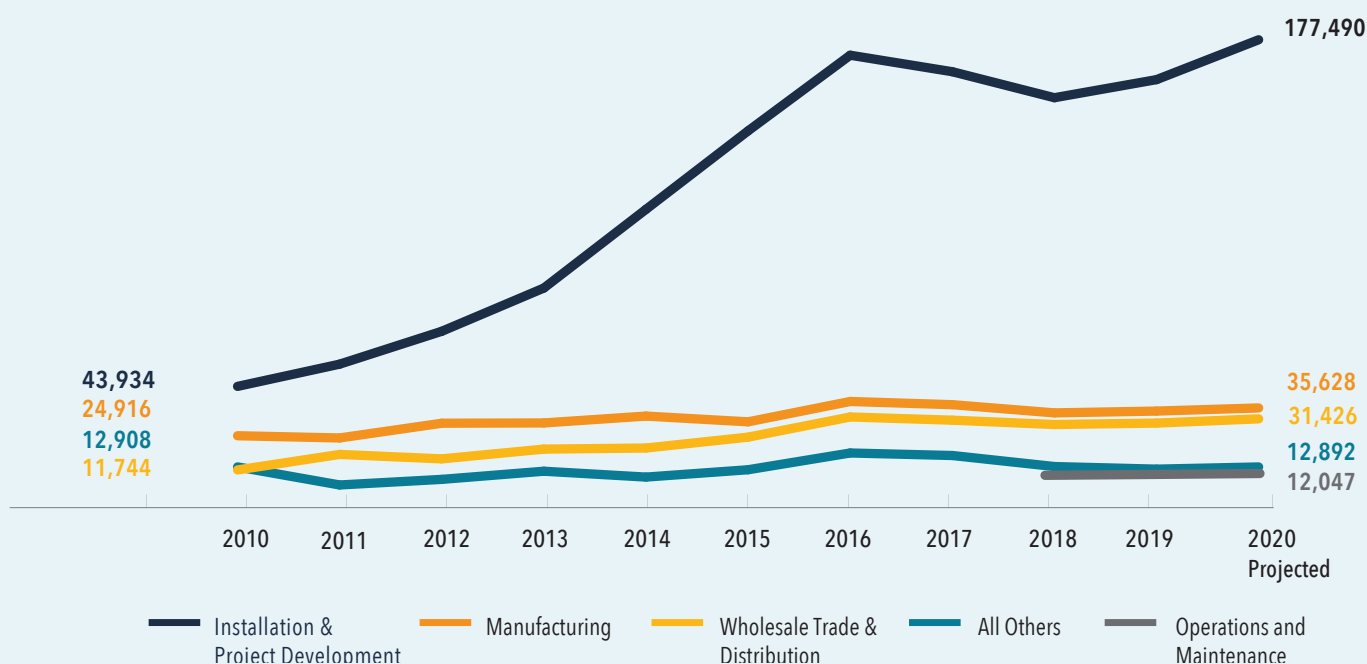
Solar installers were also asked to identify jobs in their organizations that primarily work on battery storage. Establishments reported that about 16,000 installation jobs focus on storage, or 10% of the total in the installation sector. Separately, within firms where battery storage is the primary focus, there were 14,638 jobs directly linked to solar. This second group of energy storage jobs is not included in the solar jobs total for this report. Instead, they will be listed as part of the energy storage category in the forthcoming *U.S. Energy Employment Report*, published by the Energy Futures Initiative and the National Association of State Energy Officials.

LONG-TERM TRENDS FOR SOLAR JOBS

As solar energy has taken hold in the United States, the job market has expanded rapidly over the past decade. While the solar job losses in 2017 and 2018 reflected short-term policy and market challenges, overall trends have been positive. Since 2010, solar employment has grown 167%, from just over 93,000 to nearly 250,000 jobs in all 50 states. The most significant growth has taken place in the installation and project development sector, which has grown 269%, or 3.7 times the number of jobs in 2010. Wholesale trade and distribution, the second fastest growing sector, grew by 154%, and manufacturing jobs grew by 38% (Table 3, Figure 3).*

Figure 3

SOLAR EMPLOYMENT GROWTH BY SECTOR, 2010-2019



* The "other" sector lost 7% of jobs. As noted, however, this sector no longer includes O&M as of 2018, so the low growth doesn't accurately reflect the long-term trend for this sector. For comparison, the "other" sector grew by 34% between 2010 and 2017.

COMMUNITY SOLAR BROADENING REACH TO LMI MARKET

Community solar projects geared toward low-and-moderate income (LMI) communities are becoming more prevalent across the country. Since 2011, 15 states and the District of Columbia have implemented programs that encourage these LMI projects.²⁸ Across these states, the program design, structure, and incentives differs greatly.

Maryland is one state that is seeking to make LMI community solar more successful by addressing common issues with the design of such programs.²⁹ The state community solar program, established in 2017, includes a 60 MW carve-out requiring at least 50 percent LMI participation.³⁰ While carve-outs ensure a minimum level of LMI participation, they can also raise customer acquisition costs due to turnover and the increased financial risk to project developers.³¹ Maryland's program addresses financial risk by providing grants to local subscriber organizations that purchase the project's capacity and offer the power at a discount to LMI residents.³²

Nautilus Solar, a national solar acquisition, development, and asset management company, is currently developing nine projects serving LMI communities in Maryland, which will serve approximately 1400 LMI households by Q1 2021. The first of these projects is a 1.8 MW community solar project in White Marsh, Maryland, expected to be energized in 2020.³³ Over 50 percent of the energy generated will be provided to approximately 220 LMI households in the area. Nautilus partnered with Power52, a Maryland-based nonprofit, on three of their projects. Power52 assisted with customer acquisition, offering the power to LMI households at an energy cost savings. The projects are also being constructed by members of the Power52 Energy Institute's 11-week solar training program for individuals in disadvantaged communities.³⁴

Other states including Illinois, Oregon, and Massachusetts have also launched innovative programs to reach LMI customers. As more of these state programs mature, they will provide valuable case studies on how to optimize program design, incentives, financing options, and outreach strategies.

Table 4

SOLAR ENERGY SECTOR EMPLOYMENT, 2010-2020

SECTOR	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Installation and Project Development	43,934	48,656	65,165	81,827	112,143	142,383	171,533	165,174	155,157	162,126	177,490
Wholesale Trade and Distribution	11,744	13,000	16,005	19,771	20,185	24,377	32,147	30,912	29,243	29,798	31,426
Operations and Maintenance	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	11,164	11,583	12,047
Manufacturing	24,916	37,941	29,742	29,851	32,490	30,282	38,121	36,885	33,726	34,423	35,628
All Others	12,908	5,548	8,105	11,248	8,989	11,816	18,274	17,300	13,053	12,053	12,892
Overall	93,502	105,145	119,017	142,697	173,807	208,859	260,077	250,271	244,340	249,983	269,482

*Note: There was no sector-level data available for Puerto Rico prior to 2019, but Puerto Rico is included in overall 2018 and 2019 employment.

In the five-year period between 2014 and 2019, solar employment grew by 44% overall or 7.5% annually, adding a net of 76,176 jobs.* By comparison, U.S. employment grew 8.2% overall and 1.6% annually during that time period. Therefore, solar employment grew approximately five times faster than employment in the overall U.S. economy.³⁵ Solar growth accounted for 0.7% of the 11.3 million jobs added by all U.S. businesses, equal to one in every 150 new U.S. jobs.[†]

Long-term job growth over the past decade was primarily driven by the falling costs of solar energy, especially materials, or “hard costs.” From Q3 2010 to Q3 2019, price estimates for PV installations have declined by nearly 57% for residential systems, 76% for non-residential or commercial systems, and 78% for utility-scale projects (Figure 1).‡ The federal ITC, which

began scaling down in 2020, has also helped drive solar market development. State renewable portfolio standard policies, the Public Utility Regulatory Policies Act, and net energy metering also support the vibrant U.S. solar power market. Even as climate change and energy policy remain very contentious in U.S. politics, solar energy enjoys widespread and bipartisan support among elected leaders and the general public.³⁶

The solar industry employs almost twice as many workers as the coal industry, and ranks third in total employment among energy industries, behind only petroleum and natural gas.[§] Compared to more established industries, solar currently employs more workers per unit of generation due to its current high growth rate, requiring more workers to construct new projects.

* Based on the compound annual growth rate.

† Based on 76,176 growth in solar jobs divided by 11,314,449 growth in total U.S. jobs.

‡ Using the Solar Market Insight report series, 2010-2019, this analysis compares Q3 2010 to Q3 2019. The reporting switched from capacity-weighted average installed costs to modeled national PV installed price estimates with component costs in 2014. The prices are based on a 6 kW residential system, 100 kW rooftop for non-residential, and a 10 MW utility-scale system.

§ This comparison is based on data from 2018 for other energy industries, the most recent year available. See National Association of State Energy Officials and Energy Futures Initiative, The 2019 U.S. Energy and Employment Report, May 2018, <https://www.usenergyjobs.org/>. An updated report with 2019 data will be released this year.



SUNNOVA GOES PUBLIC IN FIRST SOLAR IPO SINCE 2015

On July 25, 2019, Houston-based residential solar and storage service provider Sunnova Energy International [NYSE: NOVA] launched its initial public offering, marking the first time a major U.S. solar company has gone public since 2015. The company provides residential solar and solar + energy storage services, currently operating in more than 20 states with over 72,600 customers. In its [SEC filing](#), Sunnova detailed the company's vision of "disrupting the traditional energy landscape" by changing the way homeowners generate and consume electricity.[1]

Leading residential solar companies are jockeying for position as the sector experiences record growth, with a record 712 MW installed in Q3 2019.[2] Some advantages for Sunnova include its business model, which relies on a network of 136 third-party dealers for installations, leading to reduced customer acquisition costs, greater operating leverage, and the ability to quickly scale the business.

In 2020, Sunnova is [making additions to its workforce](#) both in its Houston corporate offices and across its field services unit, and Sunnova also continues to support solar jobs through its expansive dealer network across the United States. The company is placing a priority on workforce diversity and inclusion as part of its long-term growth strategy. Sunnova also plans to expand its geographic footprint and broaden the scope of its services.

Overall, 2019 was a boom year for solar company stocks following significant losses in 2018. The Invesco Solar Energy ETF, which tracks the Mac Global Solar Energy Index, was up 64% in 2019, well above the 30% gain for the S&P 500.[3]

LOOKING AHEAD TO 2020

With about 71 GW of total capacity nationwide, solar energy comprised 2.6% of U.S. electricity generation over a 12-month period ending in November 2019.³⁷ As in 2017 and 2018, new installations in 2019 are expected to exceed all other sources of new electric generating capacity except natural gas.³⁸ The United States also reached the milestone of 2 million solar installations in 2019, just three years after crossing the 1 million threshold.³⁹

The coming year is expected to be a historic time for solar energy development. In 2020, Wood Mackenzie Power and Renewables expects 19 GW of new solar capacity to come online, a 46% increase over the pace of new deployment in 2019 and representing the largest year ever for U.S. solar. While over 70% of new capacity will come from utility-scale solar in 2020, residential solar development is also expected to see modest growth. The volume of non-residential solar installations declined in 2019 and is also projected to decline in 2020.⁴⁰

Solar and wind will provide most new energy generation in 2020, exceeding all fossil fuels, combining to represent 78% of all new capacity added.* Coal and nuclear plants will continue to be decommissioned as renewable energy assumes greater importance as part of the country's energy mix. About 11 GW of coal, gas, and nuclear energy generating capacity is scheduled for retirement in 2020.⁴¹

This anticipated increase in solar installations should lead to accelerated solar job growth in 2020. The *National Solar Jobs Census* survey respondents project employment growth of 7.8% in 2020, bringing the total to about 269,500 jobs (Figure 4). Firms focused on installation expect to grow by 9.5%, adding just over 15,000 jobs – by far the most of any sector. Wholesale trade and distribution is expected to grow at a 5.5% rate, and O&M is expected to grow at a 4% rate.† Manufacturing is expected to experience just under 3.5% growth, adding about 1,200 jobs over the coming year. Jobs in the "other" category are expected to grow by 7%.

* If distributed generation is included, the U.S. Energy Information Administration predicts both solar and wind will provide 39% of new generating capacity in 2020. Natural gas is only expected to provide 20%. While rooftop solar generation will be widespread, utility-scale solar will be more concentrated, with over half of new utility-scale projects being developed in California, Texas, Florida, and North Carolina.

† Unlike most of the jobs in the other sectors, O&M jobs are a function of cumulative installation rather than annual installation volume.

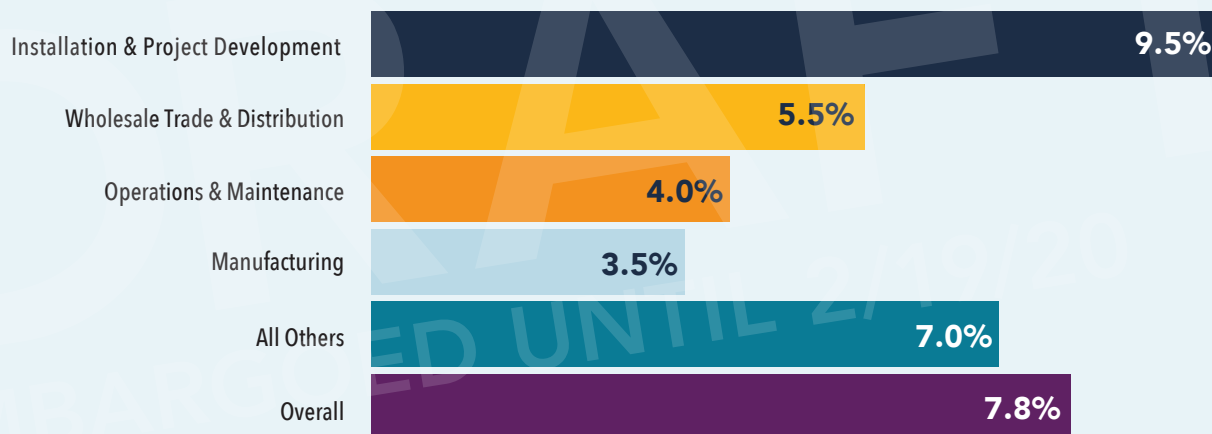
It is important to note, however, that industry predictions will not necessarily become reality. The 2020 employment trends will be influenced by many unpredictable factors, including economic conditions, access to capital, and major policy shifts at the federal and state levels. Last year, solar firms predicted 7% job growth in 2019, much higher than the 2.3% growth that occurred.⁴²

SOLAR INDUSTRY CHARACTERISTICS

The *National Solar Jobs Census 2019* includes detailed additional data on solar industry characteristics, including the focus of establishments by value chain, types of employees, the number of employees per firm, employee job locations, and supply chain analysis. These figures can be found in Appendix B (p 48).

Figure 4

EXPECTED SOLAR EMPLOYMENT GROWTH FROM 2019-2020



PROJECT FINANCE ENTERING NEW ERA AFTER ITC STEPDOWN

Tax equity has been critical to helping the solar industry mature, historically supporting 40-50 percent of the costs of solar projects.⁴³ One of the largest players in solar tax equity is **U.S. Bank**, which has over 10 years of experience serving as a tax equity investor for residential, commercial behind-the-meter, and utility-scale solar projects. In fact, U.S. Bank has invested over \$1 billion annually over the past decade to support project financings. In 2019, U.S. Bank's tax equity investments helped finance several noteworthy projects under development. One of these is Wagyu Solar, a 162 MW project that is now under construction in Damon, Texas, and is expected to create 800 construction and 40 permanent jobs.⁴⁴ Another was Green Mountain Power's VT Microgrid, which consists of three solar + storage projects now under construction in Vermont, totaling 14.4 MW of solar and 6 MW of storage.⁴⁵ These projects are expected to create 100 construction jobs and 9 permanent jobs.

Tax equity, in part, helped fund the massive rush of solar development in 2019 while the full federal investment tax credit was still in effect. Although safe-harbor provisions exist, the ITC begins ramping down in 2020, and many projects will face capital constraints as tax equity opportunities diminish. The tax equity market is expected to be robust through 2023, after which the ITC will drop to a permanent 10%. Though there is much uncertainty, it is clear that in the future, tax equity will occupy a smaller share of the market as well as a reduced portion of the project capital stack. Consequently, the solar industry will need to look to new financial solutions, such as cash-heavier tax equity structures, additional debt, or securitization, to help fill that void.⁴⁶



are largely imported, and virtually all cells used for domestic module production are imported.

Overall, the manufacturing sector added about 700 solar jobs in 2019. States that saw a large increase in manufacturing jobs include Georgia, New York, Florida, and Alabama, while other states including California and Arizona lost manufacturing jobs. However, the majority of states (44) saw little change over 2018, with a difference of 50 jobs or fewer from one year to the next.

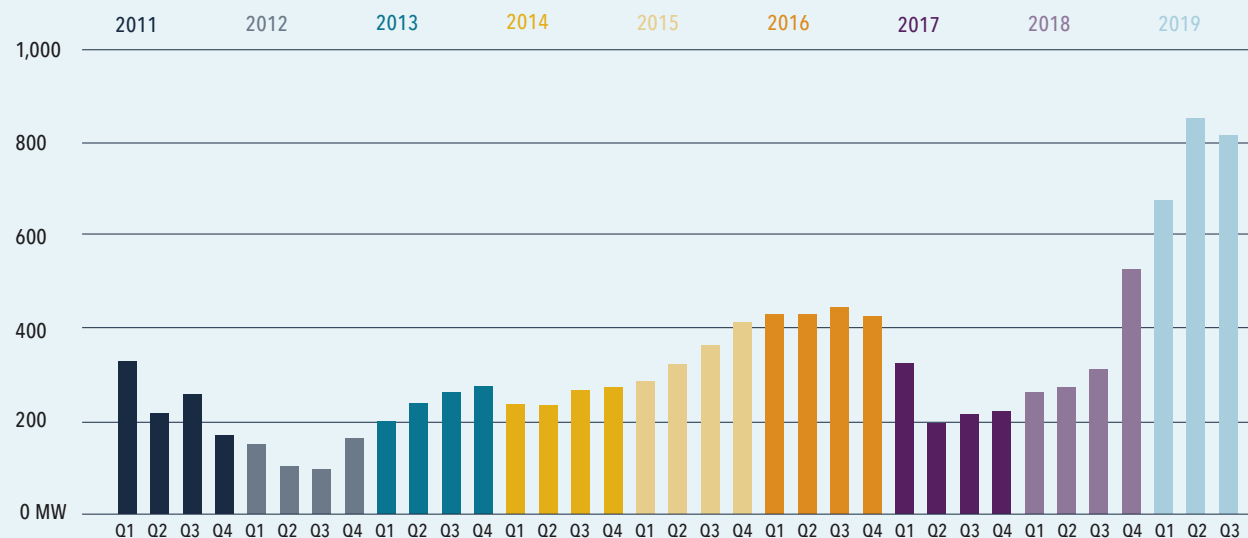
When asked what solar energy components they manufacture, 41% of firms produce mounting structure hardware (including trackers) and a third of *Census* respondents said they manufacture modules. Another 21% produce monitoring systems, 17% produce water thermal collectors, 13% produce inverters, and 18% manufacture other items (Table 6).

U.S. solar module production spiked dramatically in 2019 to reach 2,371 MW, a 176% increase from the same period in 2018. In 2019, new facilities opened, such as the LG Electronics plant in Alabama and the Q CELLS manufacturing plant in Georgia (see *Census In-Depth*, p 32).

Current tariff conditions are pushing companies to begin or expand production in the U.S. The Section 201 tariffs that were enacted in February 2018 mandate 30% duties on cells and modules imported to the U.S. The tariffs will step down 5% each year for the next four years.

Figure 5

U.S. DOMESTIC SOLAR MODULE PRODUCTION, 2011-2019



Source: SEIA/Wood Mackenzie Power and Renewables

Table 5

PERCENTAGE OF ESTABLISHMENTS COMPONENTS
SOURCED FROM SUPPLIERS AND VENDORS OUTSIDE THE U.S.

	INSTALLATION AND DEVELOPERS	MANUFACTURING	OPERATIONS AND MAINTENANCE
MODULES	74.4%	26.3%	45.5%
INVERTERS	50.6%	21.1%	45.5%
ELECTRONICS	6.5%	0.0%	0.0%
HOUSING/SUPPORT STRUCTURE	10.1%	5.3%	0.0%
BATTERIES/STORAGE	10.7%	0.0%	0.0%
WIRES/CABLES	2.4%	5.3%	18.2%
OTHER	8.9%	36.8%	36.4%

Table 6

COMPONENTS PRODUCED BY SOLAR
MANUFACTURING ESTABLISHMENTS

TECHNOLOGY	TECHNOLOGY
Mounting structures/trackers	41%
Modules	33%
Monitoring systems	21%
Water Heater / Thermal Collectors	17%
Inverters	13%
Cables/conduits/wires	9%
Battery storage	7%
Cells	5%
Wafers	1%
Other	18%
Note: Respondents could choose more than one component	

*The solar manufacturing
sector **added about
700 jobs in 2019,**
for a total of
34,423 workers.*

Q CELLS Georgia Manufacturing Plant



In 2019, Q CELLS, one of the world's largest and most recognized photovoltaic manufacturers, opened its first U.S. manufacturing facility in Dalton, Georgia. In this rural area an hour north of Atlanta and 45 minutes from Chattanooga, Tennessee, Q CELLS was attracted by the skilled workforce, extensive manufacturing resources, and Georgia's excellent transportation infrastructure.

Critically, the Dalton site was also certified by Georgia Ready for Accelerated Development, which identifies areas that are ready for fast-track construction projects. This ensured that Q CELLS could quickly set up shop to tap into the burgeoning U.S. solar market.* Construction began in August 2018, and by February 2019 the first round of Q CELLS modules shipped. Today, the 300,000-square-foot facility cranks out 10,000 solar panels daily and has a nameplate annual capacity of 1.7 GW. It is the largest single solar manufacturing site in the Western Hemisphere.† Over 650 employees, working across four shifts each day, make the Dalton plant tick. Q CELLS expects to hire another 50 employees, mostly in high-skilled positions, to help the facility soon reach its peak output of 12,000 panels a day.

The Q CELLS facility has played a big role in recharging the community, which was hit hard by the Great Recession and a long-term decrease in manufacturing jobs, says Lisa Nash, Human Resource Manager. Nearly 400 of the operators and technicians hired come from local high schools and technical schools and live within a 30-mile radius of the Dalton plant. The plant has also been a magnet for high-skilled workers, such as engineers, from top colleges and employers across the country. "About 70 percent of the Q CELLS engineers moved to the region from outside the state,"

* Georgia Department Of Economic Development, "GRAD Certified Sites," accessed January 13, 2020, <https://www.georgia.org/grad-certified-sites>. Q CELLS, "Grand Opening Of Hanwha Q CELLS In Georgia Spotlights Western Hemisphere's Largest Solar Panel Manufacturing Facility, Responsible For 650 Jobs And A Daily Output Of 12,000 Solar Modules," October 2, 2019, https://www.hanwha.com/en/news_and_media/press_release/grand-opening-of-hanwha-q-cells-in-georgia-spotlights-western-hemispheres-largest-solar-panel-manufacturing-facility-responsible-for-650-jobs-and-a-daily-output-of-12000-solar-modules.html.

† Ibid.



says Nash, “and these are folks buying homes and raising families in the community.”

A majority of the workforce at the Dalton facility fall into three categories: operators, technicians, and engineers. Operators focus on manufacturing the products. Technicians manage the process flow by overseeing the quality and mechanics of the machines. Operator positions need a high school diploma or a technical college degree depending on the level, while technician positions require a technical college or a two-year degree, Nash said. Engineers manage process improvement, quality control, and line efficiency, operations, and assessment.

An engineer position at Q CELLS is a more demanding skill and experience level, requiring a bachelor's or master's degree. Many of the experienced engineers come from the automotive and robotics industries, while new engineers typically have an interest or a background in solar, energy, or robotics. Employees work across several core teams. Engineers and technicians oversee manufacturing from both a people and product perspective. They evaluate and test products, machines, operating procedures, personnel training plans, and more, with the goal to reduce waste and increase efficiency.

Initially, Q CELLS had some difficulty finding candidates with the right experience, Nash says, noting that even many of the more experienced job candidates were intimidated by the fast pace, cutting-edge manufacturing process, and advanced technology and robotics. Q CELLS helps new hires acclimate with an on-the-job training program, which can last from two weeks to six months depending on the position. “You don't have to be an expert in solar or robotics to join the company,” Nash says, “We want people who want to make a difference.”

The number of qualified job candidates has greatly increased over the past year, Nash said. In response to the opportunities at the plant, many local schools have ramped up their STEM programs, and Q CELLS has partnered with local high schools and technical colleges to strengthen candidate pipelines, create robotics training programs, and raise awareness of their work.

*The **Q CELLS** facility has played a big role in **recharging the community**, which was hit hard by the Great Recession and a long-term decrease in manufacturing jobs.*

DEMOGRAPHIC ANALYSIS

As one of the top three job creators among U.S. energy industries, the solar industry will grow stronger as its workforce becomes more diverse. Today, the solar workforce is not yet representative of the America's ethnic, racial, and gender diversity. However, more and more companies are making diversity and inclusion a priority as the new decade begins. In the spring of 2019, The Solar Foundation released the *U.S. Solar Industry Diversity Study* along with the *Diversity Best Practices Guide for the Solar Industry*, in partnership with the Solar Energy Industries Association (SEIA).⁴⁷ These resources assess the current state of diversity and inclusion in the industry and outline best practices to chart a path forward.

Within the past year, there was little change in the demographic makeup of the solar workforce (Table 7). Representing a slight decrease from 2018, this year's *Solar Jobs Census* found that only 26% of the solar workforce was made up of women, while women make up 47% of the overall workforce (Table 8). This puts the

solar industry ahead of the construction sector overall, where women make up 10% of the workforce, but still leaves much room for improvement.

The representation of people of color in the solar industry also changed very little from 2018. The proportion of solar workers who are Latino or Hispanic remained at 17%, which is comparable to the overall U.S. workforce. The proportion of black or African American employees in solar remained steady at 8%, below their national representation at 10% of the workforce. Just under 9% of the solar workforce is made up of Asian workers, higher than the 6% rate within the overall workforce.

As in previous years, the latest solar job figures make it clear that veterans are often excellent candidates for solar careers. In 2019, 8% of the solar workforce was comprised of veterans, compared to only 6% of the overall U.S. workforce. The proportion of solar workers 55 and over has steadily decreased since 2015, making the industry increasingly skewed toward younger employees.

Table 7

SOLAR WORKER DEMOGRAPHIC BREAKDOWN, 2014-2019

	2014 % of workforce	2015 % of workforce	2016 % of workforce	2017 % of workforce	2018 % of workforce	2019 % of workforce	2019 Overall
Women	21.6%	23.9%	28.0%	26.9%	26.3%	26.0%	65,300
Gender Non-Binary	-	-	-	-	1.4%	0.7%	1,625
Hispanic	16.3%	11.3%	17.2%	16.8%	16.9%	17.2%	44,490
American Indian or Alaska Native	-	-	1.1%	1.0%	1.1%	1.2%	2,938
Asian	7.0%	8.7%	9.1%	8.4%	8.5%	8.5%	20,967
Black or African American	6.0%	5.2%	6.6%	7.4%	7.6%	7.7%	19,348
Native Hawaiian or other Pacific Islander	-	-	1.3%	1.2%	1.2%	1.2%	3,040
White	-	-	73.6%	73.7%	73.3%	73.2%	182,849
Two or more races	-	-	8.3%	8.3%	8.3%	8.2%	20,841
Veterans	9.7%	8.1%	9.0%	8.6%	7.8%	7.6%	19,004
55 and over	-	18.5%	11.2%	11.4%	10.5%	10.4%	25,915

Table 8 SOLAR WORKER DEMOGRAPHICS BY SECTOR AND IN COMPARISON TO OTHER INDUSTRIES

	Female	Gender Non-Binary	Latino or Hispanic	American Indian or Alaska Native	Asian	Black or African American	Native Hawaiian or other Pacific Islander	White	Two or more races	Veterans	55 and over
Solar Installation and Project Development	23.8%	0.5%	16.5%	1.2%	6.9%	7.9%	1.1%	76.7%	7.8%	7.4%	9.3%
U.S. Construction	9.9%	-	30.7%	-	2.0%	6.2%	-	88.4%	-	6.4%	21.7%
Solar Wholesale Trade and Distribution	34.6%	0.1%	19.9%	1.4%	9.0%	5.8%	2.4%	62.7%	10.0%	7.0%	9.9%
U.S. Wholesale Trade	28.5%	-	19.2%	-	5.2%	8.9%	-	83.2%	-	6.7%	22.1%
Solar Operations & Maintenance	24.6%	0.7%	15.0%	0.6%	8.3%	8.5%	0.4%	82.1%	3.2%	7.8%	9.2%
U.S. General Repair & Maintenance	12.5%	-	27.2%	-	3.3%	8.1%	-	84.7%	-	4.6%	23.5%
Solar Manufacturing	27.4%	2.0%	19.6%	1.1%	15.0%	8.9%	1.2%	59.9%	11.3%	10.0%	14.4%
U.S. Manufacturing	29.2%	-	16.7%	-	6.9%	10.4%	-	79.5%	-	7.1%	24.7%
Solar All Others	32.5%	0.6%	14.4%	1.5%	10.8%	5.3%	0.9%	80.7%	5.4%	5.3%	16.8%
Solar Overall	26.0%	0.7%	17.2%	1.2%	8.5%	7.7%	1.2%	73.2%	8.2%	7.6%	10.4%
U.S. Workforce Overall	46.9%	-	17.3%	-	6.3%	10.4%	-	79.5%	-	5.9%	23.3%

WORKFORCE DEVELOPMENT

America's growing solar workforce is open to people with a wide variety of skills and educational backgrounds. A few of the different solar worker occupations include rooftop installers, module assemblers, salespersons, materials researchers, project managers, and engineers. Over half (68%) of the new hires in 2019 were hired to fill newly created positions, an increase from the 48% in 2018 (Figure 6). Most of the remainder (26%) were hired to replace workers due to turnover or retirement at the company. Another 6% of new hires in 2019 represent existing employees that added solar responsibilities to their workloads.

WAGES

The solar industry provides competitive wages to solar installers and production workers, from entry-level to senior level positions. For solar installers, the *Solar Jobs Census* survey found the median wage for entry-level unlicensed (non-electrician) installers was \$16.00, just below the national median wage of \$18.58 for all occupations.⁴⁸ The median wage for entry-level licensed (electrician) installers was \$20.00 (Table 9).

At manufacturing plants, reported median wages for solar production workers began at \$15.00 for entry-level employees, just below the national reported median wage of \$16.85 for production workers. Wages reached \$36.50 for senior-level production employees (Table 10).

Figure 6

NEW HIRES

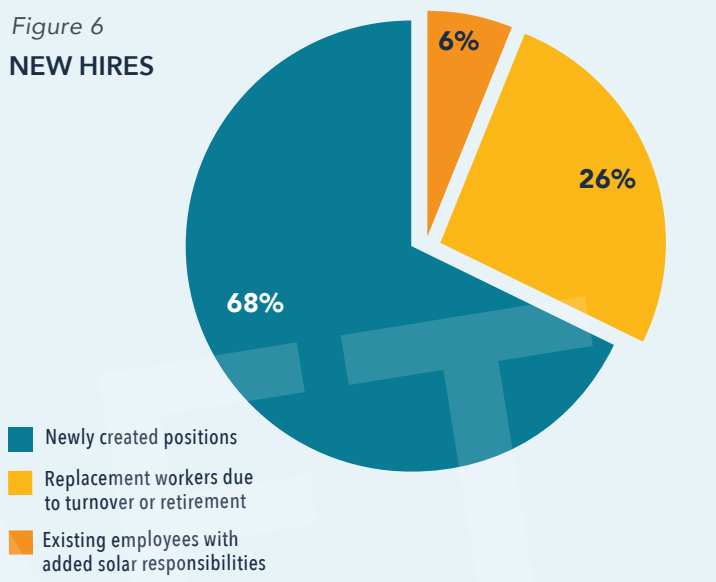


Table 9

MEDIAN SOLAR INSTALLER WAGES

	Unlicensed Installer	Licensed Installer
Entry-level wage	\$16.00	\$20.00
Mid-level wage	\$23.00	\$28.00
Senior/Crew-lead	\$30.00	\$37.50

Table 10

MEDIAN SOLAR PRODUCTION WAGES

	Manufacturing
Entry-level wage	\$15.00
Mid-level wage	\$22.00
Senior/Crew-lead	\$36.50

Table 11

PERCENTAGE OF ESTABLISHMENTS REQUIRING EXPERIENCE AND EDUCATION

	WITH EXPERIENCE					2019		
	2015	2016	2017	2018	2019	% with Bachelor's Degree or Higher	% with Vocational or Technical Certificate or Credential	% with Associate's Degree or Certificate from Accredited College
Installation and Project Development	71.3%	61.4%	48.9%	60.9%	46.0%	22.4%	12.9%	6.1%
Wholesale Trade and Distribution	65.1%	66.2%	62.4%	79.5%	69.3%	56.2%	12.7%	10.3%
Operations & Maintenance	N/A	N/A	N/A	89.7%	29.7%	26.9%	24.6%	26.1%
Manufacturing	65.0%	62.5%	45.5%	43.4%	41.4%	31.9%	11.2%	11.4%
All Others	79.1%	76.3%	64.3%	81.6%	30.6%	16.3%	3.5%	3.8%
Overall	67.0%	64.5%	54.8%	60.4%	44.6%	27.6%	11.8%	12.1%

EXPERIENCE AND EDUCATION REQUIREMENTS

The *Solar Jobs Census* found that 45% of new positions in 2019 required previous experience in new hires, lower than in 2018, when 60% of employers required experience (Table 11). This trend was found across all industry sectors. The solar jobs growth in 2019, combined with a low unemployment rate, may have led to fewer experienced employees being available for open positions. Further, the *Census* found that more employers required either a bachelor's degree, technical certificate, or associate's degree compared to 2018.

HIRING DIFFICULTIES

The *Solar Jobs Census* has consistently found that large numbers of firms find it difficult to hire qualified employees, and this past year was no exception. In 2019, 26% of solar employers reported it was “very

difficult” to find qualified applicants to fill open positions, a percentage that is unchanged since 2018 (Figure 7). Further, 57% of firms reported it was “somewhat difficult” to find qualified applicants, which is also nearly identical to the 2018 figure. When broken down by sector, installation and project development firms had the greatest difficulty hiring compared to other solar industry sectors, followed by O&M firms (Figure 7).

Almost half (49%) of all solar employers reported a lack of experience, training, or technical skills as the most significant reason for their difficulty hiring, a finding similar to what the *Solar Jobs Census* reported in 2018 (Figure 8). The second most common reason for reported difficulty hiring was a competitive job market and small applicant pool. This is unsurprising, as unemployment rates in 2019 remain the lowest the U.S. has experienced in the last 10 years.⁴⁹

Figure 7

PERCENTAGE OF ESTABLISHMENTS REPORTING HIRING DIFFICULTY

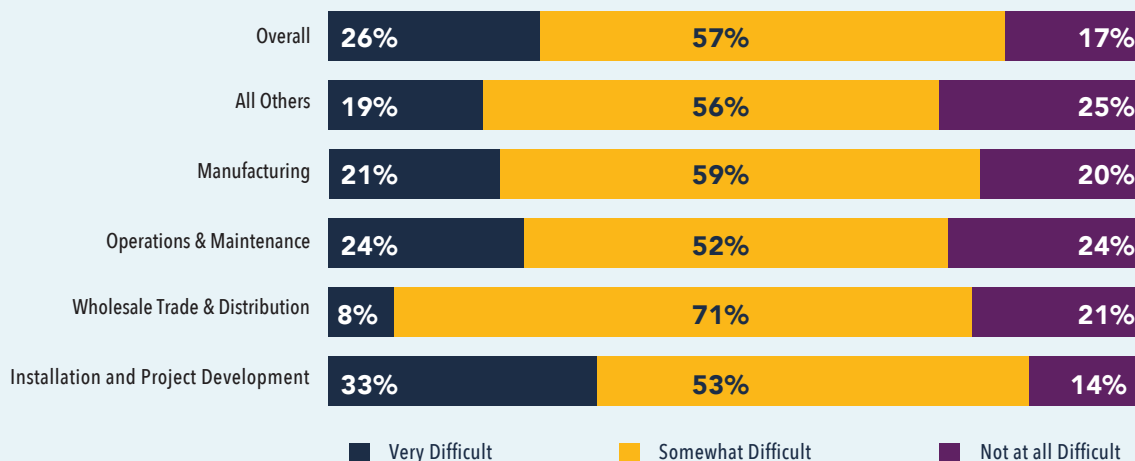


Figure 8

MOST SIGNIFICANT REASONS FOR REPORTED DIFFICULTY HIRING

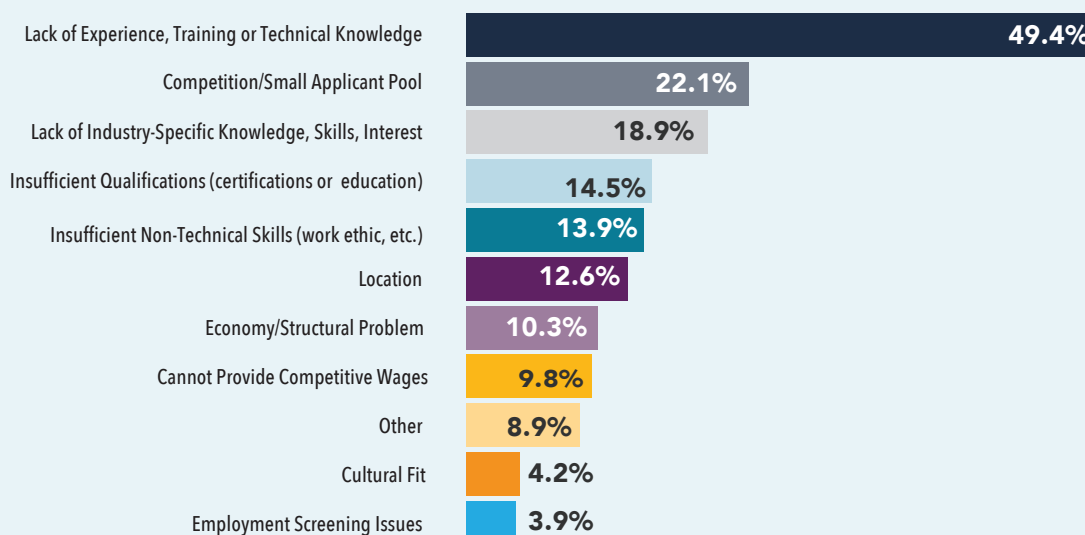


Figure 9

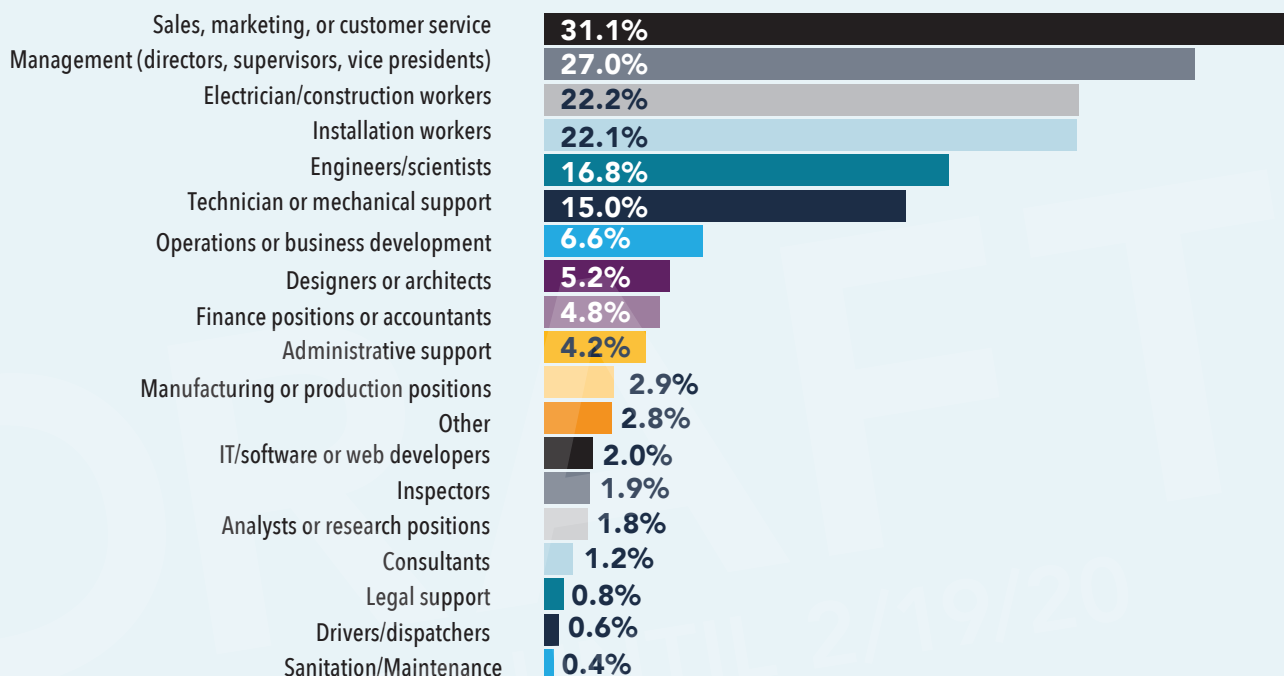
MOST DIFFICULT POSITIONS TO FILL

Table 12

HIRING DIFFICULTY BY CENSUS REGION

	U.S. CENSUS DIVISIONS								
	New England	Middle Atlantic	East N. Central	West N. Central	South Atlantic	East S. Central	West S. Central	Mountain	Pacific
Very difficult	28.4%	24.6%	21.2%	35.5%	27.1%	10.6%	19.8%	20.9%	26.5%
Somewhat difficult	56.1%	60.0%	49.4%	51.7%	61.3%	89.4%	57.1%	62.4%	63.6%
Not at all difficult	15.6%	15.3%	29.3%	12.7%	11.6%	0.0%	8.8%	16.7%	9.9%

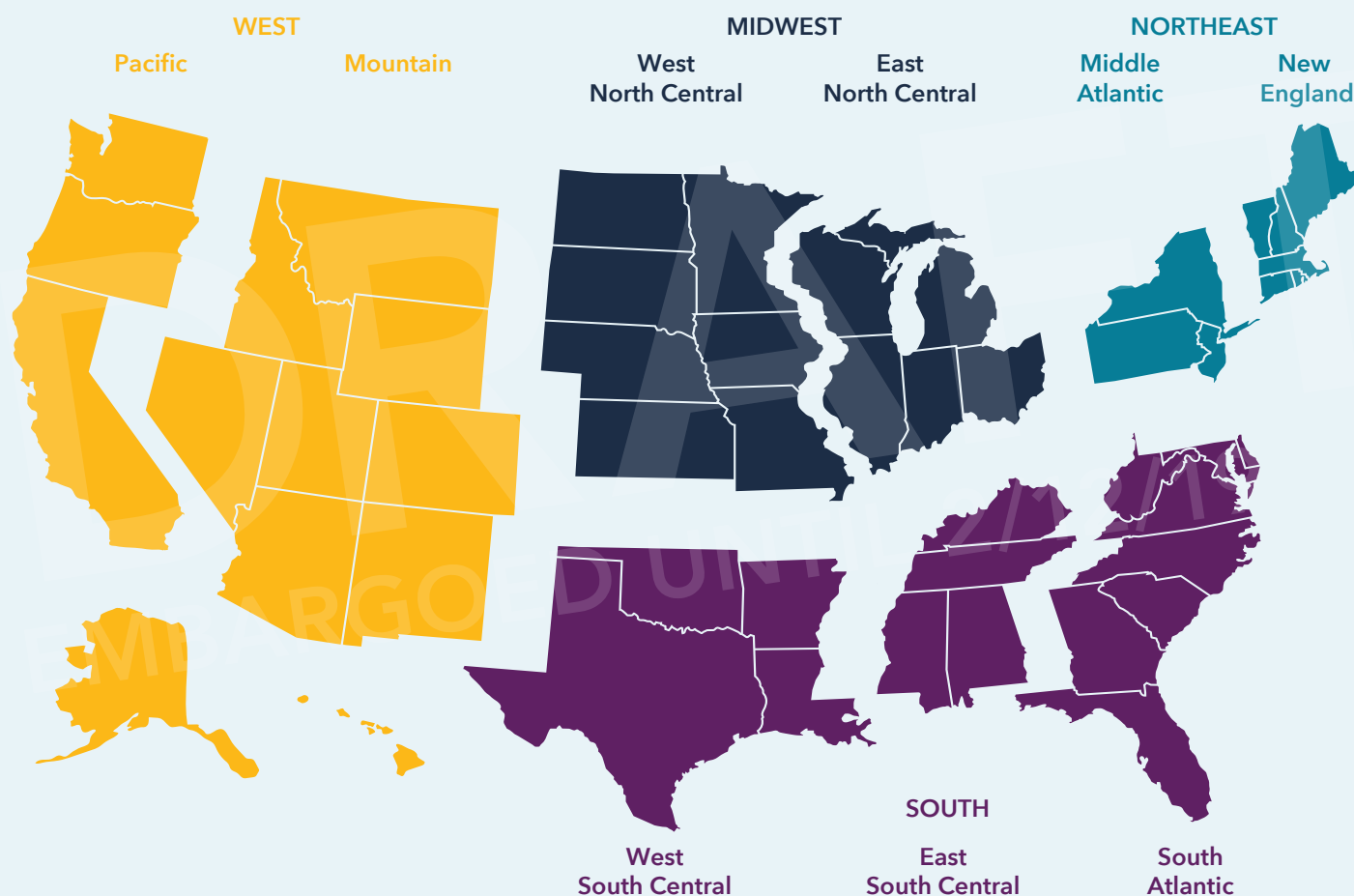
When asked to list the most difficult positions to fill, the most common response was sales, marketing, or customer service positions (31%). Following that, other common responses include management positions, electricians, and installers (Figure 9).

Hiring difficulty varied considerably by geographic region. The greatest difficulty hiring was in the West

North Central census region, where 36% reported it was “very difficult” to find qualified applicants (Table 12). Many of the states in this region have less established solar markets, making it more difficult to find qualified applicants. The New England, South Atlantic, and Pacific regions also experienced greater hiring difficulty than the nationwide average. (See Figure 10 for a map of all U.S. Census regions.)

Figure 10

U.S. CENSUS DIVISIONS



MEETING THE HIRING CHALLENGE

Fortunately, there are a number of effective strategies for solar companies to achieve their workforce development goals. These include tapping into local workforce development resources (such as training providers, community colleges, and workforce boards), and expanding work-based training programs that allow entry-level employees to learn on the job. These strategies are detailed in The Solar Foundation's recent report, published through the Solar Training Network: *Strategies for Solar Workforce Development: A Toolkit for the Solar Industry*.⁵⁰ One example featured

in this year's *Solar Jobs Census* is McCarthy Building Companies, which is enhancing its on-site training and recruitment at utility-scale solar projects using Training Within Industries, a method that dates back to World War II (see *Census In-Depth*, p 18).

To attract talent, another successful approach is to step up recruitment among military veterans. The Solar Foundation leads a Solar Ready Vets Fellowship program that will place transitioning service members in on-the-job training programs with solar companies.⁵¹

Aurora Solar

California's Rooftop Solar Mandate: *How to Succeed*



This year, California's Title 24 mandate went into effect, requiring all new residential homes to be built with solar PV. This represents a new business opportunity for the industry, which in the coming years will help drive solar expansion and job growth in America's largest solar market. We asked [Aurora Solar](#), a solar design and sales software company, about the approaches and strategies that will be key to a company's success.

For homebuilders, solar installers, and other stakeholders, Title 24 is a change to the state's building code standards, laying out a new set of requirements and considerations that could fundamentally revamp their work processes. The main requirement for homebuilders is to show that the PV system is sized to offset the home's energy usage. The mandate requires energy efficiency measures to be designed first, so that a PV system is accurately sized to offset the energy consumption of the home. The other key requirement is the ability to document that there is sufficient solar access for the system to generate the right amount of energy. In other words, this means showing that shading from trees or other buildings won't interfere with the PV system's production.

To stay in compliance, homebuilders, installers, and energy consultants will need to work more collaboratively, says Meredith McClintock, Head of Business Development at Aurora Solar. McClintock noted that builders have typically worked with energy consultants and solar installers on separate tracks. Now, however, since energy efficiency will impact the sizing and cost of the solar PV system and vice-versa the process will need to be more iterative to ensure the mandate is met efficiently and effectively. "Increased and earlier collaboration is critical," says McClintock, "because it will lead to a consensus for what the process will look like, with faster and smoother back-and-forth among stakeholders, and efficient cost tradeoffs between solar and additional measures."



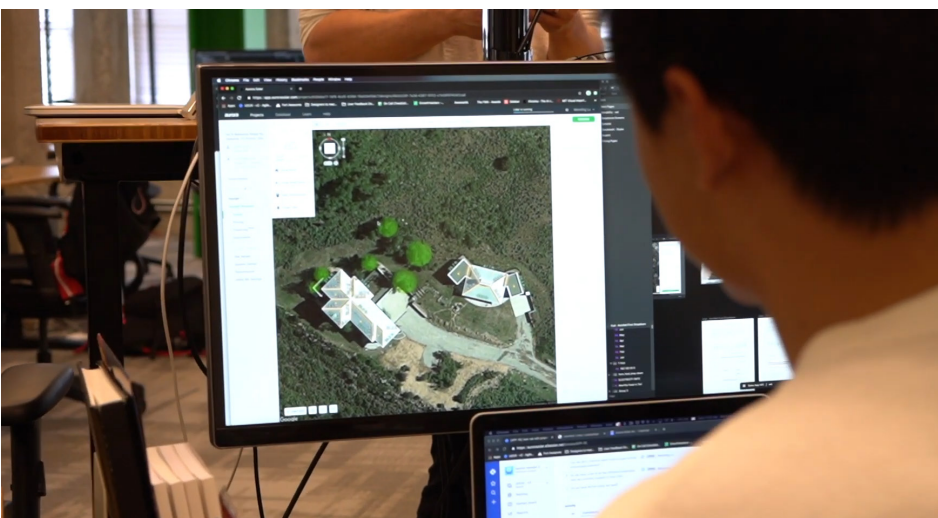
USEFUL RESOURCES FOR TITLE 24 COMPLIANCE

1. CEC's [Residential Compliance Manual](#) for the 2019 Building Energy Efficiency Standards
2. CEC's [Reference Appendices For The 2019 Building Energy Efficiency Standards Appendix JA11 – Qualification Requirements for Photovoltaic System](#) (JA11 begins on p.205)
3. Aurora Solar's [Ultimate Guide to Success Under the California Title 24 Solar Mandate](#)

Title 24 is expected to result in solar installations on an additional 65,000 homes every year.* To capitalize on that growth, there are several key actions industry stakeholders will need to take. Most importantly, according to McClintock, they must learn the new requirements and be familiar with the residential compliance manuals and software guides. "Stakeholders also need to make sure their design and shading analysis tools have all the capabilities necessary to comply and can do so accurately. Otherwise," she said, "they are at risk of cost overruns from rework." For example, if a PV system is sized incorrectly or the shade report is inaccurate, they will have to go back and resolve the issue, which could require a lot more time and money.

Aurora Solar has been working with the California Energy Commission (CEC) to find ways to make compliance easier for everyone, and they've gotten their software formally approved as a solar assessment tool for compliance. The company will be releasing a [Guide to Title 24](#), which is a comprehensive handbook for stakeholders to understand all the new solar requirements and how Aurora can be used in their workflow to guarantee full compliance. Aurora Solar's software has the capability to design PV systems from a blueprint, conduct shade analysis, forecast how much energy a PV system will produce, and provide other tools now critical to Title 24 compliance. "From our in-depth conversations with the CEC," said Sunny Wang, Director of Government Affairs & Communications at Aurora Solar, "it was great to learn that our software already has the functionalities needed to help home builders and installers meet the requirements."

* Chris Crowell, "Countdown To 2020, Part 1: The Role Solar Plays In California's New Building Efficiency Standards," Solar Builder Magazine, January 24, 2019, <https://solarbuildermag.com/news/countdown-to-2020-part-1-the-role-solar-plays-in-californias-new-building-efficiency-standards/>



SPOTLIGHT

SOLAR JOBS IN THE U.S. SOUTHEAST

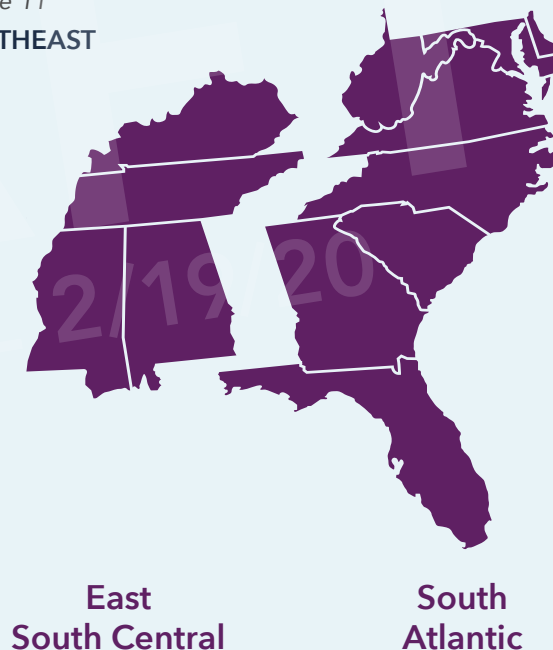
The Southeastern United States is one of the hot spots for American solar job growth. Combined, this region had a total of 45,263 solar jobs in 2019, an increase of 9% over 2018. Since 2015, solar jobs in the Southeast have increased 45%, much higher than the overall 20% growth across the United States. In 2019, the state with the largest number of jobs added nationwide was Florida, with an increase of 1,843 jobs, while Georgia had the highest job growth rate (30%, with 1,102 added jobs).

Until recently, North Carolina was the primary market for solar energy in the Southeast region. However, falling solar costs, improved market access, and corporate procurement have dramatically increased solar development in other states, including Florida, Georgia, South Carolina, and Virginia.

This discussion focuses on the two Census divisions of the Southeast region: South Atlantic, including the states of Delaware, Maryland, West Virginia, Virginia, North Carolina, South Carolina, Georgia, and Florida, along with the District of Columbia; and East South Central, including Kentucky, Tennessee, Alabama, and Mississippi (Figure 11). The region covers a broad geography, from the sunny states of Florida and Alabama to the historically coal-generating states in the Appalachian region, such as West Virginia and Kentucky.

Most states in the Southeast rank among the lowest for average electricity price, with an overall regional average of 9.86 cents per kWh, lower than the national average electricity price of 10.53 cents per kWh.⁵² Low electricity prices tend to make solar less cost competitive, increasing the time it takes to recover the costs of a solar installation. However, the Southeast has a higher solar resource rank than many other areas of the country, leading to greater energy yield. As in much of

Figure 11
SOUTHEAST



the rest of the country, falling solar costs have pushed solar into positive economic territory in the Southeast.

Eight of the 13 states in the Southeast experienced solar job growth in 2019 (Table 13). The largest number of jobs were added in Florida and Georgia, followed by Virginia, Maryland, South Carolina, Alabama, Mississippi, and Delaware. All but one of those states also experienced solar capacity growth in 2019, which usually correlates with an increase in jobs.

The exception is Virginia, which was expected to experience a 5% decrease in new installed capacity, though the Commonwealth gained 600 solar jobs. This relationship can be explained by the large pipeline of utility-scale solar projects in Virginia, with 1.3 GW expected to come online in 2020. Many of these projects are currently under construction, creating solar jobs without immediate capacity growth.



Table 13

SOLAR JOBS AND CAPACITY IN THE SOUTHEAST

State	SOLAR JOBS						SOLAR CAPACITY	
	2018 Jobs	2019 Jobs	Growth 18-19	National Rank	Jobs per Capita Rank	2020 Projected Growth	Cumulative Installed Capacity (MW)	National Rank
AL	614	707	15.2%	42	50	9.7%	283	26
DC	1,092	1,051	-3.8%	35	7	4.2%	81	41
DE	468	495	5.7%	45	29	5.6%	132	35
FL	10,358	12,202	17.8%	2	25	10.0%	3,414	5
GA	3,696	4,798	29.8%	15	36	1.0%	1,762	10
KY	1,410	1,362	-3.4%	32	40	9.1%	45	44
MD	4,515	4,854	7.5%	14	13	1.3%	1,160	15
MS	770	847	10.0%	41	45	4.0%	241	29
NC	6,719	6,617	-1.5%	11	20	10.2%	5,662	2
SC	2,983	3,307	10.9%	25	19	0.0%	1,050	16
TN	4,690	4,194	-10.6%	19	24	8.4%	341	24
VA	3,890	4,489	15.4%	16	28	7.9%	843	17
WV	341	340	0.0%	47	49	0.0%	8	48

Installed Capacity Data Source: SEIA/Wood Mackenzie Power and Renewables. Sources: The Solar Foundation, National Solar Jobs Census; Wood Mackenzie, Limited, and the Solar Energy Industries Association, U.S. Solar Market Insight (capacity data through 2019).

North Carolina boasts the second highest cumulative installed solar capacity in the country after California, reaching over 5.5 GW through September 2019. However, the state's solar jobs ranking leaves it at number 11, and it ranks 20th on a per capita basis. This is most likely because the majority of the state's solar capacity is in utility-scale projects, which create fewer jobs per MW than residential or non-residential solar.* In addition, utility-scale projects are sometimes developed by out-of-state companies.

In 2019, utility-scale solar installations in North Carolina were expected to decrease almost 50% year over year. This downturn stems from state law HB 589, signed in

2017, which altered the standards of North Carolina's Public Utilities Regulatory Policies Act (PURPA) legislation.⁵³ Until then, PURPA drove the majority of the utility-scale installation in North Carolina, accounting for 92% of utility-scale capacity in the state in 2015.⁵⁴

The new law made it far more difficult for utilities to install solar energy under PURPA, and they must now go through a competitive procurement process in order to receive a contract, greatly reducing the feasibility of these projects. The state's large drop in utility-scale capacity was balanced with a 59% growth in the residential sector and 168% growth in the

* Our 2018 analysis found the residential sector created 38.7 jobs per MW installed, compared to 21.9 jobs for the non-residential sector and 3.3 jobs for utility scale. See The Solar Foundation, National Solar Jobs Census 2018, February 2019, <http://www.solarjobscensus.org>.

non-residential sector. Overall, however, the state lost approximately 100 solar jobs in 2019.

Florida is close behind North Carolina for its total installed solar capacity, with a cumulative 3.4 GW overall and an expected 1.45 GW installed in the last year alone. Florida also ranks second in the country for the number of solar jobs, though the state remains well behind California's 74,255 solar workers and ranks 25th on a per capita basis. The state's utilities, including Florida Power and Light (FPL) and Tampa Electric Company, have led the way in the deployment of utility-scale solar.

In fact, FPL and Tampa Electric Company rank among the top 10 utilities in the country for annual solar capacity.⁵⁵ In early 2019, FPL announced a goal to install 30 million solar panels by 2030, amounting to over 10 GW of solar capacity; and in May, FPL announced that construction had commenced on 10 solar power plants across the state.⁵⁶ Recently, Florida has also opened up solar leasing for homeowners, helping to expand the market for residential solar.⁵⁷

The region's third largest market is Georgia, where utility-scale installations grew from only 11 MW to approximately 1.2 GW from 2018 to 2019. Along with Florida, California, and Texas, Georgia is one of four states that was expected

to install more than 1 GW of new capacity in 2019. Basic market forces are driving this growth, including the steadily declining cost of solar installations and the fact that Georgia offers vast amounts of cheap, sunny land.⁵⁸ As was the case in Florida, the state utility, Georgia Power, has announced plans to heavily invest in solar energy in the coming years. Georgia Power released an updated Integrated Resource Plan (IRP) in 2019, calling for over 2 GW of new capacity from wind, solar, and biomass.⁵⁹ Meanwhile, in 2019, the Georgia Public Service Commission issued a final order in Georgia Power's rate case that approves net metering for up to 5,000 solar customers, which will help encourage growth in residential solar.⁶⁰

Georgia also experienced major growth in the solar manufacturing sector in 2019, as did Florida and Alabama. Hundreds of new workers were hired to staff the new Q CELLS manufacturing facility in Dalton, Georgia (see *Census In-Depth*, p 32). Of the 1,102 additional solar workers in Georgia last year, 641 were in the manufacturing sector. In Florida, Jinko Solar opened a module production facility that became fully operational last fall, which led to an increase in solar manufacturing jobs. In Alabama, LG Electronics began module production in the fall of 2019.

Solar jobs in Virginia increased by 15% as the state developed its large pipeline of utility-scale projects. Thanks to new state policies in support of renewable energy, this growth is expected to continue. Governor Ralph Northam issued an executive order in 2019 to produce 30% of the Commonwealth's energy from renewable sources by 2030, and 100% from carbon-free sources by 2050.⁶¹ In August, Virginia regulators approved the largest solar project east of the Rocky Mountains, a 500 MW installation developed by sPower that will power Microsoft data centers.⁶²

In Maryland, meanwhile, the legislature passed a new law increasing the state renewable portfolio standard to 50% renewable energy by 2030, including a carve-out to mandate that 14.5% of the renewable energy be derived from solar.⁶³ Governor Larry Hogan also signed HB 683 to extend Maryland's community solar pilot program through 2022.⁶⁴ Solar jobs in Maryland increased 7.5% in 2019 for a total of 4,854 jobs.

South Carolina is poised to become another major solar market after Governor Henry McMaster signed the Energy Freedom Act, eliminating the net metering cap that was reached in 2018, though questions remain about the bill's implementation (see box, p 45).⁶⁵ In Delaware, which now has just under 500 solar jobs, Governor John Carney signed HB 65, lifting restrictions on residential solar installations.⁶⁶



IN SOUTH CAROLINA, ENERGY FREEDOM ACT OPENS NEW BUSINESS OPPORTUNITIES BUT UNCERTAINTY STILL REMAINS

In 2019, the South Carolina legislature passed the Energy Freedom Act (EFA), which is expected to open the door to rapid solar expansion across all segments of the industry. The new law eliminated the 2 percent cap on net metering, directed utilities to introduce distributed energy resources in their Integrated Resource Planning, and required utilities to establish Public Utility Regulatory Policies Act (PURPA) power purchase agreement rates and contract lengths. From 2019 through 2024, there is an additional 150 MW of forecasted residential installations in South Carolina due to the new legislation.⁶⁹

One of the companies taking advantage of this opportunity is Southern Current, founded in 2008 and headquartered in Charleston, South Carolina. **Southern Current** has rapidly risen to a dominant developer of commercial and small utility-scale projects in the Southeastern U.S. Late last year, the company announced a 630 kW ground-mounted solar installation at the Contec manufacturing facility in Spartanburg, South Carolina, slated for construction in early 2020. Overall, 2019 marked a year of expansion for Southern Current, which increased its workforce to over 80 full-time employees and an anticipated collective capital investment of more than \$141 million in the Palmetto State.

For Southern Current and other stakeholders, however, there is still considerable uncertainty over how the new law will be implemented. In November, the State Public Service Commission approved Duke Energy and Dominion's PURPA contracts for large-scale solar, which set some of the lowest rates and shortest contract lengths in the nation.⁷⁰ For solar developers, the low rates plus the short contract length would make large-scale solar projects in South Carolina unfinanceable.⁷¹ The PSC somewhat reversed course in January by raising Dominion's rate, but questions still linger over whether contract lengths will remain at 10 years.⁷² Solar developers will be closely watching this decision to determine if they will keep their investments in South Carolina or look to neighboring states with more appealing finance landscapes.⁷³

The Southeastern states that lost solar jobs in 2019 include North Carolina, Kentucky, West Virginia, and Tennessee, as well as the District of Columbia. In 2019, Tennessee gained capacity but lost solar jobs, which likely reflects workers coming in from out of state.

The smallest solar markets in the Southeast include Kentucky and West Virginia, with Kentucky at 45 MW in cumulative solar capacity and West Virginia at only 8 MW, ranking 44th and 48th, respectively. Kentucky ranks 32nd for solar jobs nationwide, while West Virginia ranks 47th. The states are well-known in the energy industry for their abundance of coal deposits, and do not currently have substantial policy support for renewables. These two states also have the lowest average electricity prices in the Southeast, reaching just 8.52 cents per kWh in Kentucky and 8.72 cents per kWh in West Virginia.⁶⁷ Nonetheless, both states have a solar resource that is just as abundant as their neighbors, and enormous potential for growth if supportive policies are in place.

Louisiana is not included in the two Census regions discussed here, but the state is notable for its strong job growth in 2019. Louisiana gained just over 400 jobs to reach 3,352 solar workers, a 14% increase since 2018. Overall, Louisiana has installed 108 MW of solar, and

the state's capacity additions in 2019 were expected to increase by 300% over the previous year, thanks to utility-scale projects expected to come online in the final months of 2019. However, in September 2019, regulators voted to end the net metering program in the state, which will discourage residential solar growth.⁶⁸

In the Southeast, just as elsewhere in the country, the *Solar Jobs Census* found a majority of solar employers have difficulty hiring qualified workers (Table 14). A particular challenge exists in states with new or emerging solar markets where there is a smaller pool of experienced candidates. Twenty-six percent of the region's solar employers find it "very difficult" to hire qualified workers, while 63% find it somewhat difficult. Both percentages are similar to what is found nationwide.

Table 14

DIFFICULTY HIRING IN THE SOUTHEAST

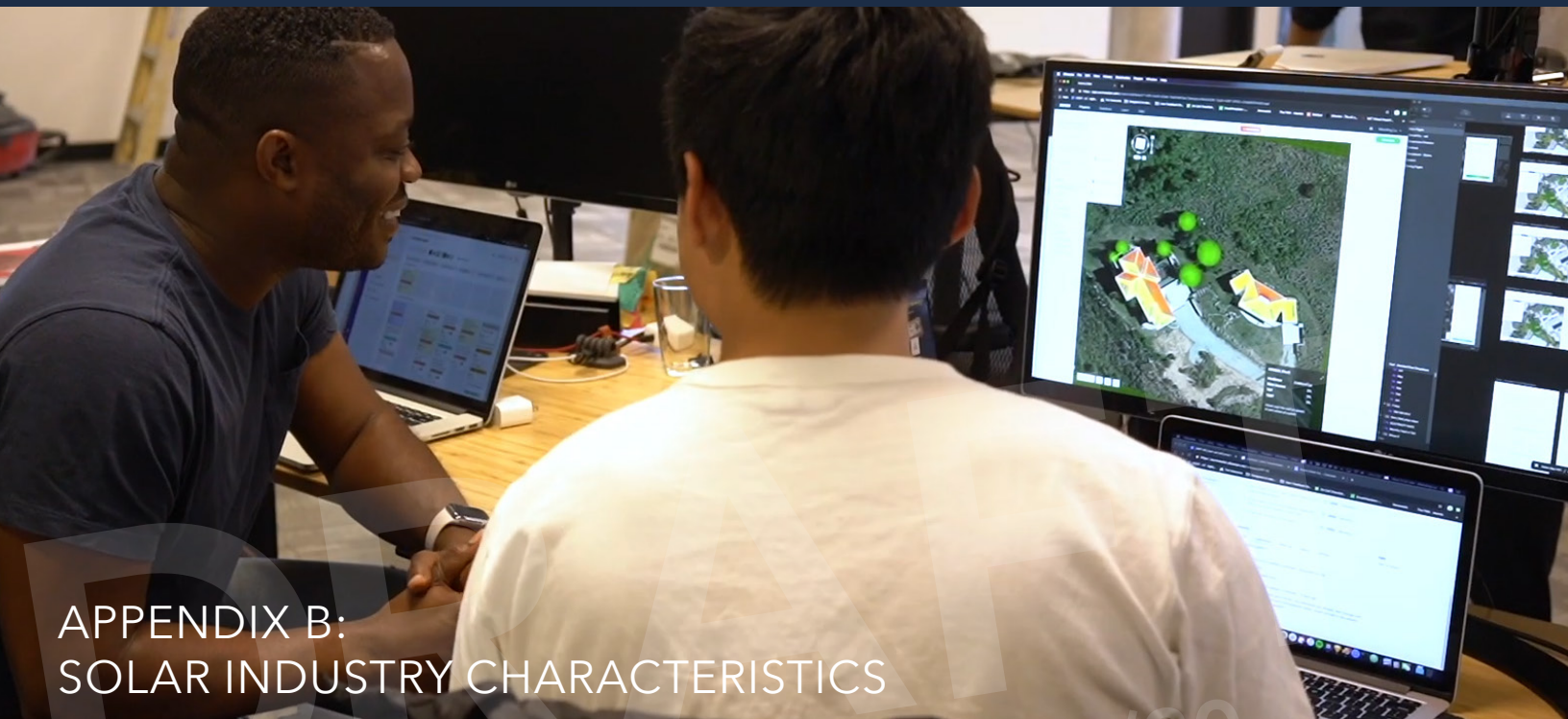
	Southeast	National
Very Difficult	26%	26%
Somewhat Difficult	63%	60%
Not at all Difficult	11%	14%

APPENDIX A: SOLAR JOBS BY STATE

State	2019 Solar Jobs	2018 Solar Jobs	Year/Year % Growth	Year/Year Change in Jobs	Solar Jobs Rank	Solar Jobs Per Capita Rank	Ratio of Solar Worker to Overall Workforce
AK	64	66	-3.5%	-2	52	52	1:5,127
AL	707	614	15.2%	93	42	50	1:2,969
AR	329	369	-10.9%	-40	48	51	1:3,903
AZ	7,777	7,524	3.4%	253	6	9	1:381
CA	74,255	76,838	-3.4%	-2,583	1	4	1:237
CO	7,174	6,847	4.8%	326	8	8	1:391
CT	2,234	2,193	1.9%	41	29	21	1:761
DC	1,051	1,092	-3.8%	-41	35	7	1:766
DE	495	468	5.7%	27	45	29	1:949
FL	12,202	10,358	17.8%	1,843	2	25	1:745
GA	4,798	3,696	29.8%	1,102	15	34	1:969
HI	2,484	2,120	17.2%	364	28	5	1:266
IA	869	844	3.0%	25	39	46	1:1,834
ID	512	557	-8.1%	-45	44	44	1:1,487
IL	5,513	4,879	13.0%	634	13	35	1:1,122
IN	3,600	3,114	15.6%	486	23	27	1:879
KS	887	896	-0.9%	-8	38	41	1:1,623
KY	1,362	1,410	-3.4%	-48	32	40	1:1,438
LA	3,352	2,950	13.6%	402	24	16	1:595
MA	10,400	10,210	1.9%	190	4	6	1:356
MD	4,854	4,515	7.5%	339	14	13	1:574
ME	639	635	0.6%	4	43	33	1:990
MI	3,876	4,169	-7.0%	-293	20	37	1:1,147
MN	4,335	4,602	-5.8%	-267	17	14	1:685
MO	2,647	2,819	-6.1%	-172	27	36	1:1,104
MS	847	770	10.0%	77	41	45	1:1,382
MT	308	274	12.7%	35	49	43	1:1,574
NC	6,617	6,719	-1.5%	-102	11	20	1:694
ND	232	233	-0.8%	-2	50	42	1:1,887
NE	1,332	1,328	0.3%	3	33	18	1:779
NH	1,031	890	16.0%	142	36	15	1:667
NJ	6,225	6,410	-2.9%	-184	12	17	1:677
NM	2,021	2,168	-6.8%	-147	30	10	1:427
NV	7,000	6,680	4.8%	320	10	1	1:206
NY	10,740	9,729	10.4%	1,011	3	26	1:915
OH	7,282	7,162	1.7%	120	7	22	1:769
OK	849	838	1.3%	11	40	48	1:1,994
OR	3,750	3,654	2.6%	96	22	12	1:522
PA	4,231	4,219	0.3%	12	18	39	1:1,435
PR	1,949	1,997	-2.4%	-48	31	24	1:448
RI	1,009	1,007	0.2%	2	37	11	1:502
SC	3,307	2,983	10.9%	324	25	19	1:663
SD	448	444	1.0%	5	46	30	1:1,003
TN	4,194	4,690	-10.6%	-496	19	23	1:747
TX	10,261	9,612	6.7%	649	5	38	1:1,262
UT	7,107	6,045	17.6%	1,062	9	2	1:223
VA	4,489	3,890	15.4%	599	16	28	1:902
VT	1,186	1,229	-3.5%	-43	34	3	1:267
WA	3,781	4,045	-6.5%	-264	21	31	1:930
WI	2,871	3,007	-4.5%	-135	26	32	1:1,038
WV	340	341	-0.0%	0	47	49	1:2,145
WY	159	190	-16.2%	-31	51	47	1:1,807



The Solar Foundation has
tracked solar job growth
in this dynamic industry
since 2010. Read all ten years
of the Solar Jobs Census at
SolarJobsCensus.org.



APPENDIX B: SOLAR INDUSTRY CHARACTERISTICS

The Census collects additional data on workforce characteristics, supply chains, and factors for success.

INDUSTRY FOCUS

The *National Solar Jobs Census 2019* found the clear majority of U.S. solar establishments (about 93%) are working in solar PV electricity generation. About 16% of firms work on solar heating and cooling, such as solar water heaters, and 7% work on projects related to concentrating solar power (CSP).

The employment numbers for each industry sector are based on what an establishment reports as its primary focus. However, many establishments focus on multiple sectors of the value chain. For example, 22.5% of manufacturing establishments also work in wholesale trade and distribution, and 19% of the wholesale trade and distribution establishments also work in manufacturing (Table 15). Seven percent of installers work in wholesale trade and distribution and 42% of them work in O&M. Roughly a quarter of the O&M firms report that they also work on installation.

Table 15

FOCUS OF SOLAR ESTABLISHMENTS BY PRIMARY SECTOR

	PRIMARY SECTOR FOCUS				
	Installation and Project Development	Wholesale Trade and Distribution	Operations & Maintenance	Manufacturing	All Others
Installation and Project Development	100.0%	35.1%	25.7%	25.6%	19.4%
Wholesale Trade & Distribution	7.2%	100.0%	21.8%	22.5%	6.9%
Operations & Maintenance	41.9%	22.6%	100.0%	21.3%	14.2%
Manufacturing	5.8%	19.1%	9.3%	100.0%	4.2%
Research & Development	4.7%	10.0%	10.8%	24.6%	24.3%
Utility	2.1%	6.5%	61.8%	1.8%	1.7%
Consulting, engineering, finance, legal, or other services	30.6%	29.4%	23.8%	22.6%	100.0%

TYPES OF OCCUPATIONS

In addition to its findings on solar jobs by industry sector (p ____), the *National Solar Jobs Census* compared employment by occupational category. Unlike in the sector survey results, occupational categories match each specific job to a category (Table 16). For example, the manufacturing sector comprises 14% of solar jobs, but those in manufacturing occupations make up only 8% of jobs across all sectors.

Table 16 SOLAR WORKERS BY OCCUPATIONAL CATEGORY

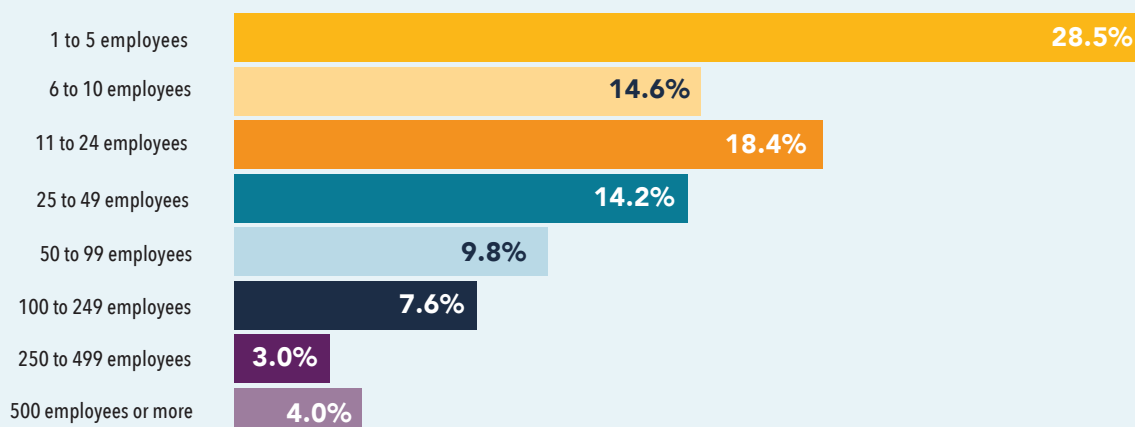
	Production/ Manufacturing	Installation or Repair	Administrative	Management/ Professional	Sales	Other
Installation and Project Development	2.8%	37.6%	18.9%	14.2%	21.8%	4.8%
Wholesale Trade and Distribution	9.9%	18.3%	27.8%	17.0%	19.7%	7.4%
Operations and Maintenance	7.4%	23.0%	17.8%	25.8%	16.4%	9.6%
Manufacturing	31.4%	12.3%	17.2%	14.7%	13.7%	10.6%
All Others	7.7%	9.3%	16.9%	42.7%	10.2%	13.1%
Overall	8.0%	29.8%	19.6%	16.5%	19.6%	6.5%

SOLAR FIRMS BY NUMBER OF EMPLOYEES

The *Solar Jobs Census* survey also found that most establishments have fewer than 50 employees.

Figure 12

ESTABLISHMENTS BY NUMBER OF EMPLOYEES





INSTALLATION SECTOR EMPLOYEE JOB LOCATIONS

The *Solar Jobs Census* survey asked where employees work and whether the job is located in the same state or region as the firm’s office. Utility-scale installers (engineering, procurement, and construction firms) often employ out-of-state labor for their larger projects.

Figure 13

WHERE INSTALLATION EMPLOYEES WORK RELATIVE TO OFFICE LOCATION

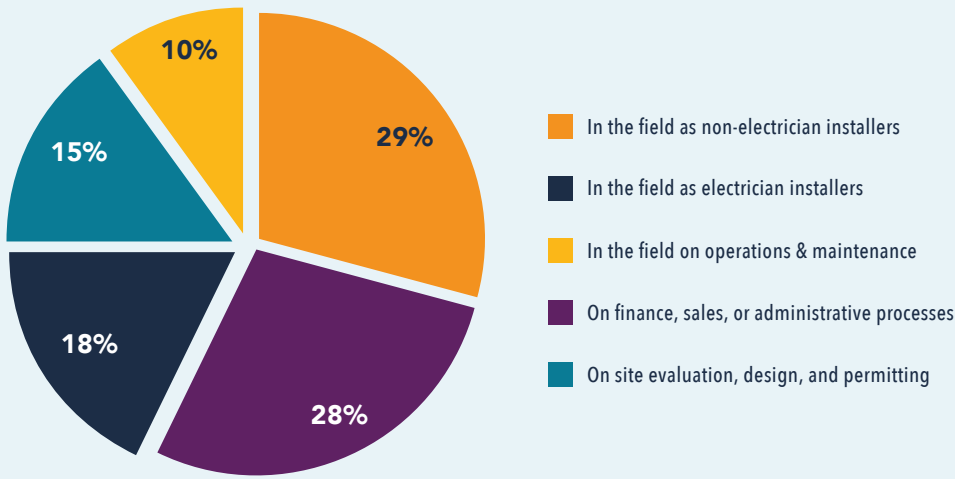


Table 17

GEOGRAPHICAL LOCATION OF INSTALLATION EMPLOYEES RELATIVE TO THE OFFICE

In-state within your region/metropolitan area	59%
In-state outside your region/metropolitan area	29%
Out-of-state	12%

SUPPLY CHAIN ANALYSIS

The majority of solar establishment customers are located within their states, and only 3% of their customers are located outside of the U.S. (Table 18). Solar establishments report that, on average, 76% of their suppliers and vendors are in the United States (Table 19), an increase from 70% in 2018.

Table 18 PERCENTAGE OF ESTABLISHMENTS PRIMARY CUSTOMER LOCATION BY SECTOR

	In-state	In a bordering state but out of state	In the United States, but outside of a bordering state	Outside of the United States
Installation and Project Development	71.0%	10.9%	16.2%	2.0%
Wholesale Trade and Distribution	41.5%	12.9%	43.5%	2.1%
Operations and Maintenance	64.5%	4.0%	26.6%	4.8%
Manufacturing	27.8%	10.6%	53.3%	8.3%
All Others	44.5%	13.3%	36.2%	5.9%
Overall	59.5%	10.9%	26.4%	3.2%

Table 19 PERCENTAGE OF ESTABLISHMENTS PRIMARY SUPPLIER AND VENDOR LOCATION BY SECTOR

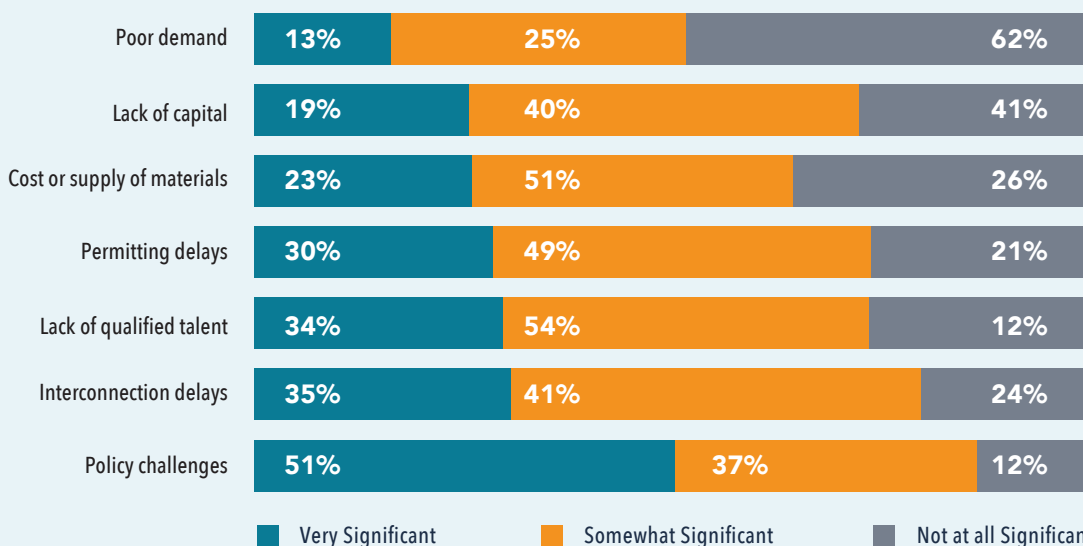
	In the United States	Outside of the United States
Installation and Project Development	77.0%	23.0%
Wholesale Trade and Distribution	63.4%	36.6%
Operations and Maintenance	80.1%	19.9%
Manufacturing	77.1%	22.9%
All Others	83.3%	16.7%
Overall	75.8%	24.2%

FACTORS FOR SUCCESS

Respondents were asked to identify which key factors contribute to the difficulty of growing a profitable business. About half of the establishments selected federal or state policy challenges as “very significant,” followed by interconnection delays, lack of qualified talent, and permitting delays (Figure 14).

Figure 14

FACTORS THAT CONTRIBUTE TO THE DIFFICULTY OF GROWING A PROFITABLE BUSINESS



APPENDIX C

METHODOLOGY

The *National Solar Jobs Census* methodology is closely aligned with the Bureau of Labor Statistics methodology for its Quarterly Census of Employment and Wages (QCEW) and Current Employment Statistics (CES). Like the BLS, this report uses survey questionnaires and employer-reported data, though Solar Jobs Census surveys are administered by phone and email, as opposed to mail. In 2019, this included approximately 66,900 phone calls and over 47,000 email invitations, and more than 49,000 letters inviting participants to take the survey.

The *National Solar Jobs Census* 2019 includes data gathered between October and November 2019 from known and potential solar energy establishments or locations. The survey was administered by BW Research Partnership to a known universe of solar employers that included 9,821 separate establishments, and was derived from the Solar Energy Industry Association's National Solar Database. Of these establishments, 2,766 provided information about their solar activities (or lack of solar activities), and 1,859 completed full or substantially completed surveys.

It is important to note that surveys were completed for each employment location and not necessarily for each firm. If a solar employer was asked to participate in a survey, s/he would be asked about the employment profile of a given location and not of the entire firm. The survey was also administered to a stratified, clustered, random sampling from various industries that are potentially solar-related and include a total of 668,784 establishments nationwide. After an extensive cleaning and de-duplication process, a sampling plan was developed that gathered information on the level of solar activity (including none) from 12,141 establish-

ments. This level of sampling rigor provides a margin of error of $\pm 2.27\%$ for the national jobs data.

These establishments stemmed from a sampling of employers in specific industries within wholesale trade, manufacturing, professional services, other services, and the construction (installation) industries. The survey was completed online and over the phone and the sample was stratified by industry, region, and firm size (4 or fewer employees, 5 to 49 employees, or 50 or more employees).

It is also important to note that known employment was allocated based on 2-digit and 6-digit NAICS code of responding establishments and removed from the unknown QCEW totals prior to generating employment estimates in the unknown. As a result, the potential for double counting establishments or employment is nonexistent.

Since responses to the survey are often not representative by industry, a weighting adjustment (by size of segment) is applied to the primary value chain of the responding location. This prohibits inaccuracy of responses by value chain (over-representation or under-representation) and ensures an accurate read of employment and other responses within the survey. Since 2010, The Solar Foundation has defined a solar job as one held by a worker spending at least 50% of his or her time on solar-related work. Census findings have consistently shown that roughly 90% of these workers (91.4% in 2019) spend 100% of their time on solar-related work. The *National Solar Jobs Census* 2019 also includes separate data on the number of solar workers who spent any amount of their time on solar-related work.

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