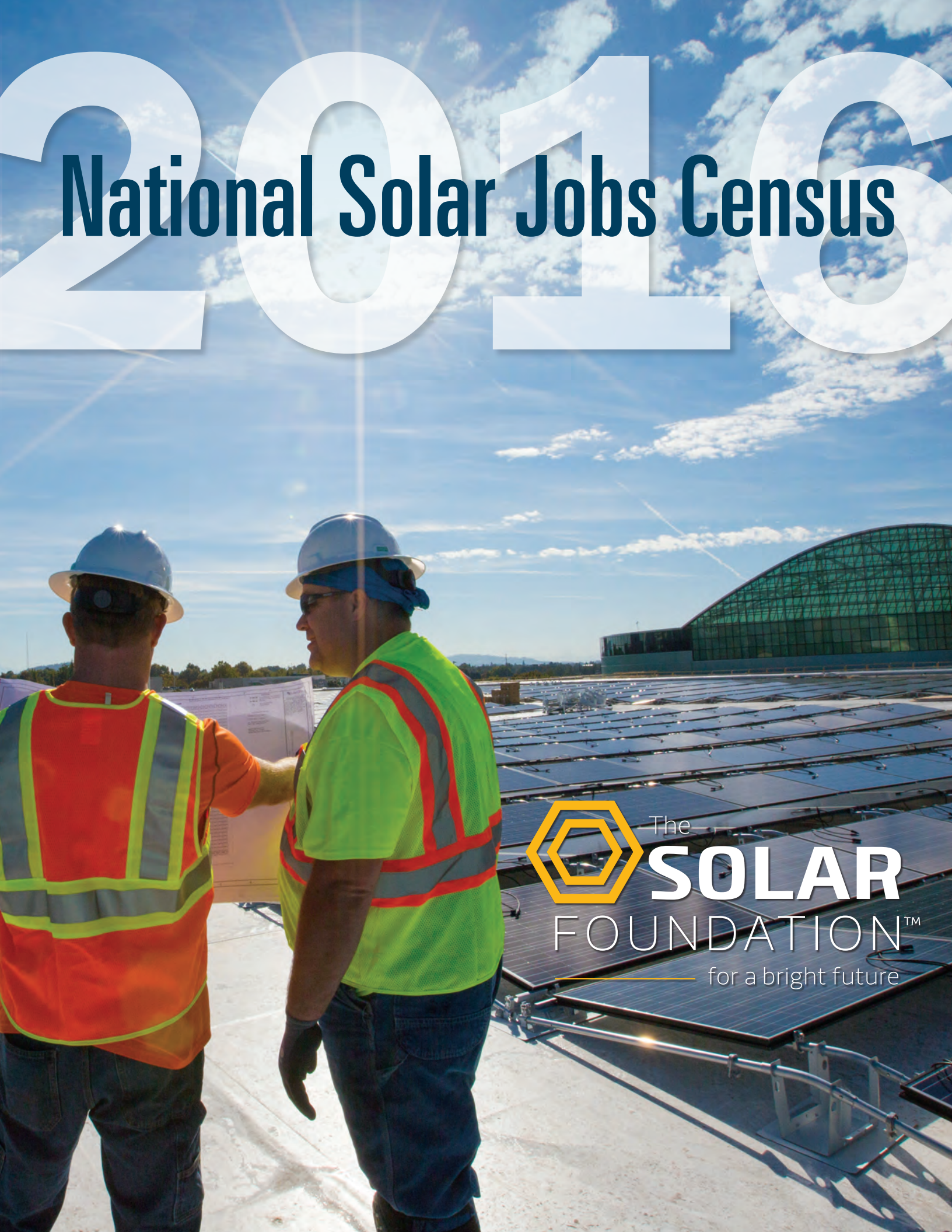
2016 National Solar Jobs Census



The SOLAR FOUNDATION™
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ACKNOWLEDGEMENTS

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 technology is integrated into all aspects of our lives. In 2010, The Solar Foundation conducted its first *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 last seven years to track changes and analyze trends.

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Unless otherwise indicated, all jobs data for 2010–2015 derive from The Solar Foundation's *Census* report series. All jobs data for 2016 (unless otherwise indicated) derive from the U.S. Department of Energy's *2016 U.S. Energy and Employment Report* (USEER).

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EXECUTIVE SUMMARY

The Solar Foundation's *National Solar Jobs Census 2016* is the seventh annual edition of current employment, trends, and projected growth in the U.S. solar industry. To keep pace with the industry's rapid transformation, The Solar Foundation conducts annual employer surveys of the domestic solar labor force and gathers perspectives on job growth and future opportunities.

The results from *Census 2016* are based on rigorous survey efforts that include more than 500,000 telephone calls and over 60,000 emails to known and potential energy establishments across the United States, resulting in a total of 3,888 full completions for establishments involved in solar activity in the U.S. Unlike economic impact models that generate employment estimates based on economic data or jobs-per-megawatt (or jobs-per-dollar) assumptions, the *National Solar Jobs Census* series provides statistically valid and current data gathered from actual employers.

This year's *Census* found that the solar industry continues to outpace most other sectors of the economy, adding workers at a rate nearly 17 times faster than the overall economy and accounting for 2% of all jobs created in the U.S. over the past year. The Solar Foundation's long-term research shows that solar industry employment has grown by 178% since 2010, resulting in over 166,575 new domestic living-wage jobs.

As of November 2016, the solar industry employs 260,077 solar workers, representing a growth rate of 24.5% since November 2015. Meanwhile, U.S. businesses added just over 2.07 million jobs at an annual growth rate of 1.45%.[1] Over the next 12 months, surveyed employers expect to see total employment in the solar industry increase by 10%—10 times faster than the overall economy is expected to grow—to approximately 286,000 solar workers.[2]

This report includes up-to-date information on the solar industry, information on the potential for further growth, and on factors that are likely to impact the industry over the coming years. In addition to the above statistics, the following were observed as of November 2016:

- **2016 was the fourth consecutive year in which solar employment grew by approximately 20% or greater.** At 24.5%, 2016 growth exceeded each of the three previous years' 20% growth.

- **One out of every 50 new jobs created in the U.S. over the 12-month period was created by the solar industry.**

- **Solar is a major source of new U.S. jobs.** Of the 51,000 solar workers added since November 2015, 80% were newly created positions, with the remaining comprised of existing positions that have added solar responsibilities (20%). Of the more than 260,000 solar workers in the United States, approximately 89% spend 100% of their time on solar-related activities.

- **Despite representing only approximately 1.3% of overall energy generation, the solar industry ranks second in total employment among energy industries.** Solar employs slightly more workers than natural gas, over twice as many as coal, over three times that of wind energy, and almost five times the number employed in nuclear energy. Only oil/petroleum has more employment (by 38%) than solar.[3]

- **Employees of installation companies accounted for 17,200, or 34% of the new solar jobs added in 2016.** Project development and the "other" sector experienced the highest rates of growth, each exceeding 50%. Project development also added the second most number of jobs, with almost 12,000 new workers, representing 23% of new solar jobs.

- **Demand-side sectors (installation, sales and distribution, and project development) make up about 78% of overall solar industry employment.** Installation firms account for the largest share of the solar workforce at 53%. Manufacturing comprises the second largest share at almost 15%, followed by the project development sector (13%).

- **Approximately 41% of the 260,077 solar jobs were mostly in the residential market segment, while 28% were in commercial and 31% were in utility-scale project development.** Utility-scale development is less labor intensive than residential, so there are fewer utility-scale jobs despite the greater amount of utility scale capacity.[4]

- **Nearly one in four employers (23%) report that it is "very difficult" to find qualified employees and 80% report that it is at least somewhat difficult.** The installation and project development sectors had the most difficulty hiring. About a quarter of those establishments reported that it is "very difficult" to find qualified employees. After significant increases from 2014 to 2015, the 2016 changes were less substantial. For example, difficulty hiring for utility-scale project development firms nearly doubled from 12.5% to 24.5% from 2014 to 2015, but increased only slightly from 2015 to 2016.

- **Wages paid to solar workers remain competitive with similar industries and provide many living-wage opportunities.** Companies listing job postings for solar installers advertised a median wage of $26 per hour.[5]

- **More women and racial and ethnic minorities are working in solar.** Women represent a greater proportion of the solar workforce than in previous years, having risen steadily from 18.7% in 2013 to the 28% reported in 2016. The increase from 2015 to 2016 represented the largest annual jump to date, moving from 24% to 28%. Minorities also experienced increases in solar workforce participation since 2013, although not to the same degree.

- **Experience is the most important hiring requirement for all sectors, with 65% of establishments requiring experience, compared to 32% requiring a bachelor's degree or higher.** Just over 18% require a technical certificate or credential and just under 13% require an associate's degree, but not a bachelor's degree. Since Census 2015, requirements for experience and bachelor's degrees have decreased while the percentage of employers seeking associate's degrees and/or a technical credential or certificate has increased.

- **Solar jobs are in all 50 states.** In 2016, state-level data shows the number of solar jobs increased in 44 of the 50 states. A complete table of solar jobs by state, along with state growth rates over 2015, can be found in Appendix A. More detailed state and local data will be available in March 2017 at *SolarStates.org*.

As with the previous *Census* studies, this report includes information about all types of companies engaged in the analysis, research and development, production, sales, installation, and use of all solar technologies—ranging from solar photovoltaics (PV), to concentrating solar power (CSP), to solar water heating systems.

About The Solar Foundation®

The Solar Foundation® is an independent 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 Foundation creates transformative solutions to achieve a prosperous future in which solar technology is integrated into all aspects of our lives. The Solar Foundation is considered the premier research organization on the solar labor workforce, employer trends, and the economic impacts of solar. It has provided expert advice to leading organizations such as the National Academies, the Inter-American Development Bank, the U.S. Department of Energy, and others during a time of dynamic industry growth and policy and economic uncertainty.

While The Solar Foundation recognizes that solar energy is a key part of our energy future, it is committed to excellence in its aim to help people fairly and objectively gauge the value and importance of solar technologies. Learn more at *TheSolarFoundation.org*.

KEY FINDINGS

The *National Solar Jobs Census 2016* is The Solar Foundation's seventh annual review of the size and scope of employment in the U.S. solar industry, and represents the most comprehensive and rigorous analysis of solar labor market trends. This year's *Census* was part of the U.S. Department of Energy's *U.S. Energy and Employment Report* (USEER) data collection effort and includes data gathered between October and November 2016 from more than 68,000 U.S. solar establishments and 23,000 potentially energy-related ones. There were full survey completions from 3,888 solar establishments. The sampling rigor in the known and unknown universes provides a margin of error for establishment counts at +/-0.85% and employment at +/-2.30% at a 95% confidence interval.

While *Census* and USEER share the same underlying methodology, The Solar Foundation applies a significantly more rigorous test in counting solar jobs. 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% (89% for 2016) of these "solar workers" spend 100% of their time on solar-related work.

As of November 2016, the solar industry supports 260,077 jobs at 30,891 locations,[6] an increase in employment of 24.5% over the past 12 months and 178% since The Solar Foundation began its Census series in September 2010. The solar industry continues to support robust job growth, adding 51,218 new jobs in 2016, a growth rate approximately 17 times faster than that of the overall U.S. economy which grew by 1.45%.[7] The solar growth accounts for nearly 2%[8] of the 2.07 million jobs added by all U.S.employers, equal to one in every fifty new U.S. jobs.

This 2016 growth has been driven primarily by a massive increase in solar energy installations. About 35% of all existing U.S. solar energy capacity is expected have been installed in 2016—14,000 megawatts (MW)—which is 15 times the 929 MW installed in 2010 when the *Census* was first published.[9] With nearly 40 gigawatts (GW) of total capacity, solar energy comprised 1.3% of total US electricity generating capacity by the end of 2016.[10]

BOX 1

Simmering Global Growth Expected to Cool Off

In 2016, the global solar market experienced another strong year. Installed capacity is expected to have grown by 45% or 74 GW. With a 19% share of global growth, the U.S. is second only to China's 38% (28 GW) share of new installed capacity. The global market is expected to cool down to 69 GW of growth in 2017 given various policy changes such as feed-in tariff declines in China and Japan. These declines are partially offset by strong growth in India and overall market strength from price declines brought about by a PV module supply surplus. Modest growth is expected to continue through 2021; GTM Research forecasts a modest 8% compounded annual growth rate from 2016 to 2021.[11]

Of the 51,218 new solar workers,[12] installer companies were responsible for 17,202, or 34% of the total, followed by companies that self-identify as operating within the project development sector at 23% of the total. However, all sectors grew over the past year, with project development and the "other"[13] sectors experiencing over 50% growth as shown in Table 1. For both 2015 and 2016, utility-scale project development firms added jobs at a very high rate, growing 49% in 2015 and 53% in 2016, adding 11,948 employees during the year. Overall, eight in ten (80%) added jobs were newly created positions, with the remaining 20% representing existing employees that were given additional solar responsibilities.

TABLE 1

Solar Employment by Sector, 2016

Sector	2016 Employment	% Total Employment	% Growth 2015–2016	% Growth 2010–2016
Installation	137,133	52.7%	14.34%	212.13%
Manufacturing	38,121	14.7%	25.89%	53.00%
Sales & Distribution	32,147	12.4%	31.87%	173.73%
Project Development	34,400	13.2%	53.22%	330.65%
Other	18,274	7.0%	54.65%	41.57%
Total	260,077		24.52%	178.15%

Looking at longer term trends, the installation and sales & distribution sectors have experienced dramatic growth. From 2010 to 2016, employment in installation and sales & distribution sectors nearly tripled, as shown in Table 2 and Figure 1. Manufacturing grew by 53% and "Other" grew by 42%. Project development, which the *Census* began counting in 2012, has more than tripled in size over the ensuing four years.

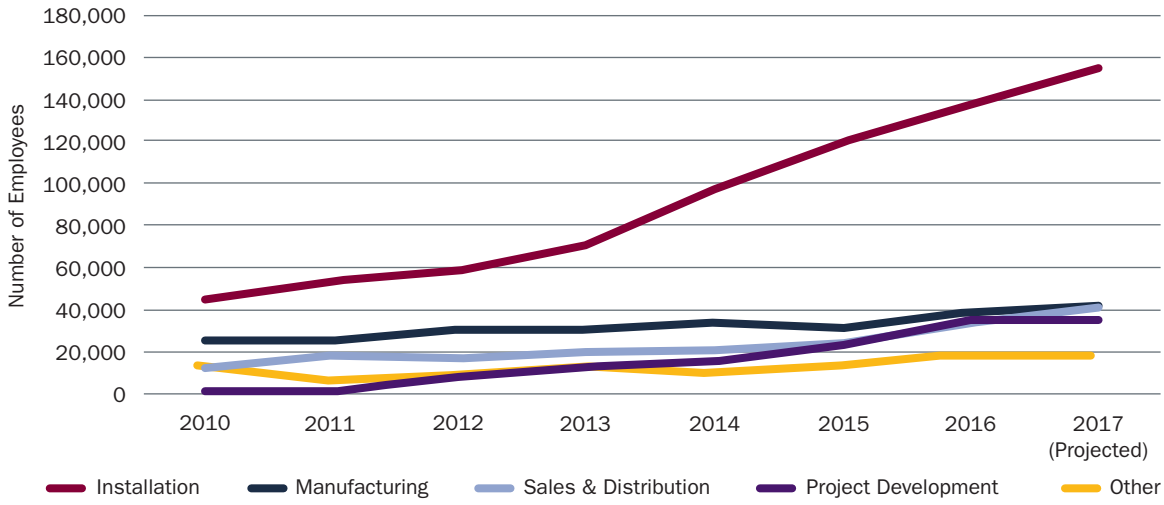
TABLE 2

Solar Energy Sector Employment, 2010–2017 (Projected)

Sector	2010	2011	2012	2013	2014	2015	2016	2017 (Projected)
Installation	43,934	52,503	57,177	69,658	97,031	119,931	137,133	154,175
Manufacturing	24,916	24,064	29,742	29,851	32,490	30,282	38,121	40,434
Sales & Distribution	11,744	17,722	16,005	19,771	20,185	24,377	32,147	39,387
Project Development	n/a	n/a	7,988	12,169	15,112	22,452	34,400	34,227
Other	12,908	5,948	8,105	11,248	8,989	11,816	18,274	18,111
Total	93,502	100,237	119,017	142,697	173,807	208,859	260,077	286,335

FIGURE 1

Solar Employment Growth by Sector, 2010–2016[14]



Because of this strong growth, the solar industry ranks second in total employment among energy industries. The solar workforce is slightly larger than that of natural gas, over twice as large as coal and bioenergy/combined heat & power, over three times the size of the wind energy workforce, and almost five times that of the nuclear energy industry workforce, as shown in Table 3. Only oil/petroleum employs more people than solar (by roughly 38%).[15] While solar accounts for approximately 1.5% of overall energy generation, solar employment growth accounted for 16.6% of all employment growth within electric power generation and fuels over the course of 2016. During that time, solar employment growth (73,615) was larger than employment growth in oil, natural gas, and coal combined (69,813).

Unlike the rest of this report, the above energy sector comparisons are based on The US Energy and Employment Report's higher 373,807 job count for solar. The higher solar number is used because it matches the methodology for other energy industries: "Employees of a qualifying firm that spend some portion of their time supporting the qualifying energy, energy-efficiency, or motor vehicle portion of the business."[16] The Solar Foundation applies a higher standard to be considered a "solar worker"; someone must spend at least 50% of their time on solar related work.

The U.S. solar industry expects total employment in the solar industry to increase by 26,258 workers to 286,335 total jobs, an annual growth rate of 10% by the end of 2017. This growth projection is almost 10 times faster than the projected U.S. employment growth rate over the next 12 months.

The projected 10% growth for 2017 is significantly less than the 24.5% growth experienced in 2016. The difference is likely due to several factors: cautious projections, calculation considerations, and the investment tax credit. *Census* projections tend to be conservative. Since 2013, the *Census* projections have underestimated actual solar employment by an average of 4.5%. There are also mathematical considerations. As the number of solar jobs grow, there is a diminishing impact of percentage changes on the growing numerical base (total solar jobs). The investment tax credit will likely affect 2017 jobs. Solar hiring likely increased in 2015 and 2016 in anticipation of the expiration of the 30% federal investment tax credit. Although the tax credit was extended in December 2015, many projects, especially

TABLE 3

Employment Comparison of Top 10 Energy Sectors

	Employment			Analysis and Comparisons			
Power Generation	**Electric Power Generation**	**Fuels**	**Total**	**Percent of Total**	**Rank**	**Comparison to Solar**	**Multiples Difference**
Oil/Petroleum	12,840	502,678	515,518	25.17%	1	137.91%	0.7
Solar	373,807	—	373,807	18.25%	2	100.00%	1.0
Natural Gas	52,125	309,993	362,118	17.68%	3	96.87%	1.03
Coal	86,035	74,084	160,119	7.82%	4	42.83%	2.3
Bioenergy/CHP	26,014	104,663	130,677	6.38%	5	34.96%	2.9
Other Generation Fuels	32,695	82,736	115,431	5.64%	6	30.88%	3.2
Wind	101,738	—	101,738	4.97%	7	27.22%	3.7
Nuclear	68,176	8,595	76,771	3.75%	8	20.54%	4.9
Traditional Hydropower	56,259	—	56,259	2.75%	9	15.05%	6.6
Advanced Gas	36,117	—	36,117	1.76%	10	9.66%	10.3

Source: U.S. Energy and Employment Report, U.S. Department of Energy

the larger utility-scale projects, were already well into the development process. Therefore, 2016 experienced an explosion of utility-scale solar development and related employment growth.

Development in 2017 is expected to throttle back from the 2016 record year. The Solar Energy Industries Association (SEIA) and GTM Research expect new installations to decline slightly from the 14.1 GW_{dc} of 2016 to 13.5 GW_{dc} in 2017. While most of the capacity growth will still be from utility-scale project development, such deployment will grow at a slower rate. Residential and commercial installations are expected to continue experiencing steady growth in installed capacity over the coming year.[17]

Despite the expected decline in the growth of installed capacity, employment growth should continue, though also at a slower rate. Utility-scale project development is more labor efficient than other sectors and focuses primarily on larger projects, so the sector tends to hire fewer employees per MW of installed capacity. The 2017 decline in utility-scale deployment will likely result in fewer jobs associated with this market segment, especially by the fall of 2017 when the next *Census* takes place. By then, many of the 2016 utility-scale projects that extended into 2017 will have been completed. The growth in residential and commercial capacity deployment may offset utility-scale job losses.

In 2017, firms focused on sales and distribution expect to grow at 22.5%, or just over 7,000 jobs. Installation is expected to grow at a slower rate (12%), but is projected to add 17,000 jobs, more than any other sector, as shown in Figure 2. Manufacturing is expected to experience about 6% growth, or 2,300 jobs over the coming year. As discussed above, project development will likely experience a slight loss in jobs.

Growth in annual installed capacity continues to be primarily driven by the falling installed costs of solar energy, especially materials or hard costs. As shown in Figure 3, installed PV costs have declined by nearly 57% for residential installations, 73% for non-residential systems, and 77% for

FIGURE 2

Expected Solar Employment Growth from 2016–2017 (Overall and by Sector)

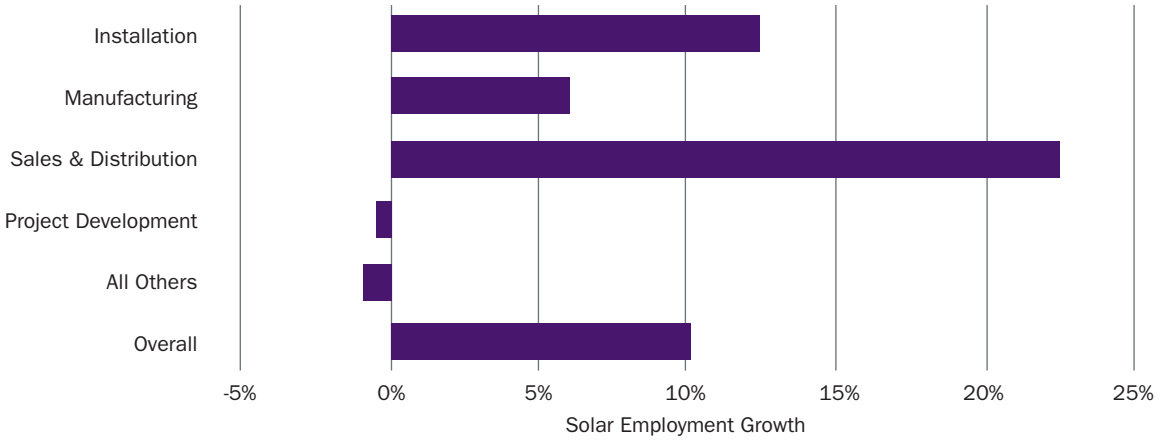
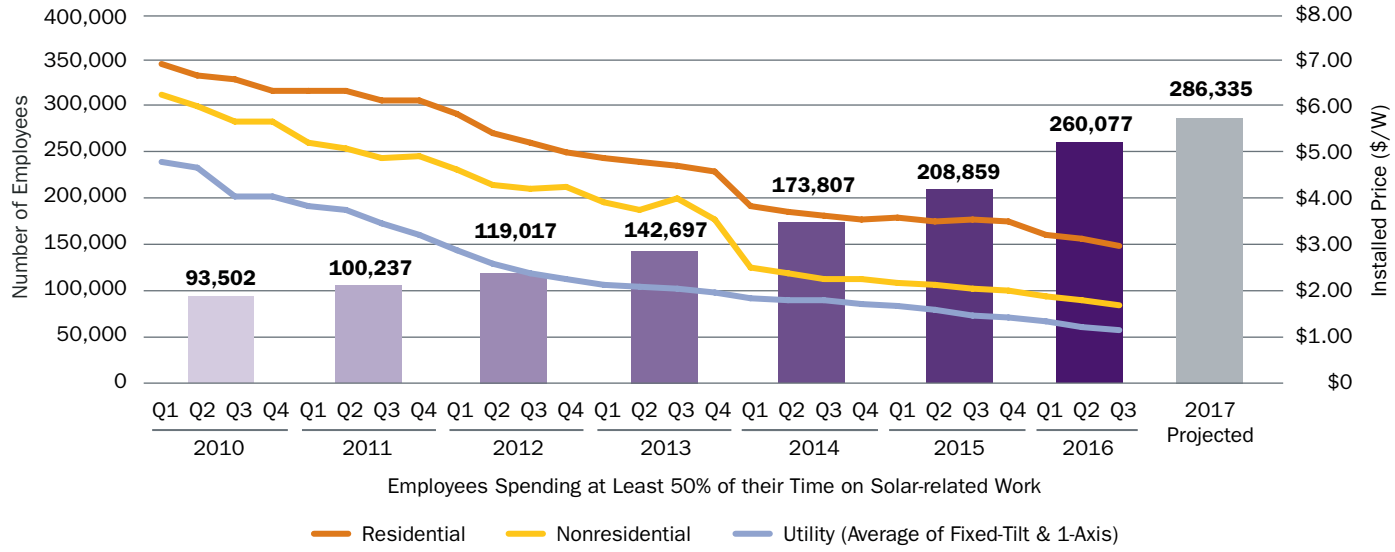


FIGURE 3

Installed Solar PV Costs by Segment Compared to Solar Employment Growth, 2010–2016[20]



SOURCE OF COST DATA: GTM RESEARCH, A WOOD MACKENZIE BUSINESS/SEIA U.S. SOLAR MARKET INSIGHT®

utility-scale projects since the beginning of 2010.[18] Unsubsidized utility-scale development is at cost parity with new fossil fuel generators in some locations, particularly in the southwest.[19]

Because of the current oversupply of many solar system components, 2016 saw costs plummet. Residential installed costs dropped 20% to below $3.00 per watt (W) for the first time, to $2.98/W. Nonresidential prices dropped to $1.69/W with utility-scale solar ranging from $1.09 to $1.21/W, depending on the technology.[21] Both hard and soft costs are declining. Module and inverter costs dropped 41% and 26% respectively between Q3 2015 and Q3 2016.[22] Residential soft costs dropped 15% over the same period.[23] Therefore, despite the decline in soft costs, the greater decline in hard costs means that soft costs make up a greater proportion of total costs. Unlike residential, nonresidential and utility-scale soft costs did not decline, except for labor. Soft costs represent 66% of residential system costs and 53% and 33% of nonresidential and utility-scale costs respectively.[24]

SOLAR JOB CHARACTERISTICS

The clear majority of U.S. solar jobs are focused on solar photovoltaic (PV) electric generation. About 93% of solar workers are focused on solar PV electric generation; about 5% support heating and cooling technologies, such as solar thermal, and another 2% work on projects related to concentrating solar power (CSP). Establishments were asked to allocate their employees by the market segment in which they spend a majority of their time working. Approximately 41% of the 260,077 workers focused primarily on the residential market segment, while 28% focused on commercial, and 31% focused on utility-scale development. Utility-scale firms hired an average of 20 workers in 2016, about twice the average for all solar firms. However, based on the lower median number of hires for all segments, there is a highly-skewed distribution toward large firms, meaning that these firms did the lion's share of the hiring.

TABLE 4

Time Spent by Solar Employee

	2015	2016
Residential projects	39%	41%
Commercial projects	35%	28%
Utility-scale projects	26%	31%

TABLE 5

New Hires at Solar Firms

	All	Residential	Commercial	Utility-scale
Mean	10.42	9.58	7.57	20.14
Median	2.00	2.00	3.00	3.00

Census 2016 found that demand-side sectors (installation, sales and distribution, and project development) make up almost 78% of overall solar industry employment, with installation firms accounting for 53% of the total solar workforce. In contrast, manufacturing comprised only 15% of U.S. solar jobs.[25] When comparing employment by occupational category, 35% were found to be in installation and repair positions and 12% were in manufacturing positions. About 40% of all solar employment is reported to be in administrative, management, and professional positions, and 13% in sales positions. Unlike in *Census* sector survey results, occupational categories match each specific job to a category.[26]

The number of *Census 2016* jobs includes occupations critical to meeting domestic installation demand. These include most of the direct jobs and many of the indirect jobs in the solar industry, except some indirect jobs in the component and materials supply chain. Those jobs, combined with induced impacts of the industry, support an additional 764,792 jobs, bringing the total employment impact for the U.S. solar industry to 1,024,869 jobs.[27]

SUPPLY CHAIN ANALYSIS

Eight in ten solar installation and project development establishments (80%) report that their customers are located primarily within their state. Sales & distribution also predominately serve in-state customers (60%). In contrast, most (61%) manufacturing customers are primarily outside the facility's state, including 10% with customers that are primarily international.

TABLE 6

Primary Customer Location by Value Chain, 2016[28]

	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	80.36%	4.61%	14.09%	0.94%
Manufacturing	39.11%	2.58%	48.34%	9.96%
Sales & Distribution	59.95%	4.48%	32.34%	3.23%
Project Development	79.75%	4.69%	14.57%	0.99%
Other	56.79%	5.72%	33.89%	3.60%

Three sectors—installation, project development, and other—source 44–45% of their primary business from in-state vendors with most of their remaining purchases from other states. Only about 6% of these firms report that their primary vendors are overseas. **In contrast, 22% of manufacturers report that their primary vendors are overseas and only 26% report that they are within their state.**

TABLE 7

Primary Vendor Location by Value Chain, 2016[29]

	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	44.21%	8.22%	41.73%	5.84%
Manufacturing	26.39%	5.20%	46.10%	22.30%
Sales & Distribution	29.31%	7.97%	50.90%	11.83%
Project Development	44.36%	8.12%	41.71%	5.81%
Other	45.07%	6.07%	42.69%	6.18%

SunLink embarked on a concerted effort to recruit female engineers beginning in 2010. Today, women represent nearly half of those with engineering degrees at SunLink, spread across structural, mechanical, and software engineering teams.

More women and minorities are working in solar. Women represent a greater proportion of the solar workforce than in previous years, having risen steadily from 18.7% in 2013 to the 28% reported in 2016. The increase from 2015 to 2016 represented the largest annual jump to date, moving from 24% to 28%. Ethic and racial minorities also have experienced increases since 2013 (except 2015), although not to the same degree. Latino/Hispanic solar workers increased from 15.6% of the workforce in 2013 to 17.2% in 2016. African American workers increased from 5.9% to 6.6%. Two phenomena might account for this increase. Larger, more diverse regional firms have taken market share from smaller, predominantly male firms, thereby increasing workforce diversity. Similarly, growth by the larger project development firms and "other" firms less closely tied to the traditional construction industry likely also contributed to increased diversity.

All 2016 demographic questions were updated to reflect federal data collection procedures so there will be differences among responses between 2015 and 2016, particularly since Latino/Hispanic is asked in a separate question (Latino/Hispanic vs. not Latino/Hispanic) and not among other minority categories.

Diversity within the workplace is important to overall economic growth, and recent studies show that it also yields benefits to firms. For example, in a comprehensive study that examined both inherent and acquired diversity (2-D diversity), researchers found that "employees of firms with 2-D diversity are 45% more likely to report a growth in market share over the previous year and 70% more likely to report that the firm captured a new market."[30]

While the solar industry still has work to do to become as diverse as the overall U.S. population, it is still comparable to the diversity of the electric power generation industry. The percent of women and minorities are within about 1 to 2% of that of the electric power generation industry.[31] Changes will take time, but many major companies within the solar industry have already adopted programs to recruit a more diverse staff. For example, beginning in 2010, SunLink embarked on a concerted effort to recruit female engineers. Today, women represent nearly half of those with engineering degrees at SunLink, spread across structural, mechanical, and software engineering teams.[32]

PROFILE

Lauren Busby

Structural Engineering Manager, SunLink

"I went to grad school in engineering, but I've always had an environmental interest as well. I worked in building design for five years, and at that point I started looking for a way that I could use my structural engineering background and skills to do something that was more related to sustainability or renewables. And that's where solar became a good fit. Besides the value to society, one of the biggest advantages of working in solar is that it's such a quickly evolving, dynamic field. Not only am I learning new things all the time, but everybody in the field is, too."

"Today, more and more women are becoming engineers. I think it really helps having the different perspectives of a mixed-gender team when you're designing anything. For women starting their careers, finding good mentors is probably the most important advice I can give. I would certainly encourage younger women to reach out to women who are further along in their career paths and learn about the steps they took to get there."

"It's great to be working on something that really matters to the world. My advice to anyone starting a career in engineering, or any other field, is it makes a big difference when you truly care about what you do. It really helps with job satisfaction, and it also helps you do a better job. Most of the people working in solar could be working in something else, and I think the reason a lot of smart people stay here is they truly value the work we're doing."

Lauren started her career designing hospitals and other highly technical buildings in areas of high seismic activity. She has worked at SunLink since 2015.

TABLE 8

Solar Worker Demographic Breakdown, 2014–2016

	2014 Percent of Workforce	2015 Percent of Workforce	2016 Percent of Workforce	2016 Total
Women	21.6%	23.90%	28.0%	72,753
Latino/Hispanic	16.3%	11.30%	17.2%	44,665
American Indian or Alaska Native	—	—	1.1%	2,792
Asian	7.0%	8.70%	9.1%	23,767
Black or African American	6.0%	5.20%	6.6%	17,123
Native Hawaiian or other Pacific Islander	—	—	1.3%	3,452
White	—	—	73.6%	191,420
Two or more races	—	—	8.3%	21,521
Veterans	9.7%	8.10%	9.0%	23,303
55 and over	—	18.50%	11.2%	29,210
Union	6.2%	5.50%	3.4%	8,838

SECTOR ANALYSIS

INSTALLATION SECTOR

The installation sector represents the end of the solar value chain and is the largest sector of the U.S. solar industry. It represents 53% of all solar jobs and 34% of new solar jobs for 2016. Composed of companies that primarily install photovoltaic, solar water heating, and other, more rare solar energy technologies such as solar space heating and cooling, the installation sector's growth is primarily driven by declining costs and the existence of policies that support solar deployment.

The installation sector is still primarily composed of small firms—more than half of all installers have 10 or fewer employees—yet since the first *National Solar Jobs Census* was conducted in 2010, the number of large installation firms, defined as having more than 100 employees, has more than doubled to almost 10%. This section includes the key findings from the data gathered from 1,465 U.S. solar installation establishments.

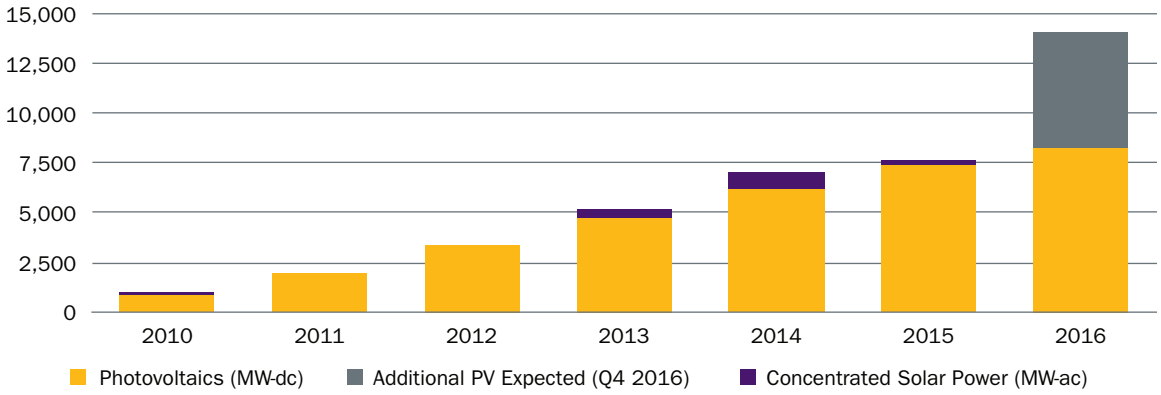
Solar installers employ a wide range of workers, though the majority are connected to the building trades, particularly electricians, construction laborers, and plumbers. They work on smaller residential systems, as well as large commercial and utility-scale systems (see Project Development Sector, page 30).[33] The demand for their work is largely driven by the demand for solar installations.

Solar installations continue to experience rapid growth. For the first three quarters of 2016, installed capacity grew by 8.2 GW, exceeding all of 2015. For all of 2016, it is projected to grow a record 14 GW, almost double the 7.5 GW growth experienced in 2015, resulting in cumulative installed solar capacity of just under 40 GW. With such growth, solar will likely exceed all other sources of new electric generating capacity for the year.

This growth has been driven by a dramatic increase in utility-scale development, which is expected to represent over 70% of all new installed capacity for 2016.[34] California continues to lead all states in installed capacity, but its dominant market share is eroding as other states ramp up development. For 2016, California is expected to represent 34% of the nation's installation activity, down from a 44% share in 2015.[35] More on how installation growth activity affects employment within states will be released by The Solar Foundation in March (2017) at *SolarStates.org.*

FIGURE 4

Annual Solar Power Capacity Installations, 2010–2016[36]

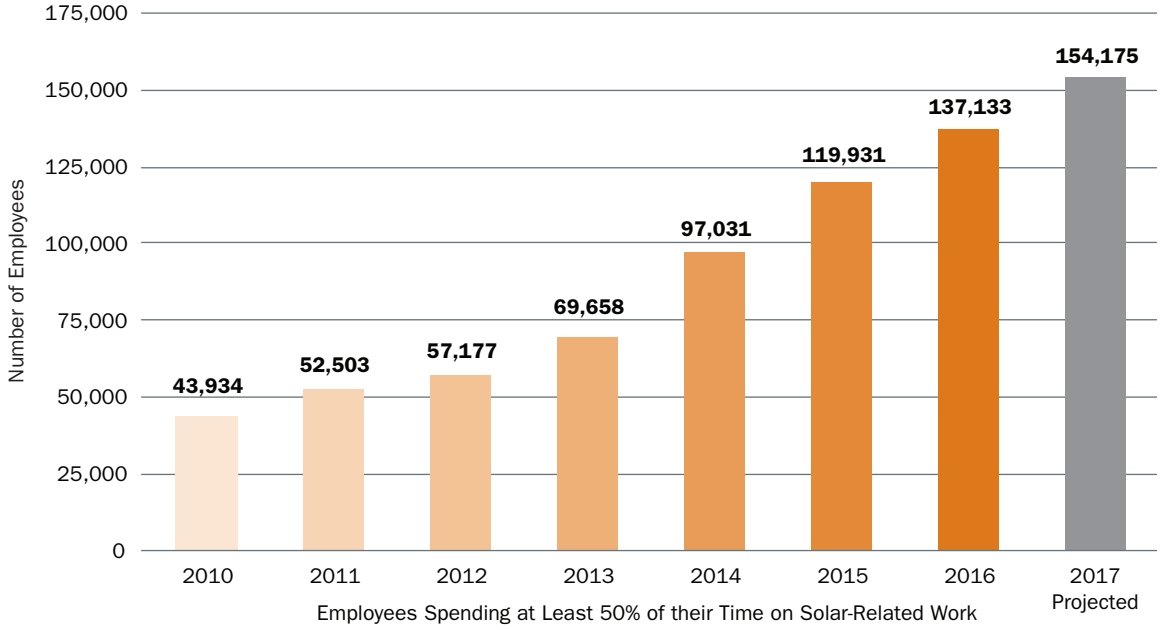


SOURCE: GTM RESEARCH, A WOOD MACKENZIE BUSINESS/SEIA U.S. SOLAR MARKET INSIGHT®

Installation companies now employ 137,133 workers, growing by almost 14% or 17,200 jobs since November 2015. The sector has over three times the number of such jobs in 2010. The installation sector anticipates adding the most workers in 2017 as well, reaching more than 154,000 jobs by year's end with an expected employment growth rate of 12% or 17,000 jobs.

FIGURE 5

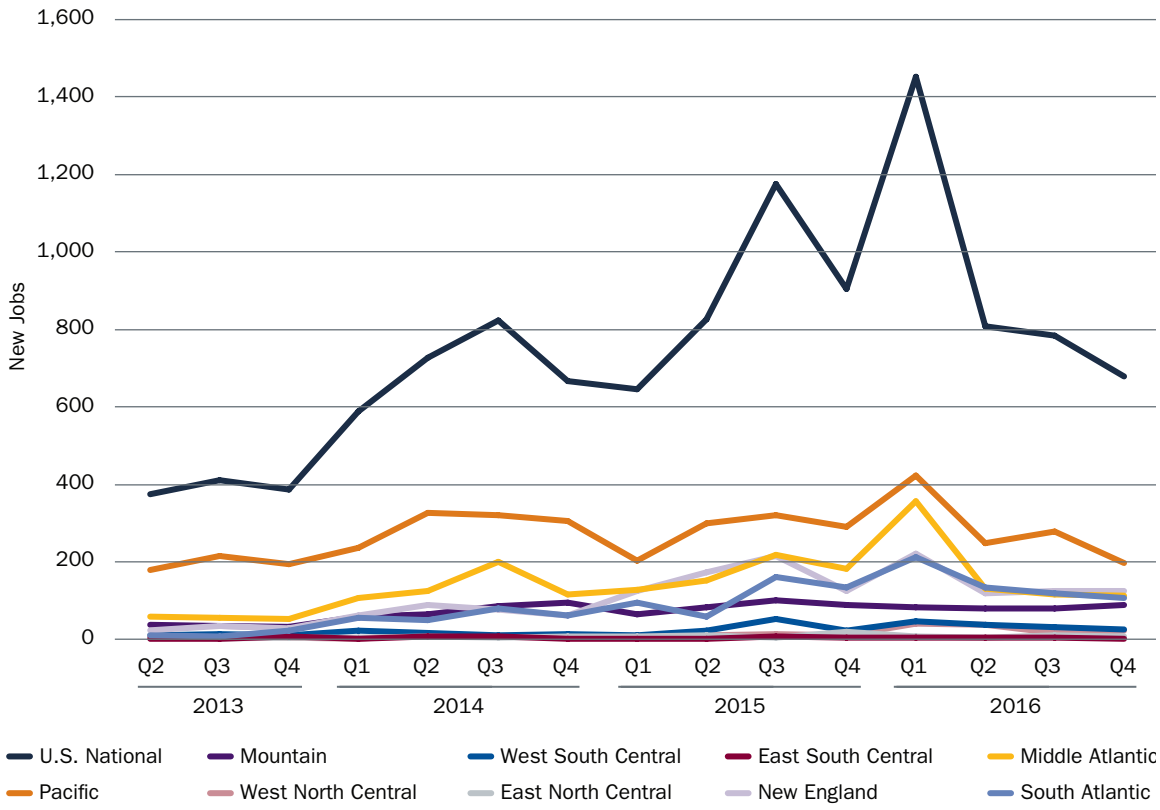
Solar Installation Employment Growth, 2010–2017



A more nuanced view of hiring is available by analyzing the volume of online ad job postings.[37] While installer-related job postings have increased since 2013, the growth has been very erratic as shown in Figure 6.[38] Beginning in Q2 2015, postings surged, pausing in Q4 2015, before jumping again in Q1 2016, and subsequently scaling back. As discussed, much of the 2015 and 2016 increase was likely caused by the anticipated expiration of the federal investment tax credit. There were also geographical differences. Most of the posting surges were in the Pacific, New England, Mid-Atlantic and South Atlantic U.S. Census Divisions.

FIGURE 6

New Installation Job Postings by Census Division[39]



SOURCE: CEB TALENTNEURON™

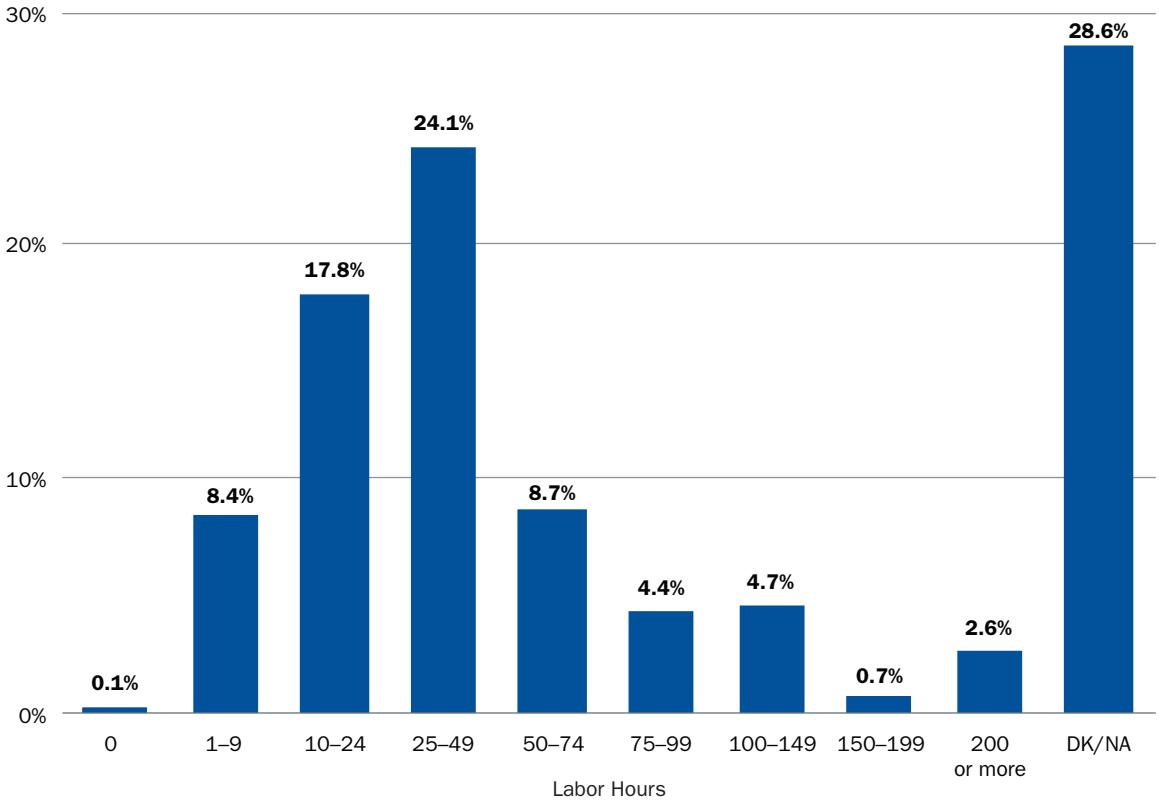
Installed capacity in the residential market is expected to have grown 16.5%, or by 2,519 MW in 2016, down from the dramatic 71% growth experienced by the segment in 2015. Market growth slowed as historically leading states such as California approached market saturation and others, such as Nevada, faced policy challenges. Nonetheless, many states, such as Texas, South Carolina, New Jersey, New York, and Utah, experienced strong growth. Despite its leveling off, California remains the market leader, representing about 43% of all residential installed capacity through Q3 2016.[40]

Nonresidential growth accelerated in 2016. It is expected to have grown by 33%, or 1,429 MW, compared to only 1% in 2015. This growth has been spurred by growth in community solar development and a favorable policy environment, especially in California.[41] Community solar's 2016 market share is expected to have grown to 20% of the nonresidential market, up from 5% in 2015. Corporations are increasingly investing in offsite (solar located away from the source of their energy usage) solar development to meet their sustainability goals. About half of all nonresidential development was offsite in 2016, up from about a third in 2015.[42]

Installer efficiency averaged 32 labor hours for a 5kW residential installation, but individual responses varied widely. A plurality of respondents reported between 25 and 49 labor hours, yet that plurality only represented about a quarter of respondents, as shown in Figure 7. Another efficiency calculation, based on jobs per MW, shows improving efficiencies since 2015. The 2016 figure of 34.73 jobs per MW shows a 7% efficiency improvement over the 37.15 jobs per MW in 2015.[43]

FIGURE 7

Labor Hours for 5kW Residential PV Installation, 2015–2016



BOX 2

Storage is Coming to Installation

Energy storage is a rapidly growing industry comprising 90,831 jobs, of which 47,634 are focused on battery storage.[44] Storage growth is needed to meet the demand for everything from mobile devices to electric vehicles to the electricity market. In the electricity market, storage is primarily used by utilities and independent system operators (ISOs) to improve the speed and accuracy of the wholesale market.

Battery storage is experiencing growing synergies with solar energy including distributed generation. Storage can smooth the impact of cloud-induced variation in solar irradiation, allowing solar to provide a greater, more consistent supply of energy. Storage batteries can also be charged by solar energy during the daytime for use at night. Similarly, storage systems can store solar or grid-provided energy when electricity rates are low and use it or sell it back to the grid when rates are high.

Still, this is only the tip of the iceberg. Co-locating solar and storage (solar + storage) can also benefit the electric grid. There is rapidly growing interest in aggregating smaller commercial and residential customers through software to provide frequency regulation and ancillary services to the grid. Demand for storage will grow as customers encounter more variable rates, battery costs decline, and policies emerge that support ways to monetize all these benefits.

The Solar Foundation projects 27,000 new solar + storage jobs by 2021. The projection is comprised of 9,000 storage jobs and another 18,000 solar jobs that would not materialize without the added value of collocating with storage. As storage costs decline, the value of the solar + storage package increases. The package cost is higher than just solar but of greater value—so storage will likely increase PV installation and related employment.[45]

BOX 3

Merger Integrates Solar + Storage

In November 2016, Tesla merged with SolarCity. The merger closely aligns the largest electric car company, Tesla, with the largest U.S. solar installer, SolarCity. With about a third of the residential rooftop solar market, SolarCity is poised to tap into Tesla's battery storage prowess. The merged companies will be able to package solar + storage as one brand and manufacture and install both batteries and modules. Tesla and Panasonic began lithium ion battery production in its Reno, Nevada manufacturing facility. When all phases are complete,[46] the Gigafactory will almost double world battery production capacity and employ 6,500 workers. Simultaneously, Tesla and Panasonic are finishing their solar module factory in Buffalo, New York with production expected to start in the summer of 2017. When construction is finished, it is expected to be the largest such plant in North America, employing over 1,400 workers.[47]

Installation companies employ fewer women and Latinos/Hispanics than their counterparts in other solar sectors. Nonetheless, installation companies employ a higher percentage of women than the construction industry, the coal industry, and the oil and gas extraction industries. There is a slightly higher percentage of African Americans in installation (7.1%) than the overall solar workforce (6.6%).

TABLE 9

2016 Installation Sector Demographic Breakdown[48]

	2016 Installation Workers	Percent of Solar Installation Employment	Percent of Total U.S. Workforce	Percent of Construction Industry Employment	Percent Oil and Gas Extraction Industry Employment	Percent of Coal Mining Industry Employment
Women	34,526	25.2%	46.8%	9.3%	18.3%	5.2%
African American	9,669	7.1%	11.7%	6.0%	3.5%	1.5%
Asian or Pacific Islander	10,589	7.7%	5.8%	1.8%	4.5%	0.0%
Latino/Hispanic	22,867	16.7%	16.4%	28.5%	13.8%	0.8%
Veterans of the U.S. Armed Forces	12,731	9.3%	7.2%	n/a	n/a	n/a
Union Members	4,428	3.2%	n/a	n/a	n/a	n/a
Older Workers (55+)	13,328	9.7%	22.5%	n/a	n/a	n/a

MANUFACTURING SECTOR

Solar manufacturers produce a variety of products and components for domestic and international markets. This section includes the key findings from the data gathered from 402 solar manufacturing establishments. Manufacturing is critical to the U.S. economy. Overall, the sector provides wages of over $20/hour[49] that support other manufacturers (suppliers) and service sector jobs. Growth in domestic manufacturing supports professions such as lawyers and accountants, and industries such as transportation and logistics. Manufactured goods that are exported provide income to the national economy. Similarly, from a local perspective, goods exported to other regions and states inject dollars into the local economy.

Manufacturing provides the foundation for an innovative, high technology economy. Approximately 70% of private sector U.S. research & development fulfills manufacturing needs.[50] When technologies shift overseas, their R&D capacity often shifts as well. For example, the shift of semiconductor manufacturers to Asia resulted in a relative decline of U.S. thin-film-deposition knowledge—expertise needed in the manufacture of photovoltaic cells. A loss such as this can weaken U.S. competitiveness in solar cell development.[51]

While only half of manufacturing firms derive all their revenue from solar activities, solar manufacturing remains critical to the overall solar value chain.[52] Solar energy systems are comprised of hundreds of components such as ingots, cells, racking, modules, inverter cases, and even the equipment used to manufacture solar components. Some solar manufacturers are vertically integrated, while others specialize in one or two aspects of the value chain.

Domestic module production increased 35% for the first three quarters of 2016 compared to the same period in 2015. Due to a surplus in U.S. PV module supply at the beginning of this decade, module production fell in 2012 as shown in Figure 8. With more of a balance between supply and demand, production recovered through 2016.[54]

U.S. solar component manufacturing is facing an uncertain future as the result of a global supply glut. Polysilicon production (not counted in the *Census*) has been growing from the three U.S. plants, but may not continue given that the chief export market, China, has imposed very high tariffs. Wafer production was discontinued in the U.S. when SunEdison closed its Oregon plant. However, another manufacturer, Kerfless, plans to build a wafer production facility in New York. The one U.S. cell manufacturer, Suniva (based in Georgia), is growing, while U.S. inverter production is declining with the closing of two leading company operations. However, domestic market demand remains strong. Despite the decline in module prices, U.S. production is holding steady given the ongoing trade litigation with China and Taiwan.[55] Tesla and Panasonic are finishing their solar panel factory in Buffalo, New York with production expected to start in the summer of 2017.

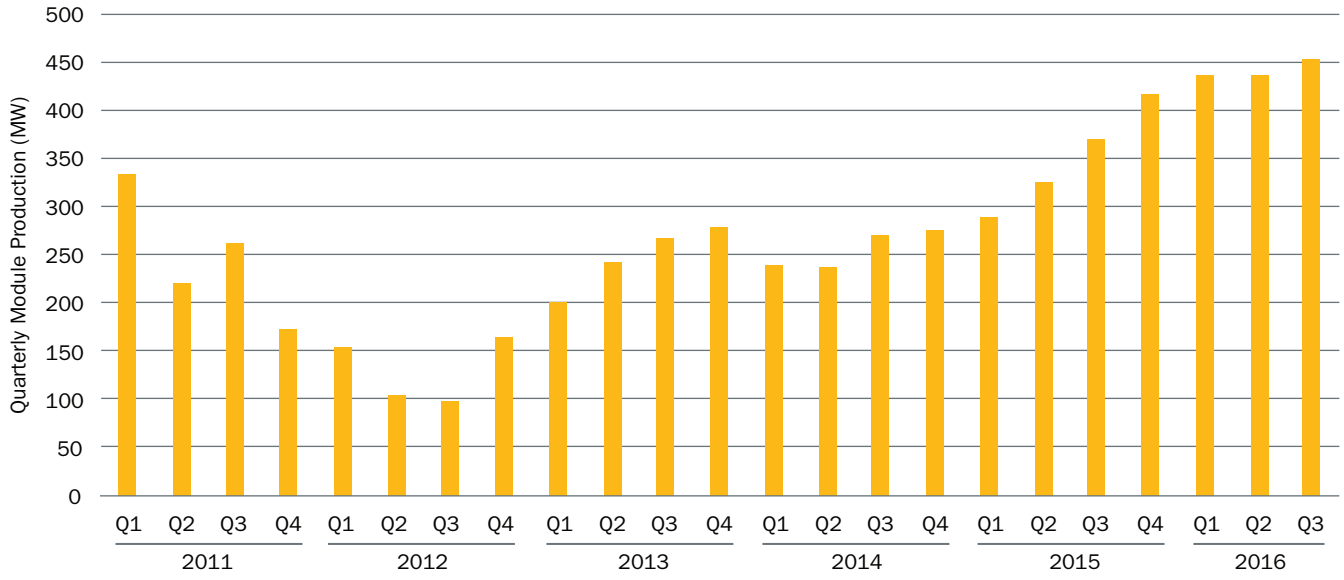
BOX 4

Asia Continues to Lead Global Manufacturing Growth

India led all countries in announced manufacturing capacity expansion in 2016, followed by China (13 GW), Vietnam, (5.2 GW), Malaysia (3.5 GW), Thailand (2.7 GW), Taiwan (2.3 GW), and the U.S. (1.3 GW). The 17 GW announced by India is over twice the country's 2015 announcement; however, given that 7.8 GW of the 2015 announcement remains unrealized, India's ability to complete the announced expansions are uncertain. While expansion is slowing in China, much of the other Asian capacity additions are from Chinese companies. The top seven countries, all from Asia, represent 46 GW or 94% of total announced expansions.[53]

FIGURE 8

U.S. Domestic Solar Module Production, 2011–2016[56]



SOURCE: GTM RESEARCH, A WOOD MACKENZIE BUSINESS/SEIA U.S. SOLAR MARKET INSIGHT®

Manufacturers currently employ 38,121 solar workers, an increase of 26% or 7,839 jobs since November 2015. Manufacturing, more than other sectors, often occurs at facilities that build some solar components but don't meet the 50% *Census* threshold that defines a solar worker for The Solar Foundation. These part-time solar manufacturing jobs aren't counted. In contrast, *Census 2016* likely counted some jobs that may have not been counted previously. This year's *Census* included expanded sampling methodology across NAICS, especially in manufacturing.[57]

Overall, manufacturers expect to continue their growth, just at a slower pace. Survey respondents expect to add 2,313 jobs, for a 6.1% rate of growth in 2017. Meanwhile, the nation's manufacturing industry (overall) is expected to decrease by 0.7% over the next year.[58]

Solar manufacturing establishments employ more ethnic and racial minorities and veterans compared to other sectors. Reported 2016 figures for new hires indicate that the proportion of African Americans and Asians should continue to increase, since their proportion of new hires is greater than what is represented in the existing workforce. In contrast, the proportion of Latino/Hispanic and veteran new hires is below existing representation.

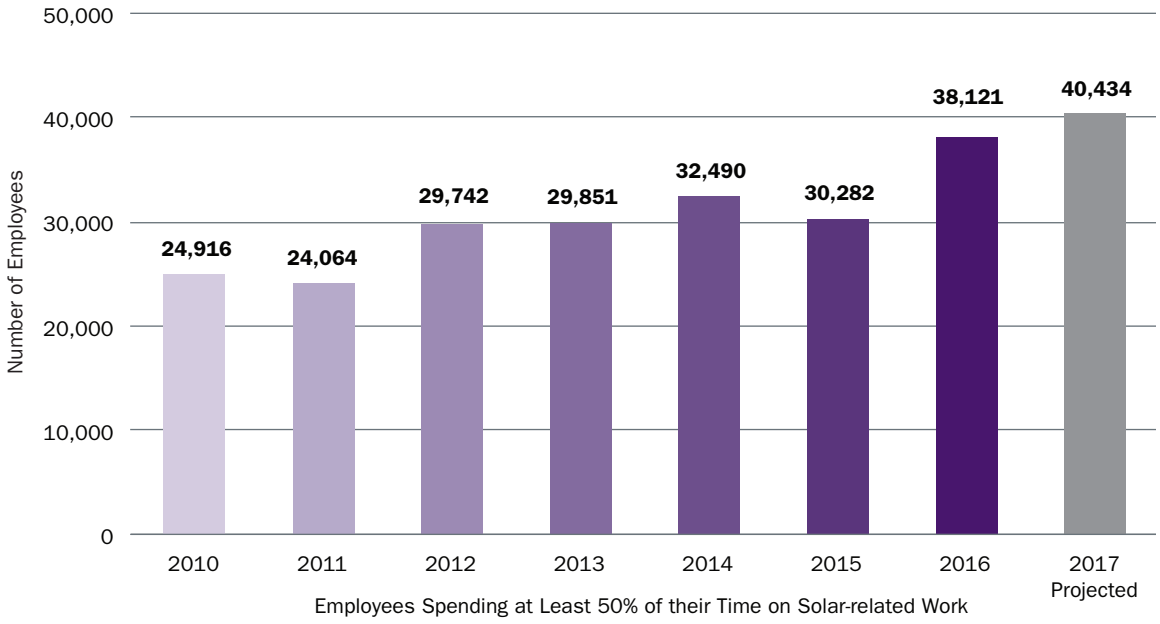
TABLE 10

Manufacturing Sector Demographic Breakdown, 2016[59]

	2016 Manufacturing Workers	Percent of Solar Manufacturing Employment	Percent of Total U.S. Workforce	Percent of Manufacturing Industry Employment
Women	11,779	30.9%	46.8%	29.1%
African American	2,897	7.6%	11.7%	9.7%
Asian or Pacific Islander	5,871	15.4%	5.8%	6.6%
Latino/Hispanic	8,348	21.9%	16.4%	16.2%
Veterans of the U.S. Armed Forces	4,613	12.1%	7.2%	n/a
Union Members	114	0.3%	n/a	n/a
Older Workers (55+)	5,756	15.1%	22.5%	n/a

FIGURE 9

Solar Manufacturing Employment Growth, 2010–2017



PROFILE

Kelly Navarro

Recruiting Lead for SolarCity in Buffalo

"We're hiring for positions in the full range of education levels, from a high school diploma to an advanced degree. We're really looking for that person who maybe never thought manufacturing was for them. Maybe they've been working retail and don't feel like what they're doing every day is making a difference. This is a unique opportunity to get involved in this field and learn something completely new."

"High school graduates are encouraged to apply for our manufacturing specialist positions. These are our production operators. The specialist is documenting processes, conducting diagnostic tests, making sure their specific tool is operating correctly. We promote from within to the supervisor level, so that provides an excellent opportunity for someone to have a career path with us. The next level would be tech positions that require 2-year degrees. These are the people maintaining the wastewater treatment systems, the HVAC systems, the people who come in and troubleshoot and maintain tools. All of the engineering roles require a minimum 4-year degree, as do the jobs in accounting, finance, recruiting, and human resources."

"We really want the plant to look like Buffalo does, a city rich in cultural diversity and with a deep-rooted history in manufacturing. Obviously we want hard workers, and we want people who work well in a team setting. You have to be patient, you have to be flexible, you have to be willing to learn. This isn't like the stereotypical manufacturing job from your grandfather's memory, this is advanced manufacturing and it is the future."

Kelly is responsible for leading the recruiting team for SolarCity's new RiverBend factory in Buffalo, New York. This 1.2-million-square foot facility is slated to open in the second quarter of 2017.

SALES AND DISTRIBUTION SECTOR

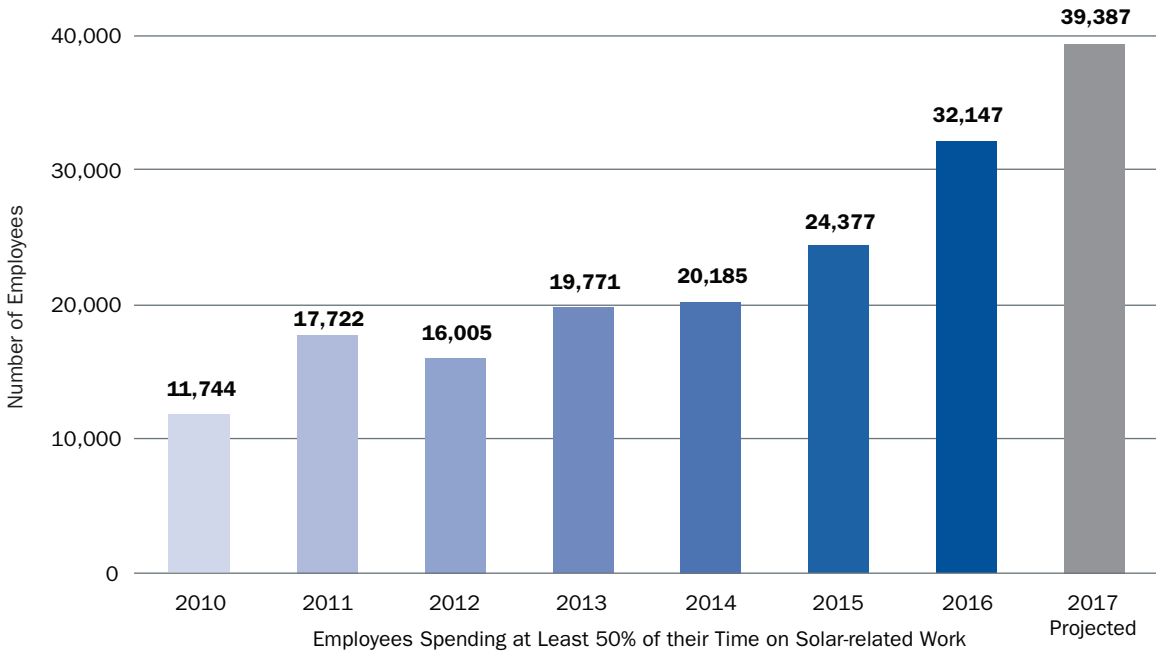
The solar sales and distribution sector is made up primarily of wholesale and retail trade establishments. They are engaged in selling (but not installing) solar and other ancillary services to customers and/or warehousing and distributing U.S. and foreign made solar goods to installers. This report delineates companies by the activities at each business location to gather the most accurate employment information. Thus, much of the data discussed in this section has been collected from the sales offices and distribution warehouses of companies across other segments of the value chain. This section includes the key findings from the data gathered from 550 U.S. solar sales and distribution establishments.

As the industry matures and companies grow, this work is increasingly being carried out in-house. In contrast, less developed state and regional markets across the country remain reliant on distributors, since firms in such markets are often not large enough to justify the investment in direct sales.

Solar establishments primarily engaged in sales and distribution currently employ 32,147 solar workers, an increase of 31.9%, or 7,770 since 2015. This is considerably higher than the nation's overall retail (1.5%) and wholesale trade (0.1%) employment growth from 2015 to 2016.[60] Employers expect to increase sales & distribution employment by 22.5%, or an additional 7,240 jobs, by November 2017, representing the largest percent increase of any sector in the industry.

FIGURE 10

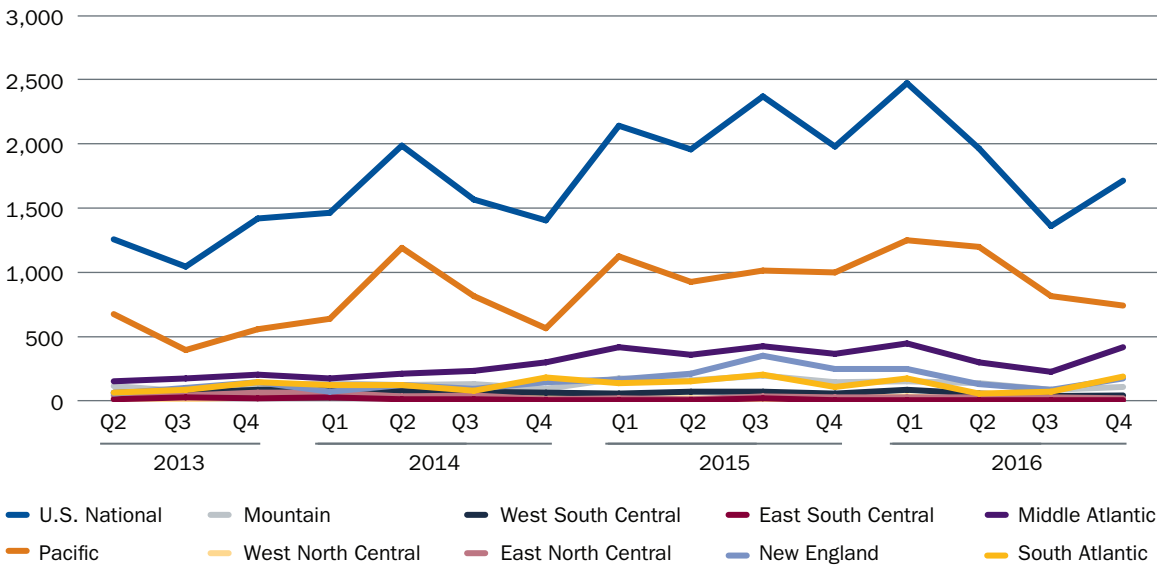
Sales and Distribution Employment Growth from 2010–2017



According to quarterly job postings data, new sales jobs have remained somewhat steady in recent years, fluctuating within the 1,500–2,500 range since 2014.[61] Regionally, The Pacific leads handily in having the most monthly solar sales postings per month. This is likely due to the previously mentioned dominance of California's residential market.

FIGURE 11

New Sales Job Postings by Census Division[62]



SOURCE: CEB TALENTNEURON™

Sales and distribution firms have a lower proportion of ethnic and racial minorities and veterans than other sectors of the solar industry. In contrast, women represent just over a third of the workforce—the highest proportion of any sector but "other." The share of women working for these firms increased significantly over the past year, from 25% to nearly 34%.

TABLE 11

2016 Sales and Distribution Demographic Breakdown[63]

	2016 Sales & Distribution Workers	Percent of Solar Sales & Distribution Employment	Percent of Total U.S. Workforce	Percent of Wholesale Trade Industry Employment
Women	10,860	33.8%	46.8%	29.5%
African American	1,448	4.5%	11.7%	11.4%
Asian or Pacific Islander	2,232	6.9%	5.8%	5.7%
Latino/Hispanic	4,588	14.3%	16.4%	16.8%
Veterans of the U.S. Armed Forces	1,688	5.3%	7.2%	n/a
Union Members	311	1.0%	n/a	n/a
Older Workers (55+)	2,643	8.2%	22.5%	n/a

PROFILE

Katina Allen

Senior Sales Consultant, Sungevity

"At Sungevity, I take calls from customers who are interested in what we have to offer, and I go about consulting with them on a solar system from start to finish. You never know who you're going to get on the phone. You don't know if it's that person who's all about the environment, or if it's the person on a fixed income who can't afford a $600 utility bill. A lot of times when a customer reaches out to us, yes they love the concept of solar and going green, but 90 percent of the time they're doing it to save money. So it's a great feeling to know that I'm getting them a great deal, and I'm also talking about the sun and its multitude of benefits all day!"

"One of the challenges is making sure customers understand the value of what they're getting, because there's no standard way to purchase solar and customers don't know how to go about it. Compare that to when you go to buy a car, and you know the process, you know what to ask and you know what you're leaving with. So we have to break down barriers and get through some of those myths they might have heard about solar from their friends or family members, and make sure people understand that solar is meaningful: They're not just putting those black boxes on the roof for nothing! That's what energizes me as we work day by day, changing the world one rooftop at a time."

Katina has worked at the Sungevity office in Kansas City, Missouri, since 2015 and has more than 15 years of experience in sales.

Site tour of one of sPower's utility projects in Antelope Valley, CA.

PROJECT DEVELOPMENT SECTOR

The project development sector includes utilities and companies that work on the largest, utility-scale solar projects. Predominantly using photovoltaic (PV) or concentrating solar power (CSP), these firms construct and sell bulk power to utilities or directly to consumers as a utility. This section includes the key findings from the data gathered from 212 U.S. solar project development establishments.

Compared to firms working on smaller solar installations, project developers and utilities require a wider range of in-house and outsourced workers and contractors, including civil engineers, land surveyors, and power plant operators. Permitting, financing, and land acquisition are more complex, requiring more, and often higher paid administrative and professional workers as well. Employers in the sector tend to be larger and highly efficient, with specialized labor tending to each component of the project.

The utility-scale market is expected to have grown just over 10 GW for 2016, more than double the 4.26 GW of utility-scale capacity growth in 2015.[64] This astronomical growth was triggered by the previous year's anticipation of a 2016 phase-out of the 30% federal solar investment tax credit (ITC). In order to benefit from the ITC before it was presumed to expire at the end of 2016, projects needed to be completed by the end of the year. As such, many of these projects were well under way when the extension passed through Congress in December of 2015, and were subsequently brought online over the course of the past year. Given this large 2016 investment binge, utility-scale development is expected to decline in 2017. Nevertheless, as noted earlier, unsubsidized utility-scale development costs are at parity with natural gas in many states, ensuring that demand for these projects will remain very strong, and that utility-scale capacity growth will continue to exceed residential and nonresidential capacity growth into the foreseeable future.

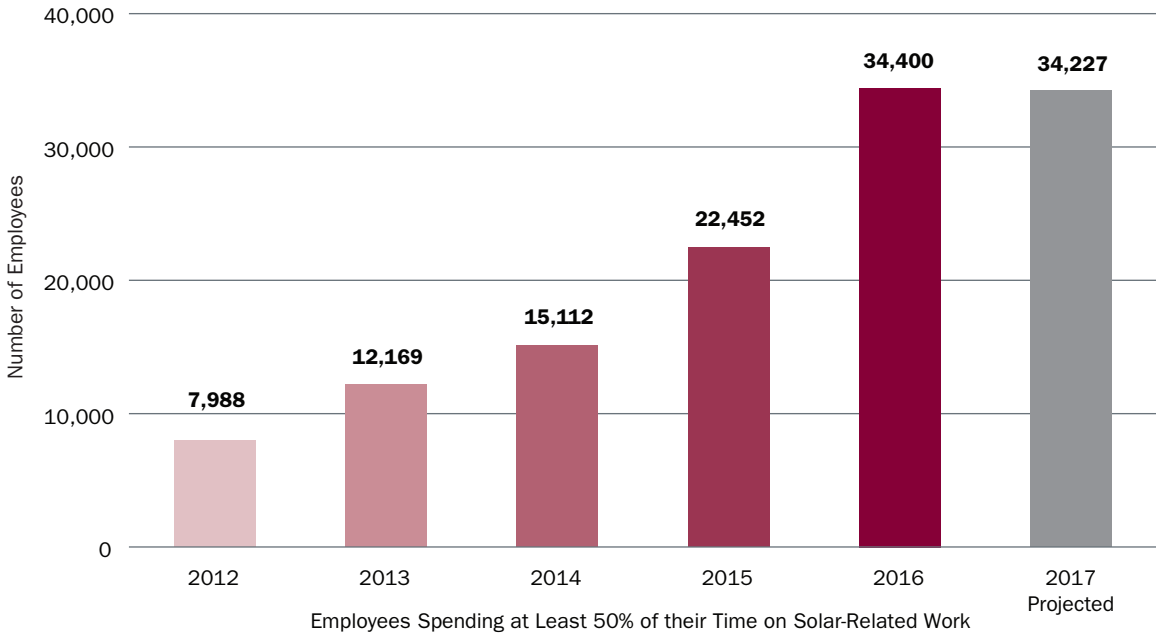
Other factors are also stimulating growth: predictable costs, declining coal generation, and the need to meet utility renewable portfolio standards (RPS) within tightening compliance timelines. Solar power costs are less volatile than those of fossil fuels and are often sought by utilities and other firms to round out an otherwise volatile energy portfolio.[65]

Over the past two years, the project development sector has been the fastest growing sector in the U.S. solar industry. By the end of 2016, the sector employed 34,400 workers, adding 11,948 jobs since

2015, representing an annual growth rate of 53.2%. In 2016, the sector gained more than 11,948 jobs to total 34,400 solar workers, a growth rate of 53.2% since 2015. As discussed, this growth is not expected to continue into 2017. Project developers expect 2017 employment to decline slightly, by 173 jobs or 0.5% over the course of the year.

FIGURE 12

Project Development Employment Growth, 2012–2017[66]



The project development sector has about the same level of diversity as the installation sector. Like installation, women represent roughly a quarter of the workforce, Latinos/Hispanics about 17%, African Americans about 7%, and veterans about 9%. Increasing representation of veterans in the project development workforce is another parallel with the installation sector, with veterans constituting 14.7% of new hires in both sectors.

TABLE 12

Project Development Solar Worker Demographic Breakdown, 2016[67]

	2016 Project Development Workers	Percent of Solar Project Development Employment	Percent of Total U.S. Workforce	Percent of Construction Industry Employment
Women	8,703	25.3%	46.8%	9.3%
African American	2,387	6.9%	11.7%	6.0%
Asian or Pacific Islander	2,626	7.6%	5.8%	1.8%
Latino/Hispanic	5,702	16.6%	16.4%	28.5%
Veterans of the U.S. Armed Forces	3,264	9.5%	7.2%	n/a
Union Members	1,096	3.2%	n/a	n/a
Older Workers (55+)	3,333	9.7%	22.5%	n/a

PROFILE

Jessie Klemme

Assistant Project Manager, Swinerton Renewable Energy

"You work from sunup to sundown, and oftentimes I'm one of the first ones there and one of the last to leave. Sure it's tiring, but it helps with morale to have everyone on the crew know you're there to support them and answer any questions they have. You work in subzero temperatures and often very difficult conditions, traveling from one site to another over the course of a day. I pretty much talk to everyone on site in the course of my job. One of the interesting parts of the job is that I can show up to work and have no idea what's going to happen that day. Every day is a surprise."

"One of my favorite things about working in the field is that we often travel together as a team. Leaving college, people don't expect you to necessarily know everything about solar, but if you're able to work on a team and you're willing to learn, those are some of the biggest points in your favor. It's really important to have solid teamwork, so that you can rely on each other to make decisions if you aren't there. We have a lot of trust in each other and we're like a little family, and that's what I really love."

Jessie came to Swinerton with a degree in environmental engineering and a minor in construction management. As an assistant project manager, she works on-site in locations such as Idaho and California.

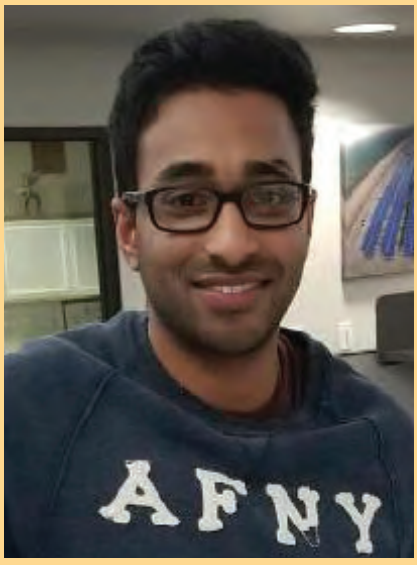
PROFILE

Neeraj Valleru

Solar Engineer, EIT, NABCEP, CalCom Solar

"When I lived in India I noticed the shortage of energy and that solar was needed. I was also interested in the dynamics of solar and the studies that would give me a lifelong career that could continue to grow. I knew that a career in solar would be a fast, rapid career with a good future!"

While working for CalCom Solar, Neeraj has developed a great understanding of the design, implementation, and maintenance of solar electrical equipment for utility and commercial systems. "My coursework and education have provided me with the sharp technical skills necessary to succeed in the challenging, fast paced environment of the solar engineering arena."

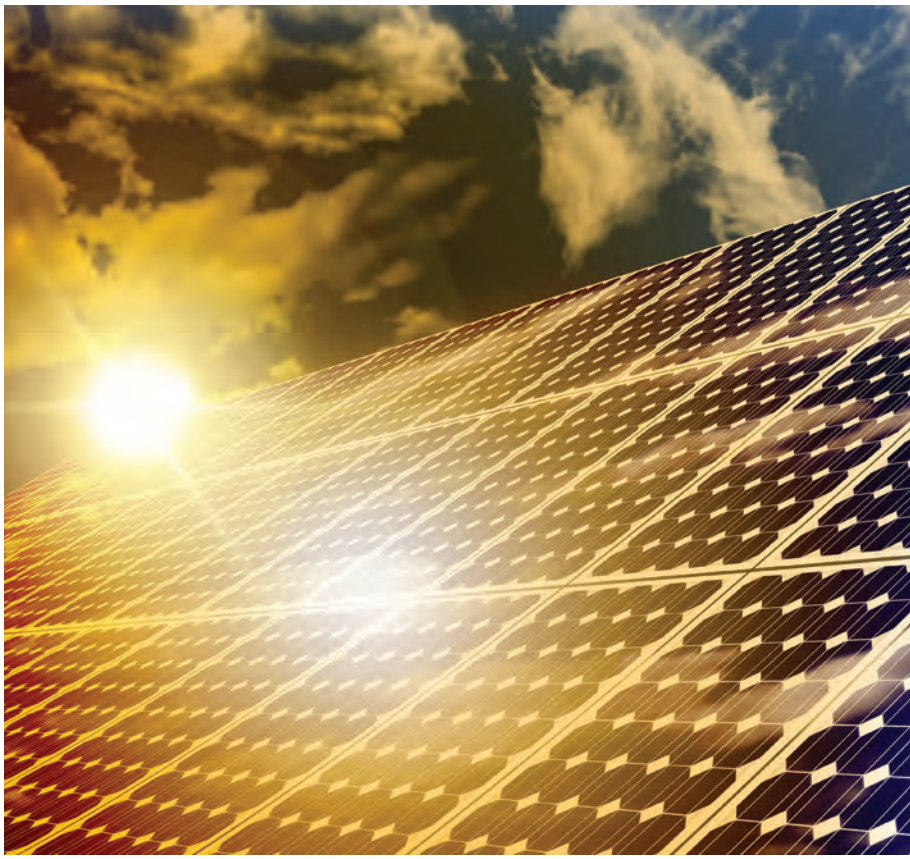


Neeraj Valleru graduated from the University of Massachusetts with a degree in Solar Energy Engineering.

"OTHER" SECTOR

Research and development firms, finance and legal firms, nonprofits, government agencies, solar training providers, and academic research centers play a small but important role in the U.S. solar industry. This section includes the key findings from the data gathered from 1,259 such establishments.

About 7% of the solar workforce, or 18,274 workers, are engaged in other solar activities, such as academic research, government oversight, research and development, nonprofit advocacy, finance, architecture, consulting, law, and communications. The "other" sector grew by a record 54.7% in 2016, adding 6,458 jobs. This sector is expected to experience a slight decline in 2017, shedding around 163 jobs, or roughly 0.9% of its workforce by the end of the year. As discussed in the project development section, this sector's employment will decline largely because so much work was conducted in 2016 in advance of the anticipated expiration of the federal investment tax credit.



BOX 5

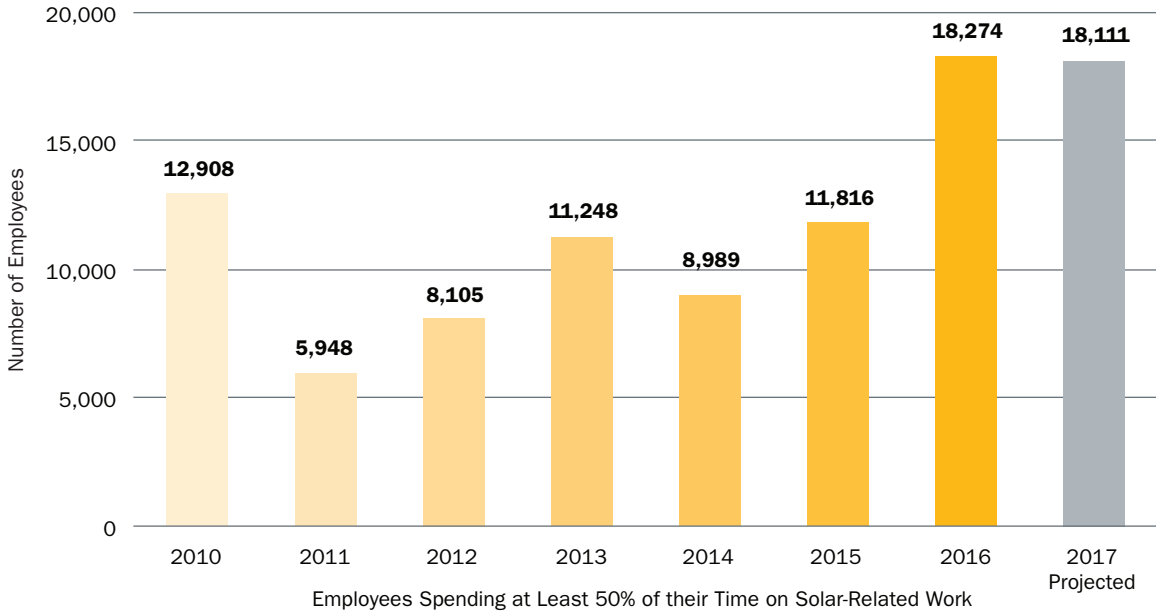
Solar Stock Prices Drop

Solar stocks continued their downward trend in 2016. Manufacturing companies were hit by a supply glut that materialized during the second half of the year. China cut its feed-in tariff, reducing demand while manufacturers like JA Solar, JinkoSolar, and Canadian Solar continued to add capacity. This phenomenon took place as the very hot U.S. utility-scale market started to experience a decline in new projects.[68] These and other manufacturers, such as U.S firms SunPower and First Solar, have seen their share prices drop.

Both manufacturers and installers have been aggressive about taking on debt to fuel growth, adding to investor concerns. High debt in the face of a cooling residential market stifled investor interest in SolarCity prior to its merger with Tesla. Financial mismanagement reportedly led to project developer SunEdison's bankruptcy.[69] Market turbulence also weakened investor appetites. SolarCity and the other top two residential installers, Vivint Solar and Sunrun, have seen their market share decline as regional installers have gained prominence. Despite declining market share for the top three firms, regional firm growth has propelled an overall gain in market share for the top ten installers.[70] Profitable, high market value companies typically raise more capital, invest more, and hire more.

FIGURE 13

Other Employment Growth, 2010—2017



This sector has the highest proportion of female employees—women account for almost 40% of workers at these firms and constituted more than half of new hires in the sector during 2016. Workers age 55 and over account for almost a quarter of the "other" workforce and over half of new hires. Solar workers are less racially and ethnically diverse in this sector than in other solar sectors. However, Latinos/Hispanics, who represent 17.4% of the workforce, represented 36% of new hires.

TABLE 13

Other Demographic Breakdown, 2016

	2016 "Other" Workers	Percent of "Other" Solar Employment	Percent of Total U.S. Workforce
Women	6,894	37.7%	46.8%
African American	730	4.0%	11.7%
Asian or Pacific Islander	2,452	13.4%	5.8%
Latino/Hispanic	3,178	17.4%	16.4%
Veterans of the U.S. Armed Forces	1,023	5.6%	7.2%
Union Members	2,882	15.8%	n/a
Older Workers (55+)	4,159	22.8%	22.5%

PROFILE

Brian Callaway

Director, M&A and Structured Finance, sPower

"The M&A aspect of my work involves finding potential acquisitions, through relationships and networking, as well as broader processes like due diligence, transaction document negotiation, and financial modeling. The structured finance piece is probably the most unique to renewables. It requires understanding what drives the various lenders/investors and the different flavors of financing you might introduce to the project. This involves working the relationships with lenders as well as a lot of math."

"There are a lot of different skills that come into this job, and I like to think that's why there aren't too many of us. It requires the bridging of a gap between hard technical math skills, somebody who likes to read and can handle dry documents/tax code, and the soft skills of being able to call people up on the phone, talk through problems, explain issues, and get everybody comfortable. For new hires, we're less focused on degrees and more focused on really sharp people who can execute quantitative reasoning but also demonstrate really strong communication skills and a high emotional IQ."

"When you compare what I do to a traditional finance job on Wall Street, what it boils down to is that you get to own what you build. You can go visit communities and see how the capital you've invested has improved their lives. It's immensely rewarding. For me, a big selling point was the opportunity to work in finance in a socially responsible manner. It's not just creating dollars out of thin air, it feels like creating real value for the world."

Brian began his career at NRG Energy in San Diego. He now works at sPower in Salt Lake City, where he works on M&A and financing for utility-scale solar projects.

WORKFORCE DEVELOPMENT

Explosive demand for solar installations has fueled a tripling in the workforce since 2010. Roughly half of the new solar industry jobs added in the last six years were positions within installation firms, with 93,199 installation-related jobs added between 2010 and 2016. These jobs pay more than the national average and often lead to upwardly mobile careers. The range of jobs in the solar industry is incredibly diverse. Solar workers are installing modules on homes, working as sales representatives, managing huge utility-scale projects, and working in factories. Solar is also an industry that has a low education barrier to entry.

Despite efforts by public and private solar training providers, 80.2% of the solar industry still reports difficulty finding qualified applicants to fill open positions. This difficulty hiring is even more exaggerated in the installation sector, which requires specific technical and safety skills before a new hire can be productive. A significant number of installation firms reported difficulty finding qualified applicants in 2016.

While simple number of applicants is an issue in many regions, the quality of new hires is frequently cited as a more pressing issue. New employees with previous training often get re-trained during the onboarding process due to company-specific installation techniques and methods that are not covered in standard training.

This gap between solar workforce supply and demand, and associated difficulty hiring qualified employees, creates inefficiencies and increases the cost of deploying solar. Soft costs, which include the cost of hiring, training, and retraining employees, account for two-thirds of total installed costs for residential solar in the U.S. Installation labor costs alone account for 7% of the total cost of a new solar PV system.[71] These soft costs keep U.S. solar PV installation prices far above the prices in many other countries, despite comparable hardware costs.[72]

Understandably, a large focus of training and safety education is to decrease mistakes and injury rates. This practice has proven effective in similar industries. Mistakes by solar installers can be costly for a company to address, and can potentially lead to serious injury or death. According to a 2014 study, a rooftop installation that has been improperly installed can require between $2,500 and $9,500 in additional removal, repair, and reinstallation costs.[73] If improved training procedures could lead to even a 1% reduction in the rate of such call-backs, the solar industry could realize millions of dollars in savings in less than a year.[74]

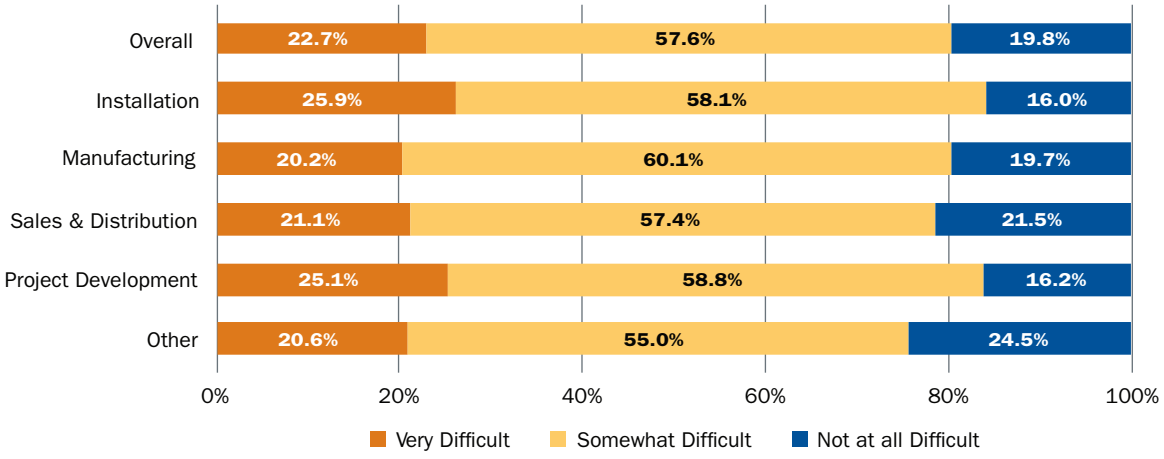
HIRING DIFFICULTY

One of the most important metrics for understanding potential gaps and surpluses in the labor market is employers' reported difficulty in hiring. Overall, solar employers report increasing difficulty in finding qualified workers as compared to previous *Census* reports, though there was less of a change from 2015 to 2016. The biggest change occurred from 2014 to 2015, when firms reporting that it was very difficult to hire qualified employees jumped from 17.2% to 24.2%. In 2016 this metric dropped back to 22.7%, or just over one in five firms. However, the broader measure for hiring difficulty, incorporating both very and somewhat difficult to hire responses, increased from 75.9% in 2015 to 80.2% in 2016. The percentage of establishments reporting no difficulty in hiring declined to just under 20%.

Establishments in the West North Central Census Division reported the most significant difficulty hiring, with 30% reporting that it was very difficult to hire qualified candidates, followed by establishments in the Middle Atlantic, at 25.6%.

FIGURE 14

Hiring Difficulty by Sector, 2016



Hiring difficulties were relatively consistent across regions. Establishments in the West North Central Census Division reported the most significant difficulty hiring, with 30% reporting that it was very difficult to hire qualified candidates, followed by establishments in the Middle Atlantic, at 25.6%. In other regions 19%–25% of respondents reported that hiring is very difficult. In 2015, the Middle Atlantic had the most difficulty hiring, followed by the West North Central U.S.

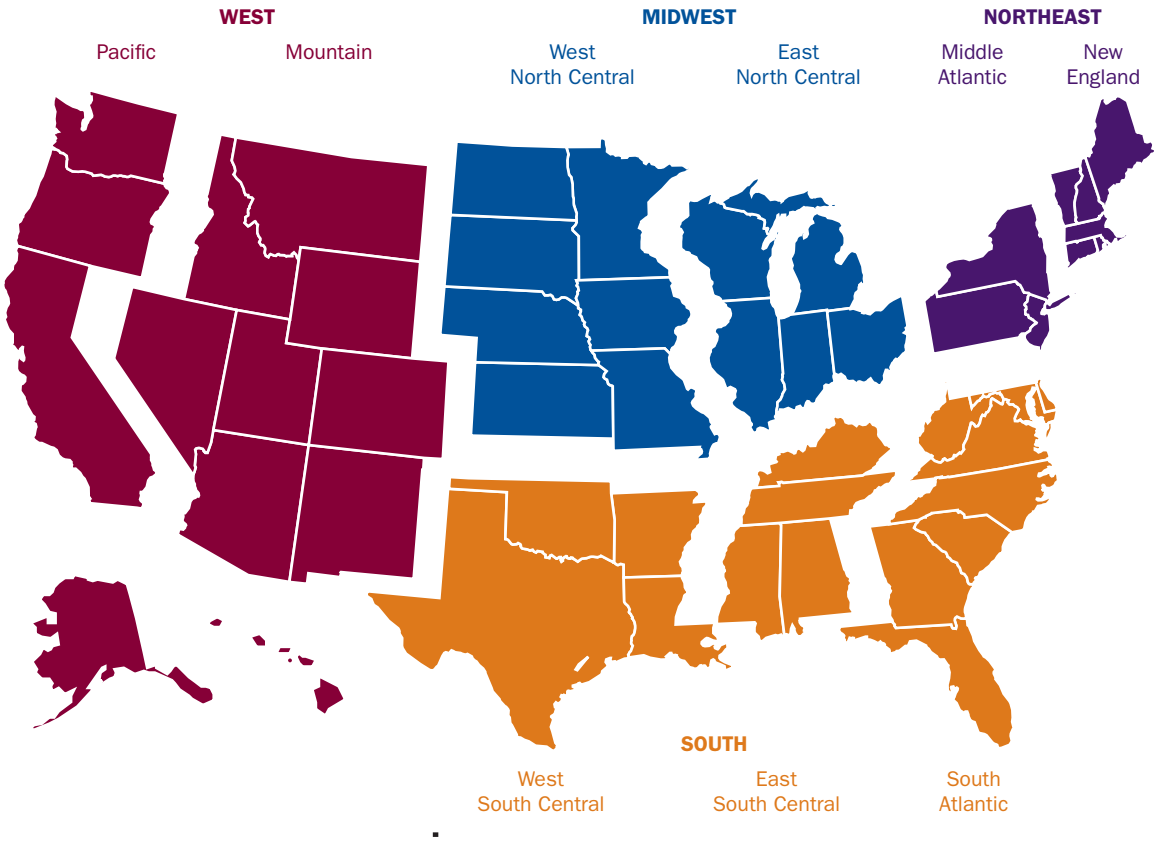
TABLE 14

Hiring Difficulty by U.S. Census Division, 2016[75]

	U.S. Census Division								
	New England	Mid Atlantic	East N. Central	West N. Central	South Atlantic	East S. Central	West S.Central	Mountain	Pacific
Very Difficult	23.1%	25.6%	24.2%	30.0%	21.6%	23.7%	19.8%	20.2%	19.6%
Somewhat Difficult	54.7%	54.6%	53.3%	50.0%	52.3%	47.4%	53.5%	63.2%	59.4%
Not at all Difficult	19.3%	17.6%	20.0%	16.0%	22.6%	28.9%	24.4%	15.2%	18.5%
DK/NA	2.8%	2.1%	2.5%	4.0%	3.5%	0.0%	2.3%	1.3%	2.5%

FIGURE 15

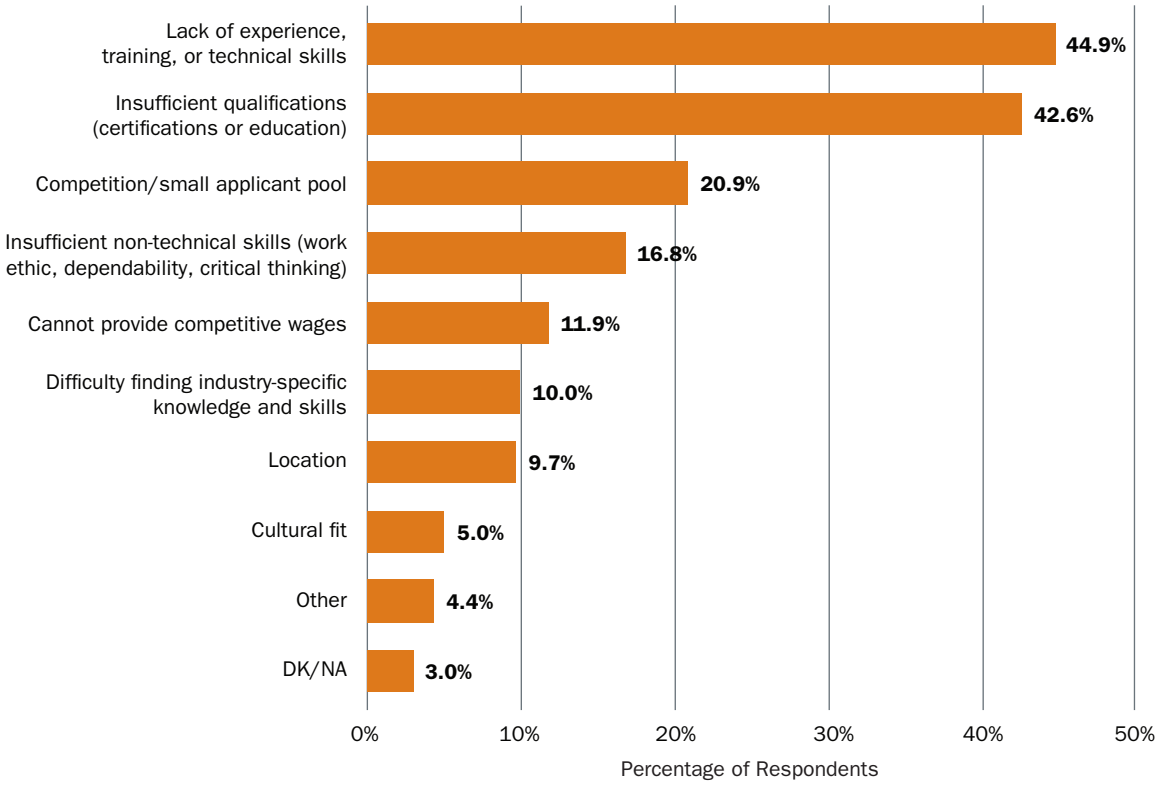
U.S. Census Divisions



Solar establishments cited two primary reasons for difficulties in hiring: 1) lack of experience, training, or technical skills; and 2) insufficient qualifications (certifications or education). Each of these factors were cited by just over 40% of the respondents as shown in Figure 16. The next two most common cited reasons were a small applicant pool and insufficient non-technical skills.

FIGURE 16

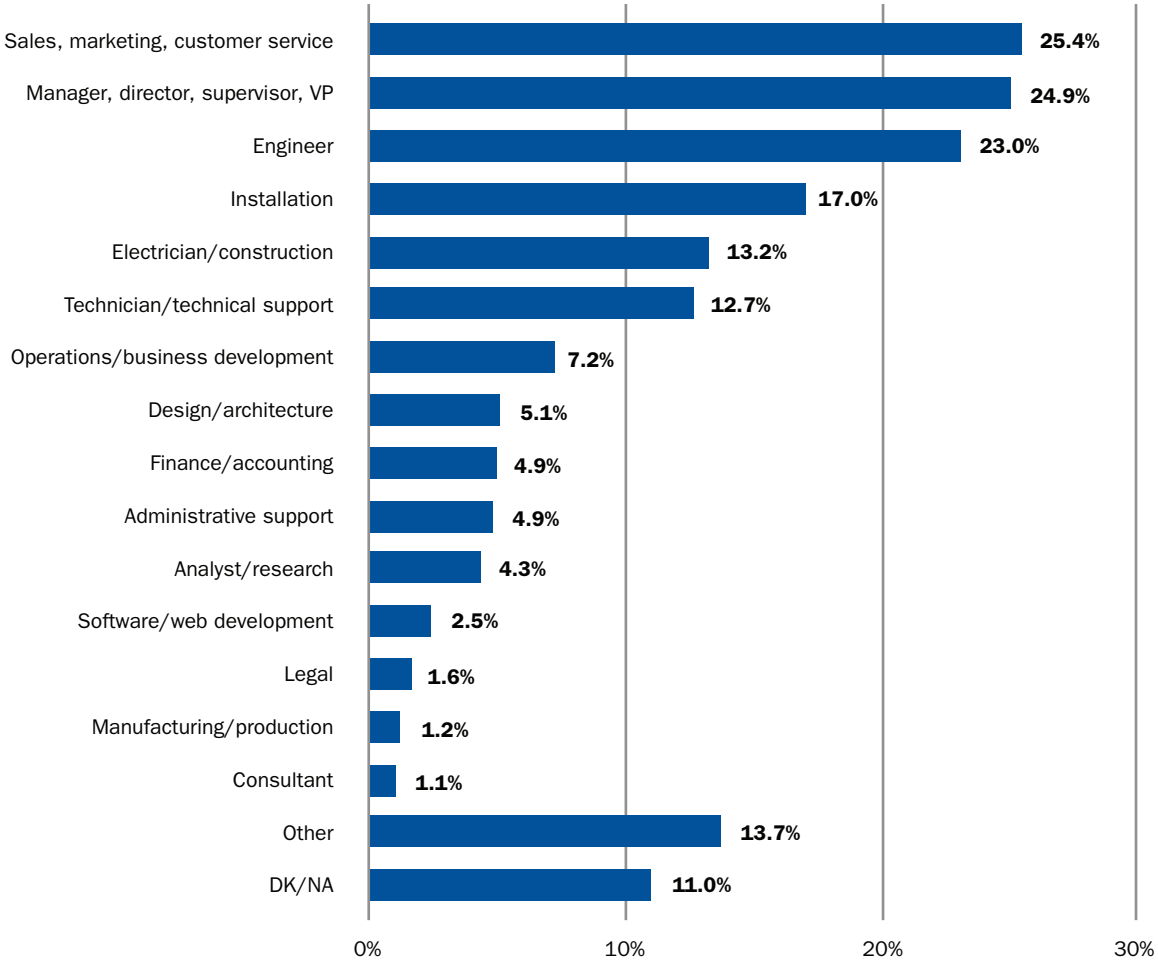
Most Significant Reasons for Reported Difficulty in Hiring, 2016



When asked for the two most difficult positions to fill, respondents most frequently identified professional positions: sales, marketing, customer service; manager, director, supervisor, VP; and engineers. Installers were the most commonly mentioned technician positions, followed by electricians as shown in Figure 17.

FIGURE 17

Most Difficult Positions to Fill, 2016

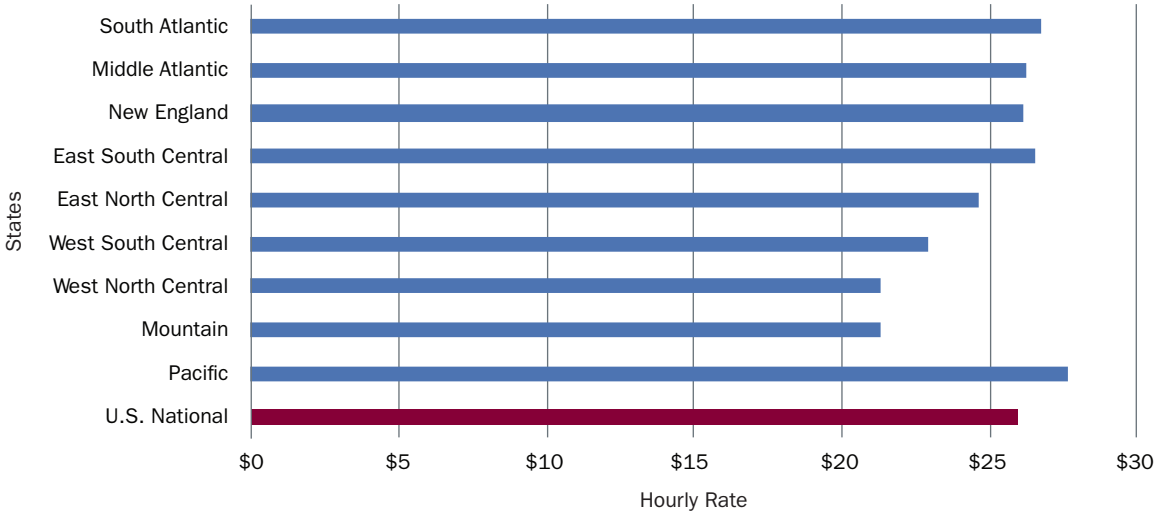


WAGES

Changes in wages offer insight into labor supply and demand as wages rise in response to the scarcity of talent. Since wages were not part of the 2016 *Census* survey, The Solar Foundation researched wages through online classified job postings. The median advertised wage for all positions identified as installers is $25.96 per hour, as shown in Figure 18.[76] If electricians are removed, the median wage drops to $24.90 per hour, and if only electricians are counted, the wage advertised increases to $28.82 per hour.

FIGURE 18

Installation Sector Advertised Median Hourly Wage by Census Division[77]

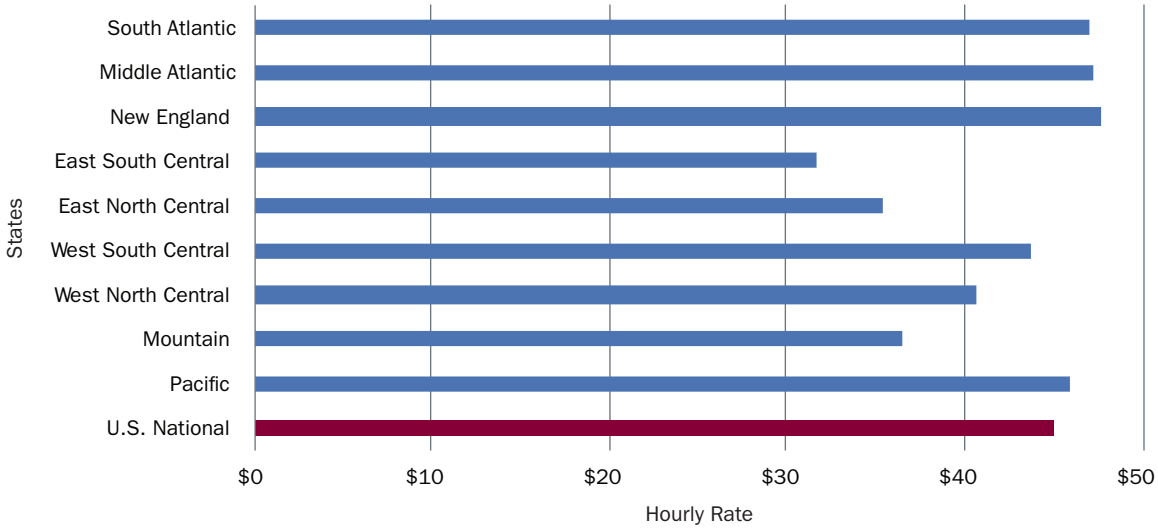


SOURCE: CEB TALENTNEURON™

The median advertised wage for sales and distribution workers was $45.26 per hour. The median ranged widely throughout the U.S. as shown in Figure 19. The lowest advertised median wage for these positions was $31.68 in the East South Central U.S. By comparison, South Atlantic, Mid-Atlantic, and New England ranged between $47 and $48 per hour. As median wage was produced from salaries advertised in job postings, and sales-related salaries are partially commission based, the actual earnings may not match the posted compensation.

FIGURE 19

Sales Sector Advertised Median Hourly Wage by Census Division[78]



SOURCE: CEB TALENTNEURON™

Based on employees hired over the last twelve months, experience is the most important hiring requirement for all sectors, with 65% requiring experience compared to 32% requiring a bachelor's degree or higher. Just over 18% require a technical certificate or credential and just under 13% require an associate's degree, but not a bachelor's degree. Since *Census 2015*, requirements for experience and bachelor's degrees have crept down while employers seeking associate's degrees and/or a technical credential or certificate have risen. Required experience declined from 65% to about 62%, while required bachelor's degrees declined from 35% to 32% from 2015 to 2016. The associate's degree requirements increased from 2015 when such degrees were only required by 10% of new hires. However, in 2016, the survey question was split into two separate questions: one inquiring about an associate's degree and the other about a technical certificate or credential. The former was required by 12.6% of the applicants while the latter by 18.5%.

Sales and manufacturing establishments also consider education important, with 40% and 42% requiring a bachelor's degree or higher, respectively. However, bachelor's degree requirements for new hires in sales decreased significantly from 58% in 2015. The installation and project development sectors are least concerned with bachelor's degrees, requiring them 22% of the time. They have a similar preference for a technical certificate. The project development sector decreased its requirements for previous experience from 80% in 2015 to 62% in 2016, but increased its educational requirements for both associate's and bachelor's degrees. For example, requirements for a bachelor's degree or higher increased from 9% in 2015 to 22.5% in 2016.

TABLE 15

New Hire Experience and Education Requirement, 2016[79]

	Percent with Experience in 2016	Percent with Experience in 2015	Percent with Bachelor's Degree or Higher	Percent with Vocational or Technical Certificate or Credential	Percent with Associate's Degree or Certificate from Accredited College
Overall	**64.5%**	**67.0%**	**32.2%**	**18.5%**	**12.6%**
Installation	61.2%	62.2%	21.7%	20.6%	11.0%
Manufacturing	62.5%	65.0%	42.4%	12.3%	10.0%
Sales & Distribution	66.2%	65.1%	39.9%	14.2%	9.9%
Project Development	61.6%	80.4%	22.5%	20.5%	12.1%
Other	76.3%	79.1%	61.2%	17.8%	15.9%

The solar industry provides an opportunity for workers in low wage jobs, who pursue some training in solar-specific technologies, to move into sustainable wage careers in as little as 12 months. For example, in 2015, The Solar Foundation published a report that found the construction trades provide a good source of feeder occupations (laborers, roofers, electricians, etc.) for installation work in the state of Maryland. Apprentice and entry-level construction trades can advance to higher wage solar installer positions making between $20 and $22 per hour.[80]

CONCLUSION & RECOMMENDATIONS

The U.S. solar industry continues its well-documented, positive growth trajectory, posting 24.5% employment growth from 2015 to 2016, and 178% job growth since 2010. All sectors across the entire value chain of solar goods and services experienced broad-based employment gains in 2016. All sectors have experienced significant gains since 2010, most notably the installation sector, which has tripled in size.

The industry ramped up employment toward the end of 2015 in preparation for the anticipated 2016 ITC expiration and amidst declining hardware costs. Despite the December 2015 ITC extension, 2016 employment grew substantially, since many of the larger utility-scale projects were already well into the development process at year end. Although the utility-scale project development sector is less labor intensive than the residential or commercial sectors on a per MW basis, the doubling of utility-scale installed capacity was enough to result in a record-breaking year of solar employment growth and the fourth consecutive year of 20% growth of greater. Given that much of the ITC-inspired development took place in 2016, 2017 will show continued growth, but at a lower rate. For 2017, establishments expect 10% employment growth.

Longer term trends and policies remain strong. They include:

- Declining cost of solar power;
- Extension of the federal Investment Tax Credit (ITC) until 2021;
- State renewable portfolio standards (RPS);
- Other state and local incentives; and,
- Solar + storage potential to drive market expansion.

In *Census 2015*, we also noted that momentum from the Paris Summit (COP 21) on Climate Change and the Clean Power Plan (CPP) would support solar deployment long term. These items are no longer considered significant factors given the change in administration. Despite the anticipated end of the CPP, many states continue to move forward to meet their RPS commitments. These state-by-state policies will support solar deployment alongside its continued emergence as an economically viable, domestic power source that creates American jobs and advances the nation's energy independence.

There are other barriers that could disrupt or slow growth:

- Continued decline in fossil fuel prices, especially natural gas;
- Changes in state net metering laws that discourage distributed power generation;
- Worker skill shortages; and,
- Policy intransigence for solar + storage.

Taken together, the opportunities outweigh the barriers. A continued decline in natural gas prices would likely accelerate the use of natural gas over coal, rather than solar power. Furthermore, solar costs are also expected to continue to decline. Utility-scale solar is already at cost parity with fossil fuels in some markets. Changes to net metering pose a significant risk for distributed solar. As more and more households develop solar rooftop power, groups will push for more fees and cuts to retail pricing. New opportunities in energy storage and smart grids may counterbalance some of these challenges as our energy system adjusts to meet modern needs.

Worker skill shortages are a concern. Prior to the Great Recession, labor skill shortages were prevalent throughout the building trades. Although the slow recovery has mitigated a return to skill shortages, solar establishments reported a jump in hiring difficulty from 2014 to 2015; those reporting that it was very difficult to hire jumped from 17.2% to 24.2%. In 2016 this metric dropped back to 22.7%. The broader measure for hiring difficulty, that includes both very and somewhat difficult to hire responses, increased from 75.9% in 2015 to 78.2% in 2016.

Given the projected slowdown in 2017 employment growth to 10%, we expect less pressure on hiring nationally, although select states could experience difficulties. Hiring difficulty is also influenced by hiring in the related trades. If the economy—and specifically construction—remains strong, the solar industry will experience greater competition for workers, making it more difficult to hire, driving up wages and installation soft costs.

One obvious way to limit the impact of rising soft costs is by increasing the supply of qualified workers through education, training, and apprenticeship. Given the stark differences among employers in reporting the use of on-the-job training, third-party training, and credentials, it is becoming clearer that the solar industry would benefit from a consistent framework for training and evaluating talent.

Local governments can play a key role in reducing other soft costs. Issues such as permitting and inspection are firmly within a local government's ability to improve and streamline, and municipalities and counties can work with local utilities to cut red tape and align interconnection processes and timelines with the local government's own practices.

Friendly community solar policies are also a means to deploy solar at a value to local community members. Community solar refers to programs in which members of a community own and benefit from a PV power system. More states each year are adopting policies to allow their residents access to this rapidly growing segment of the solar market. For example, in 2016, Maryland adopted final regulations for a state community solar pilot program, Hawaii underwent public comment on rules for a new community solar program, and state regulators in Massachusetts proposed a new community solar incentive program that would include positive modifications to how participants are compensated for solar generation.[81]

Municipalities and counties can also demonstrate leadership in addressing soft cost issues not directly under their control. Financing costs can be addressed through educating local lending institutions on solar technologies and making them more comfortable with developing and offering financial products for solar. Customer acquisition costs can be addressed in part through public outreach and bulk purchasing (or "Solarize") campaigns. The Solar Foundation and a team of national solar and local government experts provides no-cost technical assistance to help municipalities and counties address these and many other issues through the SolSmart program (*www.SolSmart.org*).

Based on these conclusions, we make the following recommendations for ensuring continued strong solar job growth:

Continue to Develop Training Infrastructure for the Solar Workforce

Without a skilled workforce, the industry cannot grow; thus, opportunities should be sought to train new entrants to the solar industry, as well as existing solar workers based on industry needs. Third-party training providers and employers should collaborate to create on-the-job training programs that use employer's specific techniques and hardware in conjunction with classroom education. This approach could lead to a standardized classroom training curriculum that covers safety and basic installation techniques, providing employers a level of certainty in the skills and knowledge of any new hire. There is also a need to develop curriculum and training for new and growing technologies such as storage systems and micro-grids.

Targeted internship opportunities with local trainers and universities can give students hands on exposure to basic construction, electrical work, and solar installation. These programs should pool the resources of several smaller installation firms that cannot develop their own in-house training programs, allowing them to use economies of scale to provide affordable training.

In addition, the creation of a clearinghouse for available tools and resources in solar industry education and the development of a central solar jobs board would be invaluable in centralizing key information. There is currently a lack of awareness in the industry regarding a broad range of underutilized workforce development tools and resources.

Continue to Develop Bridge Programs for Veterans

Veterans of the U.S. Armed Forces continue to represent a larger proportion of the solar workforce as compared to the overall economy. This strong representation may be driven in part by a high degree of skill transferability between military occupations and solar jobs, which has been demonstrated by interviews with select solar employers conducted for the 2014 report *Veterans in Solar: Securing America's Energy Future*, co-authored by The Solar Foundation and the Truman National Security Project. During The Solar Foundation's administration of the nationwide Solar Ready Vets program, it has also been observed that service members appreciate the opportunity to continue service to their country by contributing to the domestic electricity supply and American energy security.

Despite these potential skills and ideological overlaps, some groups of veterans—especially those in the 18 to 24 age group—continue to grapple with high unemployment. Comparing the skills developed in military occupations with the needs of the industry can provide a deeper understanding of the opportunities on both sides and can enable former service members to more easily transition into jobs in the solar industry. Workforce training providers are aware of this opportunity, but need greater support to further develop the solar industry as a strong employer of military veterans.

In addition, workforce training providers and solar employers should become more familiar with the Post-9/11 GI Bill, the education and training opportunities it provides, and GI Bill course approval

requirements in their state. Graduates of the Solar Ready Vets training are an excellent candidate pool, and employer participation as an industry partner is an easy way to connect with past and future graduates. Additionally, online portals such as the "Veteran's Employment Center" (*https://www.ebenefits.va.gov/ebenefits/jobs*), provided by the Department of Veterans Affairs and the Department of Defense, as well as "America's Job Centers" run by the Department of Labor (*http://www.servicelocator.org/onestopcenters.asp*), can help employers identify and connect with veterans seeking employment.

Promote Stability in State and Federal Policy

The U.S. solar industry continues to demonstrate its strength across the value chain. There is a very strong link between solar adoption and job creation. As has been the case with every domestic energy industry in our nation's history, the solar industry continues to benefit from policies and incentives that accelerate growth and help bring the industry to scale, particularly those policies with the multiyear certainty needed to leverage project financing.

Access to capital is important for solar companies and consumers. Increasing the number and availability of solar financing options for home and business owners will help further drive solar adoption, leading to increased solar employment. Though the solar industry has continually proven its ability to develop and offer innovative financing solutions, there remain market gaps. For example, as solar prices have dropped, more homeowners are opting to own their solar array rather than assign ownership to an installer through a lease or power purchase agreement (PPA). Despite this, few financial institutions have solar loans, making it difficult to obtain financing.

Lower-income households face several inherent barriers to going solar. These barriers include being less likely to own their roof, having limited access to affordable financing, being more likely to live in buildings with deferred maintenance, and being unable to realize the financial benefits of fuel-free electricity because their utility bills are partially or fully subsidized. Finding ways to serve the low-income market is essential for the solar industry to continue to expand. The rapidly growing community solar market could serve such needs, and states around the country are experimenting with ways to do just that. Colorado, for example, has begun contracting the development of community solar projects solely dedicated to serving the needs of low-income Coloradans across the state.

Many households in the U.S. are aging, and therefore less likely to remain in their homes for the number of years that may be required for full-payback of their systems. Programs that allow loans to follow the home rather than the owner (such as property assessed clean energy, or PACE) could unlock this untapped potential.

Support Early Stage R&D, Finance, and Commercialization

Due in part to continued declines in the price of traditional solar goods, investment in early-stage finance and research and development is down. Technical innovation is critical for the long-term competitiveness of the industry. Given the uncertain returns on R&D investments expected in the private sector, the gap in research funding from private sources will likely persist, suggesting an increased need for public sector support of early stage research and commercialization on new and more efficient solar technologies and applications.

Support The Solar Foundation and other groups that publish most publicly accessible primary research on practices, impacts, and benefits of solar power, one of the most important energy resources for our future.

APPENDIX A

Solar Jobs by State, 2016

State	2016 Solar Jobs	2015 Solar Jobs	Year/Year Growth	Solar Jobs Rank	Solar Jobs Per Capita Rank	Ratio of Solar Worker to Overall Workforce
AK	64	33	94%	51	51	1:11,593
AL	530	287	85%	42	49	1:9,176
AR	271	264	3%	47	50	1:11,015
AZ	7,310	6,922	6%	7	13	1:948
CA	100,050	75,598	32%	1	4	1:392
CO	6,004	4,998	20%	10	12	1:923
CT	2,174	1,951	11%	30	19	1:1,645
DC	1,180	1,000	18%	35	6	1:578
DE	363	452	-20%	46	34	1:2,626
FL	8,260	6,560	26%	5	31	1:2,496
GA	3,924	3,185	23%	16	35	1:2,627
HI	3,194	2,814	14%	21	5	1:447
IA	563	349	61%	41	38	1:2,987
ID	611	381	60%	39	36	1:2,756
IL	3,718	3,483	7%	17	40	1:3,443
IN	2,700	1,567	72%	28	30	1:2,457
KS	467	282	66%	44	48	1:6,709
KY	1,202	1,002	20%	33	41	1:3,693
LA	2,922	1,974	48%	24	18	1:1,602
MA	14,582	15,095	-3%	2	1	1:304
MD	5,429	4,269	27%	12	9	1:862
ME	572	330	73%	40	27	1:2,329
MI	4,118	2,779	48%	15	28	1:2,411
MN	2,872	1,995	44%	25	23	1:1,922
MO	2,380	1,854	28%	29	32	1:2,561

State	2016 Solar Jobs	2015 Solar Jobs	Year/Year Growth	Solar Jobs Rank	Solar Jobs Per Capita Rank	Ratio of Solar Worker to Overall Workforce
MS	883	560	58%	37	39	1:3,384
MT	168	109	54%	49	47	1:6,204
NC	7,112	5,950	20%	8	16	1:1,427
ND	175	117	50%	48	44	1:4,342
NE	1,585	776	104%	32	15	1:1,203
NH	1,184	731	62%	34	14	1:1,127
NJ	6,056	7,071	-14%	9	17	1:1,477
NM	2,929	1,899	54%	23	8	1:711
NV	8,371	8,764	-4%	4	2	1:351
NY	8,135	8,250	-1%	6	29	1:2,427
OH	5,831	4,811	21%	11	25	1:1,992
OK	814	395	106%	38	46	1:4,819
OR	4,509	2,999	50%	13	11	1:908
PA	3,061	2,498	23%	22	43	1:4,177
RI	1,176	941	25%	36	10	1:898
SC	2,772	1,764	57%	27	20	1:1,790
SD	478	319	50%	43	21	1:1,811
TN	3,548	3,798	-7%	19	22	1:1,875
TX	9,396	7,030	34%	3	37	1:2,965
UT	4,408	2,679	65%	14	7	1:692
VA	3,236	1,963	65%	20	33	1:2,600
VT	1,767	1,367	29%	31	3	1:353
WA	3,681	2,262	63%	18	24	1:1,980
WI	2,813	1,941	45%	26	26	1:2,054
WV	381	349	9%	45	45	1:4,809
WY	152	90	70%	50	42	1:3,841

APPENDIX B

Methodology

The *National Solar Jobs Census 2016* uses primary data collected by the U.S. Department of Energy (OMB Control No. 1910-5179) for its 2017 U.S. Energy and Employment Report (USEER), as well as public and private data sources collected and maintained by The Solar Foundation.

The 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 BLS, this study uses survey questionnaires and employer-reported data, though ours are administered by phone and web, as opposed to mail.

The results from the *Census 2016* are based on rigorous survey efforts that include more than 500,000 telephone calls and over 60,000 emails to known and potential energy establishments across the United States, resulting in a total of 3,888 full completions for establishments involved in solar activity in the U.S. Unlike economic impact models that generate employment estimates based on economic data or jobs-per-megawatt (or jobs-per-dollar) assumptions, the *National Solar Jobs Census* series provides statistically valid and current data gathered from actual employers.

The survey was administered by BW Research Partnership to a *known* universe of energy employers that includes approximately 68,140 establishments and is derived from the Solar Energy Industries Association's *National Solar Database* as well as other public and private sources. Of these establishments, 3,595 identified as solar and completed full or substantially completed surveys.

The survey was also administered to a stratified, clustered, random sampling from various industries that are potentially energy-related (*unknown universe*) that include a total of approximately 410,980 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 approximately 23,000 establishments. Of these, 293 establishments qualified as solar establishments and completed full surveys. The sampling rigor in the known and unknown universes provides a margin of error for establishment counts at +/-0.85% and employment at +/-2.30% at a 95% confidence interval.

The indirect and induced job figures were gathered using averaged figures from Bureau of Economic Analysis RIMS II input output model. The industries selected for installation were electrical contractors and power and communication line construction; for manufacturers, semiconductor equipment manufacturing and other electronic and electrical assembly; for sales and distribution, wholesale trade of electronic appliances and wholesale trade of heating and hot water apparatus; and for project development, heavy civil construction and engineering and power and communication line construction.

TalentNeuron Reference in Methodology

This year's *Census* included data from CEB TalentNeuron™, a source of job market data utilizing aggregated job postings from the Internet. This database was used to extract both the number of new solar-related job postings per quarter (Figures 6 and 11), as well as median salaries (Figures 18 and 19). TalentNeuron accumulates job postings from corporate websites, as well as a wide range of online recruiting sites. Median salaries are calculated based on TalentNeuron's index of salaries advertised in online postings for related jobs in a selected location. With its database of online job postings spanning several years and covering all states, TalentNeuron was used primarily as a tool for examining workforce trends and comparing regional patterns. Since TalentNeuron includes only jobs posted on the web, it omits jobs obtained through word of mouth or advertised by other media.

ENDNOTES

1 Current Employment Statistics for November 1, 2015 to October 31, 2016, BLS, updated January 6, 2017.

2 JobsEQ 2016Q3.

3 *U.S. Energy and Employment Report*, U.S. Dept. of Energy, January, 2016; Unlike the rest of this report, this analysis is based on *U.S. Energy and Employment Report*'s higher 373,807 job count for solar. The higher solar number is used because it matches the report's methodology to determine the employment numbers for other energy industries: "Employees of a qualifying firm that spend some portion of their time supporting the qualifying energy, energy-efficiency, or motor vehicle portion of the business."

4 Interestingly, the proportion of solar jobs in the residential market is much greater in the U.S. Energy and Employment Report (55%). Unlike *Census 2016*, USEER defines an energy worker as an employee that spends some time in the qualifying energy business (see Endnote 3). USEER's higher figure indicates that many residential solar workers work in other fields as well.

5 *Census 2016* wage data based on job postings from CEB TalentNeuron™, a source of job market data utilizing aggregated postings from the web.

6 When including all establishments that are involved in solar work, including those that employ solar workers that spend less than half their time on solar-related activities, the total number of firms is 63,077.

7 Current Employment Statistics for November 1, 2015 to October 31, 2016, BLS, updated January 6, 2017.

8 Based on total solar job growth of 51,218 multiplied by the 80% newly created positions divided by 2.07 million jobs created across the total U.S. workforce.

9 *U.S. Solar Market Insight® Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

10 According to *EIA Electric Power Monthly,* January, 2017 release, total solar generation, based on the 12 months ending November 2016, was about 1.3% of total power generation.

11 *Global Solar Demand Monitor: Q4 2016*, GTM Research, November 29, 2016.

12 The 2016 *Census* covers the 12-month period between November 2015 and October 2016.

13 Other firms include R&D and related services, consulting, engineering, finance, legal, or other professional services and other support services.

14 Growth for the Project Development sector is set to 2012, the first year the category was used.

15 *U.S. Energy and Employment Report*, U.S. Dept. of Energy, January, 2016.

16 *U.S. Energy and Employment Report*, U.S. Dept. of Energy, January, 2016, page 14.

17 *U.S. Solar Market Insight® Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

18 *U.S. Solar Market Insight® Solar Market Insight Report Series, 2010–2016*, GTM Research, A Wood Mackenzie Business/SEIA.

19 *Levelized Cost of Energy Analysis 10.0,* Lazard, December 2016. LCOE is based on the levelized cost of energy, on a $/MWh basis, that would provide an after-tax IRR to equity holders equal to an assumed cost of equity capital. For crystalline utility-scale solar PV projects, a 7-year average percentage decrease of 85% was observed in the unsubsidized levelized cost of energy (LCOE). The solar costs were comparable with natural gas, the lowest fossil fuel costs. Also see: *Economic Competitiveness of U.S. Utility Scale Photovoltaics Systems in 2015*, National Renewable Energy Laboratory, 2015.

20 *U.S. Solar Market Insight® Solar Market Insight Report Series, 2010–2016*, GTM Research, A Wood Mackenzie Business/SEIA; from 2010 to 2014 costs were capacity weighted average installed costs. Since 2014 they have used a bottoms-up cost model to calculate representative prices based on specific system characteristics.

21 *U.S. Solar Market Insight® Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA. Utility fixed-tilt: $1.09/W and single-axis tracking: $1.21/W.

22 These figures are based on a modeled system for residential development.

23 *U.S. Solar Market Insight® Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA. Costs are based on a modelled system for each segment. They represent averages that vary considerably among states and regions. Soft costs comprise of labor, engineering, permitting, interconnection, inspection, supply chain, overhead, and margin.

24 *U.S. Solar Market Insight® Solar Market Insight Report Series, 2010–2016*, GTM Research, A Wood Mackenzie Business/SEIA.

25 There remains significant overlap across many of these sectors; however, the industry is becoming more specialized and each year there is less reported overlap, especially among larger employers.

26 For the *Census,* establishments identified which sector applies to them and then the *Census* counts all of that establishment's employees as belonging to that sector. Sectors include installation, manufacturing, sales and distribution, project development, and other.

27 Source: The Solar Foundation. This calculation is based on the U.S. Bureau of Economic Analysis RIMS II model for the specific NAICS clusters that employ solar workers. The calculation is largely comprised of induced impacts, with a small amount of indirect employment for those segments of the value chain that are not included in the survey, such as raw materials.

28 Values displayed are with "DK/NA" responses factored out.

29 Values displayed are with "DK/NA" responses factored out.

30 *How Diversity Can Drive Innovation,* Harvard Business Review, December 2013.

31 *U.S. Energy and Employment Report*, U.S. Department of Energy, January 2016.

32 SunLink is a California Bay Area firm that designs, manufactures and delivers racking systems, combiner boxes, and wire management tools. They also develop software.

33 Most utility-scale installation jobs are tracked in the project development section of this report. Project development includes employment that works only on (or predominantly on) large scale systems such as those owned or operated by utilities. However, installers who work on different sizes and types of installations are included here.

34 *U.S. Solar Market Insight®Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

35 *U.S. Solar Market Insight® Solar Market Insight Report Series, 2010–2016*, GTM Research, A Wood Mackenzie Business/SEIA.

36 *Ibid.*

37 Job postings related data is from CEB TalentNeuron™, a source of job market data utilizing aggregated postings from the web.

38 This installation category is based on searches conducted by The Solar Foundation in the CEB TalentNeuron™ database, and includes installers as well as site surveyors, site managers, site supervisors, heavy equipment operators, carpenters hired for solar work, construction foremen, site superintendents, general labor, and electricians.

39 Based on online job postings data extracted by The Solar Foundation from CEB TalentNeuron™.

40 *U.S. Solar Market Insight®Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

41 *Ibid.*

42 *Ibid.*, In offsite projects where the power is sold wholesale to the utility, the development is counted as utility-scale development.

43 *Solar + Storage Jobs, A Discussion Paper,* The Solar Foundation. Based on 137,133 installation jobs in 2016 divided by expected 2016 residential and commercial installed capacity of 3,948 MW. Utility-scale MWs are excluded since the related installer employment is counted in project development.

44 *U.S. Energy and Employment Report,* U.S. Dept. of Energy, January, 2016.

45 *Solar + Storage Jobs, A Discussion Paper,* The Solar Foundation, July, 2016; The jobs include associated installation support jobs, but exclude related manufacturing, sales, and distribution jobs.

46 *Battery Cell Production Begins at the Gigafactory,* Tesla Blogpost, January 4, 2017.

47 *Tesla and Panasonic Will Begin Manufacturing Solar Cells and Modules in Buffalo, NY*, Tesla Blogpost, December 16, 2016.

48 Source for national statistics: 2016 annual U.S. BLS estimates available at: *http://www.bls.gov/cps/cpsaat18.htm, http://www.bls.gov/cps/demographics.htm#age.*

49 According to the BLS, manufacturing wages averaged $20.68/hr. in December 2016. Full-time manufacturing workers make 12% more on average than the full-time workforce as a whole. *The Pay Premium for Manufacturing Workers as Measured by Federal Statistics,* Economics & Statistics Administration, U.S. Dept. of Commerce, October 2, 2015.

50 *The Case for a National Manufacturing Strategy,* The Information Technology & Innovation Foundation (ITIF), April 2011.

51 *Ibid.*

52 *National Solar Jobs Census 2015,* The Solar Foundation.

53 *Key Solar Location Manufacturing Trends in 2016,* PV Tech, January 9, 2017.

54 *U.S. Solar Market Insight® Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

55 *U.S. Solar Market Insight® Solar Market Insight Report Series, 2010–2016*, GTM Research, A Wood Mackenzie Business/SEIA.

56 *Ibid.*

57 The North American Industry Classification System (NAICS) is the official standard used by U.S. statistical agencies to classify business establishments when collecting, analyzing, and publishing statistical data related to the U.S. Economy.

58 JobsEQ 2015Q3 – 2016Q3 Projected.

59 Source for national statistics: 2015 annual estimates from *http://www.bls.gov/cps/cpsaat18.htm, http://www.bls.gov/cps/demographics.htm#age.*

60 JobsEQ 2015Q3 – 2016Q3.

61 This "solar sales" category is based on search criteria in the CEB TalentNeuron™ database, and includes jobs in the solar industry defined as "Sales and Related Occupations" by the Bureau of Labor Statistics.

62 Based on online job postings data extracted from CEB TalentNeuron™.

63 Source for national statistics: 2015 annual estimates from *http://www.bls.gov/cps/cpsaat18.htm, http://www.bls.gov/cps/demographics.htm#age.*

64 *U.S. Solar Market Insight® Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

65 *U.S. Solar Market Insight® Q3 2015 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

66 2012 was the first year that project developers were counted as a separate category.

67 Source for national statistics: 2015 annual estimates from *http://www.bls.gov/cps/cpsaat18.htm, http://www.bls.gov/cps/demographics.htm#age.*

68 *Why Solar Stocks were Crushed in 2015 and What's Ahead for 2016*, Motley Fool, January 10, 2017.

69 *What the Hell is Going on with Plummeting Solar Stocks?,* GTM Research, October 26, 2016.

70 *The Rise of the Regional Solar Installer*, GTM Research, June 22, 2016.

71 *U.S. Solar Market Insight®Q4 2016 Report*, GTM Research, A Wood Mackenzie Business/SEIA.

72 Studies by the Rocky Mountain Institute concluded that soft costs for residential PV systems in the US are roughly twice the amount of Australia's and four times the amount of Germany's. These soft costs are respectively $1.22, $0.65, and $0.33 per Watt installed. Available at *http://www.rmi.org/simple#simplebosform*.

73 *White Paper: Solar Panels Last 25 Years—But Will They Stay Safely Attached to Your Roof? The Importance of Reliable Solar Mounting Systems*, 2014. Available at *http://cinnamonsolar.com/wp-content/uploads/2013/05/The-Importance-of-Reliable-Solar-Mounting-Systems-White-Paper_March-2014-copy.pdf* .

74 Assuming 30,000 installations in a year.

75 Percentages displayed with "DK/NA" factored out.

76 This category includes installers as well as site surveyors, site managers, site supervisors, heavy equipment operators, carpenters hired for solar work, construction foremen, site superintendents, general labor, and electricians.

77 From advertised salaries on job postings extracted by The Solar Foundation via CEB TalentNeuron™.

78 *Ibid.*

79 Taken as a proportion of new hires over the last 12 months.

80 *Maryland Solar Jobs, Observations and Analysis of Underserved Populations,* The Solar Foundation, October 2015.

81 *50 States of Solar: Q3 2016 Quarterly Report,* North Carolina Clean Energy Technology Center, October 2016.

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