2017

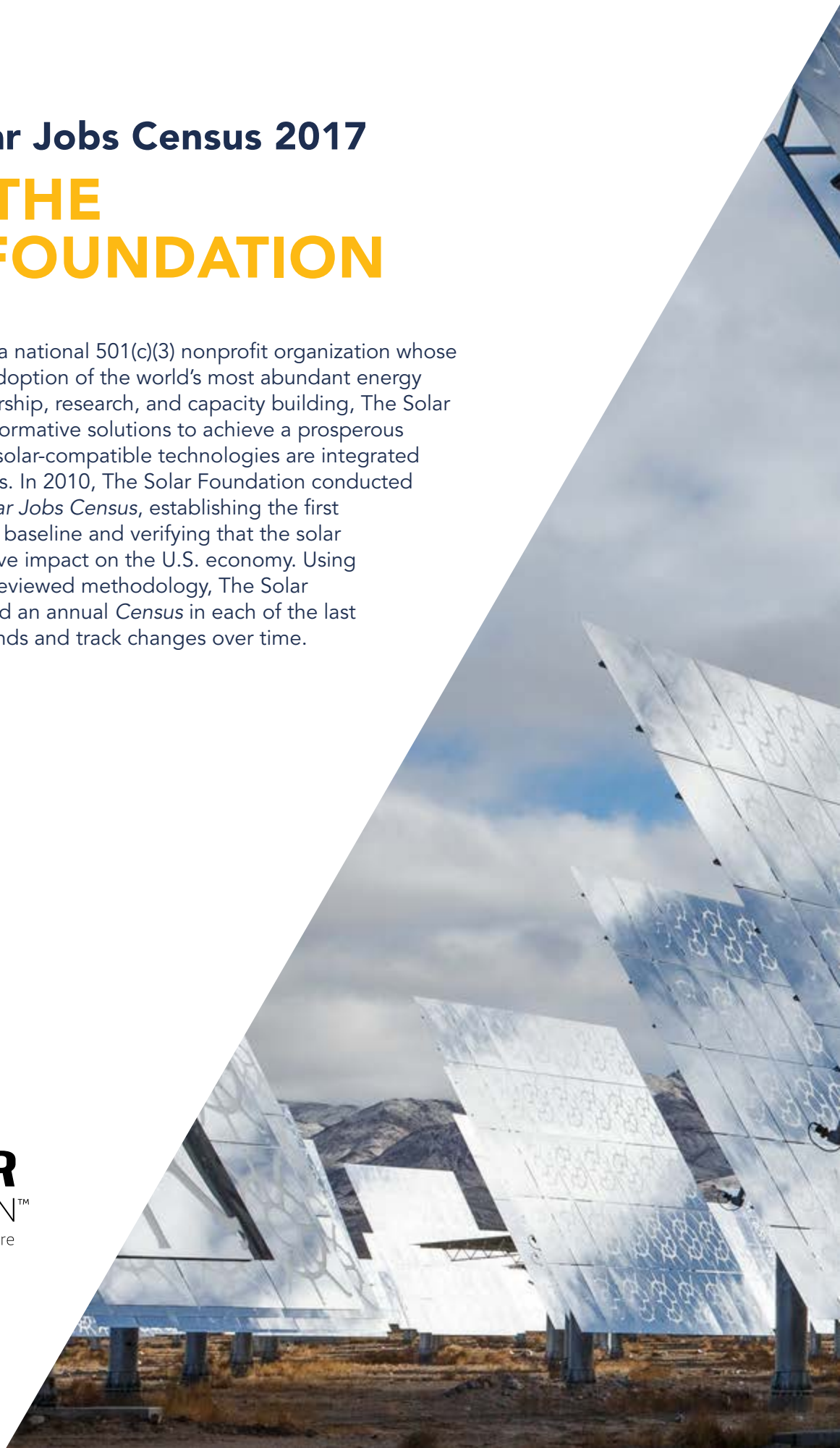
NATIONAL SOLAR JOBS CENSUS

The SOLAR FOUNDATION™
for a bright future

National Solar Jobs Census 2017

ABOUT THE SOLAR FOUNDATION

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



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Unless otherwise indicated, all solar jobs data for 2010-2017 derive from The Solar Foundation's *Census* report series.

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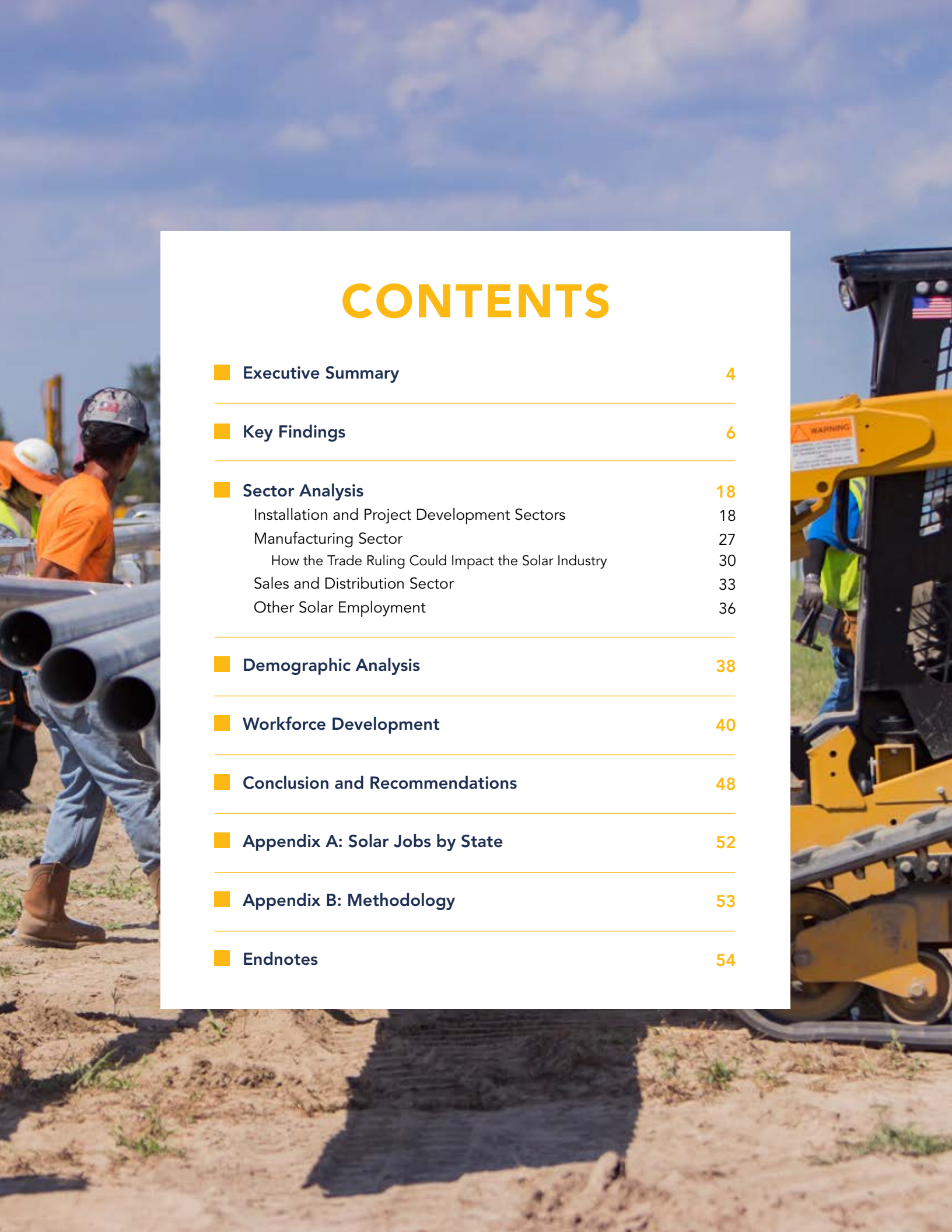

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EXECUTIVE SUMMARY

The Solar Foundation's *National Solar Jobs Census 2017* is the eighth annual report on current employment and trends in the U.S. solar industry, nationwide and state by state. To keep pace with the industry's rapid transformation, The Solar Foundation conducts rigorous surveys of employers each year on recent solar workforce trends and the outlook for the future.

This year's *Solar Jobs Census* found that solar employment experienced its first decline since The Solar Foundation began tracking jobs in 2010. As of November 2017, the solar industry employs 250,271 solar workers, representing a decline of 3.8%, or about 9,800 fewer jobs, since 2016. Importantly, the long-term trend for U.S. solar jobs has been very strong. Solar employment since 2010 has grown by 168%, from just over 93,000 to more than 250,000 jobs in all 50 states.

Key factors behind the decline in solar jobs from 2016 to 2017 include:

- A slowdown from the record-setting industry expansion seen in 2016. Installed capacity doubled between 2015 and 2016 in anticipation that the 30% federal investment tax credit would expire. In 2017, solar installations continued at a more moderate pace.
- Policy and economic challenges led to job declines in well-established solar states, such as California.
- Uncertainty over the outcome of the Section 201 trade case and its impact on the U.S. solar market.

This report includes up-to-date information on solar jobs by industry sector, state by state, and within demographic groups, as well as employer predictions on future job growth. Other major findings on the U.S. solar workforce, as of November 2017, are as follows:

- **Despite losses in states with well-established markets, 29 states and the District of Columbia saw solar job growth, including many states with emerging solar markets.** States that experienced significant gains in employment include Utah (+1,762 jobs), Minnesota (+1,383), Arizona (+1,070), New Jersey (+1,050), New York (+877), and Tennessee (+863).
- **The states that experienced the largest job reductions between 2016 to 2017 are California (-13,636 jobs), Massachusetts (-3,053), and Nevada (-1,807).** California, home to about 40% of U.S. solar capacity, has traditionally been the largest solar job generator. Massachusetts still ranks second to California in total solar jobs.
- **Long-term solar jobs growth remains strong.** In the five-year period between 2012 and 2017, solar employment grew by 110% overall or 16% annually, adding 131,000 jobs.

- **Over the last five years, solar employment grew nine times faster than the 1.76% annual growth of the U.S. economy.** During this period, one in every 100 new jobs was a solar job.
- Solar represents just under 2% of overall U.S. energy generation, yet it employs twice as many workers as the coal industry, three times that of wind energy, and almost five times the employment in nuclear energy. Solar employs almost as many workers as the natural gas industry, which represents 32% of electricity generation.[1]
- **Demand-side sectors (installation, sales & distribution, and project development) make up almost 78% of overall solar industry employment, while manufacturing represents 15%.** Demand-side sectors lost about 7,500 jobs in 2017, while manufacturing lost about 1,200 jobs.
- Prior to the final decision in the Section 201 trade case, respondents to the *Census* survey predicted that total U.S. solar industry employment would reach about 263,293 jobs by the end of 2018, a 5.2% increase year-over-year.

In addition to this overall employment data, the *Solar Jobs Census* includes detailed information on other aspects of the solar workforce, including the likely impacts of the trade case; diversity in solar industry employment; employer difficulty hiring; median industry wages; and educational requirements.

The solar trade case has caused significant industry uncertainty, and most solar companies predicted negative impacts from tariffs. In response to the *Census* survey administered during October and November 2017, 86% of solar companies indicated that if trade restrictions were imposed, their businesses would be impacted negatively. Moreover, 71% of all solar companies said they had already felt negative effects from the case in 2017, likely due to the uncertainty over the final decision. Since the decision on the trade case was not announced until January 2018, these responses reflect ambiguity over its impacts but not the final outcome.

The solar industry is more diverse than comparable industries, but more needs to be done to ensure it is representative of the greater U.S. population. In 2017, women represented 27% of the solar workforce, down 1% from 2016. In 2017, the solar industry employed slightly more Asian and African American workers than in 2016. However, more solar employers are tracking employee diversity. About 35% of employers track new and existing employee gender, ethnic, and racial diversity, and/or veteran status, an 8% increase from the 27% of employers that tracked this information around six months earlier.

Eighteen percent of solar employers reported that it was very difficult to find qualified candidates to fill open positions, a decrease from 22.7% reporting such challenges in 2016. Employers located in states with emerging, rapidly growing solar markets reported more hiring difficulties. For example, in Minnesota, where solar jobs grew by 48% and installed capacity rocketed, 33% of employers reported that it was very difficult to find qualified employees.

Experience remains the most important hiring requirement for all sectors, with 55% of solar establishments requiring experience. That number dropped from 65% requiring experience in 2016. The number of solar locations requiring bachelor's degrees also dropped. In 2017, 21% of solar locations required a bachelor's degree for new hires, a decrease from 32% in 2016.

Solar industry wages remain competitive with similar industries and above the national average. The median reported wage for mid-level installer positions for both installation and project development companies is $21 per hour. For installation companies alone, the median mid-level installer wage is $20, and for project development companies, the median wage is $25. The median wages for supervisory roles in the installation and project development sectors are $30 and $38, respectively. The median wage for a mid-level assembly or production worker in the manufacturing sector is $20, increasing to $30 for supervisors or foremen.*

* Wage information for the 2016 *Census* was gathered from TalentNeuron, an online aggregator of job postings. As a result, median wages cited in last year's report used salary information included in job postings. This year, median wages were reported by establishments responding to the survey. Because of this difference in data sources, the wage numbers differed significantly between the 2016 and 2017 reports.

KEY FINDINGS

The *National Solar Jobs Census 2017* is The Solar Foundation's eighth annual review of the size and scope of employment in the U.S. solar energy industry. It represents the most comprehensive and rigorous analysis of solar labor market trends in the United States.

This year's *Census* includes data gathered between October and November 2017 from known and potential solar energy establishments or locations.* The combined survey effort included approximately 59,300 phone calls and over 35,000 emails. Information was gathered from 2,389 establishments, of which 1,842 completed or substantially completed the survey. This level of sampling rigor provides a margin of error of +/-1.25% for the national employment numbers.

The Solar Foundation applies a rigorous test in counting solar jobs across the United States. Since 2010, The Solar Foundation has defined a solar job as one held by a worker spending at least 50% of his or her time on solar-related work. *Census* findings have consistently shown that roughly 90% of these workers (89% in 2017) spend 100% of their time on solar-related work.†

As of November 2017, the solar industry supports 250,271 jobs at 29,761 locations, a decrease of 3.8%, or about 9,800 fewer jobs, over the past 12 months. This decline represents the first time that solar employment has dropped since The Solar Foundation began conducting the *Census* in 2010.

While this reduction deserves attention, it is important to remember that the long-term trend for U.S. solar jobs has been very strong. Consider these key facts:

- From 2010 to 2017, solar employment grew by 168%.
- In the five-year period between 2012 and 2017:
  - Solar employment grew by 110% overall or 16% annually, adding a net of 131,000 jobs.‡
  - By comparison, U.S. employment grew by 1.76% annually during that time period.
  - Solar employment grew approximately 9.1 times faster than employment in the overall U.S. economy.[2]
  - Solar growth accounted for 1.08% of the 12 million jobs added by all U.S. businesses, equal to one in every 100 new U.S. jobs.§
- With about 50 gigawatts (GW) of total capacity nationwide, solar energy comprises 1.9% of total U.S. electricity generation.[3]

The slowdown in solar jobs in 2017 was primarily caused by three factors. First, the solar industry experienced a recoil from its 2016 installation binge. Installed capacity doubled between 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 utility-scale projects, were already well into the development process. Therefore, 2016 saw an explosion of utility-scale solar development and related employment growth. The decline in 2017 was expected following this unprecedented boom in utility-scale solar installations.

In 2017, installers throttled back to a more moderate level of activity. The most recent *U.S. Solar Market Insight®* report found that compared to the record 15.1 GW of installed capacity in 2016, only 11.8 GW were expected to come online in 2017, representing a 22% decline in installed capacity.¶ As a result, fewer workers were needed to complete the installations. Nonetheless, expected 2017 installations are still almost 13 times greater than the 929 MW installed in 2010, and well above the 7.5 GW installed in 2015 or any previous year.[4]

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

† 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 jobs is 349,725.

‡ Compound annual growth rate

§ Based on 131,254 growth in solar jobs divided by 12.1 million growth in total U.S. jobs.

¶ Final installed capacity numbers for 2017 are not yet available. As of this writing, the most recent *U.S. Solar Market Insight* report covers through the end of Q3 2017.

Second, 2017 brought major job losses in states with well-established solar markets. The states that experienced the largest job reductions from 2016 to 2017 were California (-13,636 jobs), Massachusetts (-3,053), and Nevada (-1,807). However, other states saw solar jobs significantly increase, including in many regions where the solar industry is only beginning to gain a foothold. States that experienced gains in employment included Utah (+1,762 jobs), Minnesota (+1,383), Arizona (+1,070), New Jersey (+1,050), New York (+877), and Tennessee (+863). Overall, employment grew in 29 states and the District of Columbia, down from the 44 states that experienced growth in 2016.

A table listing solar jobs in all 50 states, along with the gains or losses from 2016, can be found in Appendix A. In March 2018, The Solar Foundation will release more detailed state jobs data, as well as local data for counties, metropolitan areas, and congressional districts, on the interactive Solar Jobs Map at SolarStates.org.

California, which is home to about 40% of U.S. solar capacity and grew by a staggering 24,500 jobs in 2016, has traditionally been the largest solar job generator. But a combination of factors, including rainy weather, changing industry business models, and policy uncertainty, have stymied the market (see box, page 20). If California were removed from the 2017 *Census*, the nation would have experienced solar job growth.*

The third likely factor contributing to the job loss was concerns over a case filed in April by two solar manufacturers under Section 201 of the 1974 Trade Act. The petitioners sought an increase in tariffs for imported solar modules and cells. On January 22, 2018, the Trump administration set tariffs for modules and cells at 30%. (See page 30 for a more detailed discussion of the trade case.)

Although the *Census* survey was conducted while the trade case decision was still pending, most (71%) *Census* respondents reported that the case negatively impacted them in 2017. Many in the industry reported that the tariffs would increase the cost of panels and suppress sales and employment, particularly in the demand-side sectors of the industry (installation, project development, and sales & distribution). Solar manufacturers also predicted a negative impact, most of which do not manufacture panels or modules. Most (86%) manufacturing firms reported they expected negative impacts from the trade case decision.

Sector Trends

In addition to national job numbers, the *Solar Jobs Census* reports on jobs by industry sector, including installation, manufacturing, sales & distribution, project development, and "other."† Installation companies were responsible for most of the jobs lost within the 12-month *Census* analysis period between November 2016 and October 2017. Of the approximately 9,800 jobs lost, installers shed 7,700 jobs, or 5.62% of their workforce, as shown in Table 1. The manufacturing and sales & distribution sectors each lost just over 1,200 jobs, and the "other" category (which includes research & development, finance, and other miscellaneous sectors) lost just under 1,000 jobs.‡

Those companies that self-identify as operating within the project development sector gained 1,350 jobs. This sector corresponds to the utility-scale segment of the market, which is projected to have experienced a large decline in installed capacity in 2017.[5] Several factors likely explain the contradiction between declining utility-scale deployment and project development job growth. First, project development jobs typically reach their highest levels during the fourth quarter, when the *Solar Jobs Census* survey is administered. Second, engineering, procurement, and construction (EPC) firms that predominately install solar for project developers may self-identify as part of the installation sector. If their workforce declines, this change would then register as a decline in the installation sector rather than in project development. Finally, many of the project development jobs anticipate future utility-scale construction, as employees are needed for preparatory work months to years in advance.

To correct for potential survey biases between installation and project development, we combined these two sectors for the purposes of the sector analysis section of this report (page 18). The combined category lost 6,400 jobs, or 3.7% of its workforce, in 2017.

* However, by removing California, there would have been much lower growth in previous years. For example, in 2016, California represented almost half of the 51,000 new solar jobs added nationwide that year.

† An industry sector refers to the type of solar *establishment* rather than individual employees; for example, a sales representative at a solar installation firm would be classified within the installation sector.

‡ The main types of firms included in the "other" category include research & development and related services, consulting, engineering, finance, legal, and other professional and support services.

Table 1: Solar Employment by Sector

SECTOR	2017 EMPLOYMENT	% TOTAL EMPLOYMENT	% GROWTH 2016-2017	% GROWTH 2010-2017
Installation	129,424	51.7%	-5.62%	194.59%
Manufacturing	36,885	14.7%	-3.24%	48.04%
Sales & Distribution	30,912	12.4%	-3.84%	163.22%
Project Development	35,750	14.3%	3.92%	347.54%
All Others	17,300	6.9%	-5.33%	34.03%
Total	250,271		-3.77%	167.66%

NOTE: *For the Project Development sector, percent growth is between 2012-2017, as this category was added in 2012.*

Long-Term Trends

As solar energy has taken hold in the United States, the jobs market has expanded rapidly. The most significant growth has taken place in the installation and sales & distribution sectors. From 2010 to 2017, employment in the installation sector grew by 195% while sales & distribution grew by 163%, as shown in Table 2 and Figure 1 (page 9). Manufacturing jobs grew by 48%, and the "other" sector grew by 34%. Project development employment, which the *Census* began counting in 2012, has more than tripled in size over the ensuing five years.

Table 2: Solar Energy Sector Employment, 2010-2018 (Projected)

SECTOR	2010	2011	2012	2013	2014	2015	2016	2017	2018 (PROJECTED)
Installation	43,934	52,503	57,177	69,658	97,031	119,931	137,133	129,424	137,457
Manufacturing	24,916	24,064	29,742	29,851	32,490	30,282	38,121	36,885	37,275
Sales & Distribution	11,744	17,722	16,005	19,771	20,185	24,377	32,147	30,912	32,450
Project Development	n/a	n/a	7,988	12,169	15,112	22,452	34,400	35,750	37,621
All Others	12,908	5,948	8,105	11,248	8,989	11,816	18,274	17,300	18,490
Total	93,502	100,237	119,017	142,697	173,807	208,859	260,077	250,271	263,293

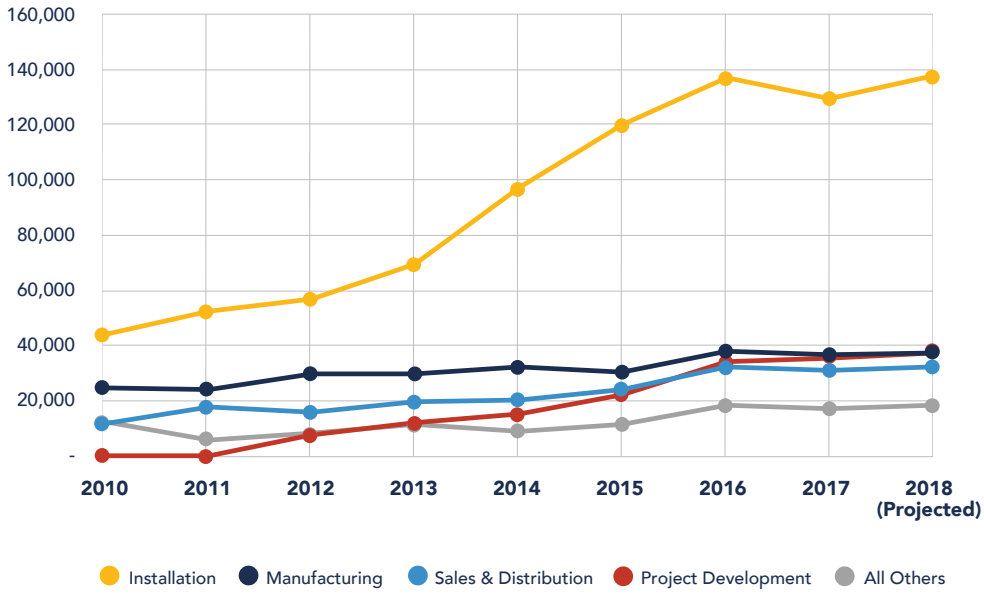
NOTE: *Projections are based on survey responses submitted prior to the trade case decision.*

INTERNATIONAL SOLAR TRENDS

Globally, solar experienced another year of steady cost declines and capacity growth. GTM Research estimates that global solar deployment was around 100 GW in 2017 alone.[6] In particular, China experienced a solar boom, with estimates that the country installed between 50 GW and 60 GW—more than half of 2017 global capacity additions—as its government shifts to cleaner sources of power.[7] This total is four times the amount of solar expected to have been installed in the United States in 2017.[8] In other markets, competitive auctions proliferated and drove deployment.[9]

Globally, the weighted levelized cost of electricity for utility-scale solar fell to $0.10 per kWh for projects commissioned in 2017, though several projects came in as low as $0.02/kWh.[10] A December 2017 auction in Mexico resulted in a low bid of 1.92 cents per kilowatt hour (kWh) of electricity, one of the lowest in the world.[11] Record-low solar prices were also set via auctions in the United Arab Emirates, Peru, Chile, and Saudi Arabia.[12] These rates put solar generation firmly on par with fossil fuel energy sources, making it an ideal choice for emerging economies.

Figure 1: Solar Employment Growth, 2010-2018 (Projected)

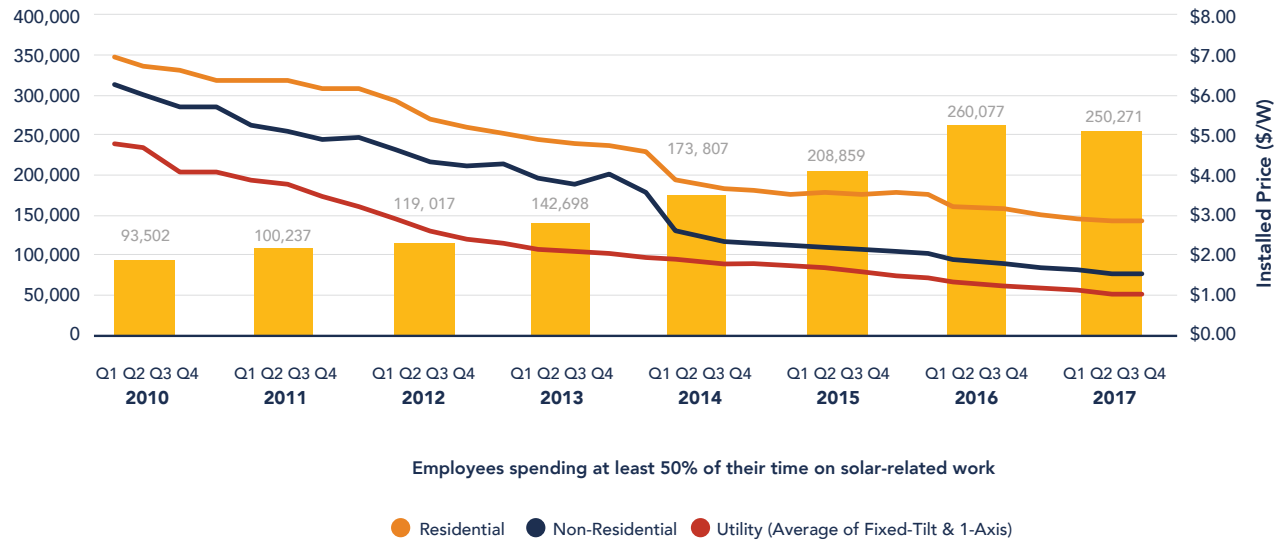


NOTE: *Projections are based on survey responses submitted prior to the trade case decision.*

This job growth was primarily driven by the falling costs of solar energy, especially materials (or "hard costs"). Since 2010, modeled national photovoltaic (PV) installed price estimates have declined by nearly 56% for residential installations, 73% for non-residential or commercial systems, and 74% for utility-scale projects, as shown in Figure 2.* Unsubsidized utility-scale development is at or below cost parity with new fossil fuel generators in some locations.[13] Other factors, such as price consistency, climate impact, shareholder demands, and national security also stimulate growth. Policies such as the federal investment tax credit, accelerated depreciation, state renewable portfolio standards (RPSs), solar renewable energy credits (SRECs), the Public Utility Regulatory Policies Act (PURPA), and net energy metering support the vibrant U.S. solar power market.

* Using the *Solar Market Insight* report series, 2010-2017, this compares Q3 2010 to Q3 2017. In 2014, the reporting switched from capacity-weighted average installed costs to modeled national PV installed price estimates with component costs in 2014. The prices are based on a 6 kW residential system, a 100 kW rooftop, and a 10 MW utility-scale system. Residential systems are typically less than 15 kW, averaging about 7 kW, and are located on-site at a home and share the home's connection to the distribution grid. Non-residential systems range from 10 kW to 5,000 kW (5MW), average about 100 kW, are located on-site at a business, school, nonprofit, or government facility, and share that facility's connection to the distribution grid. Utility-scale systems range from 1 MW – 500 MW, average about 12 MW, and are typically interconnected with the transmission grid.

Figure 2: Installed Solar PV Costs by Segment Compared to Solar Employment Growth, 2010-2017



TAX REFORM

In December 2017, President Trump signed a federal income tax bill that lowered the corporate tax rate from 35% to 21%, the lowest rate in nearly 80 years.

The specifics of the new law are a mixed bag for solar companies, and many of its impacts remain unclear. While the tax code retains the Investment Tax Credit (ITC) unaltered from its late 2015 amendments, the tax legislation changes other federal income tax deductions and key accounting rules. This includes a new tax on the very class of large taxpayer that is most critical to the solar industry capital markets, namely, the tax equity investor. A lower federal corporate tax rate, generally considered good for business, now makes tax benefits obtained from a tax equity investment less economically valuable.

Specifically, a new tax known as the Base Erosion Anti-Abuse Tax (BEAT) will be imposed on international taxpayers meeting certain technical tax rules. This general class of investors includes international financial institutions and banks that make up a notable portion of the U.S. solar tax equity investor pool.

Separately, another new rule strictly limits the ability of businesses to deduct the interest paid on debt. Congress did provide a $25 million small business exemption, but the new law expressly provides that the exemption is not available to certain categories of solar partnerships where investor limited partners receive a specific level of tax benefits. As a result, many solar partnerships will be forced to delay realization of large tax deductions for interest costs. Thus, this rule places a new economic burden on both new and existing solar deals over the term of the loan.

These and other provisions in the new law are anticipated to have negative ramifications for the tax equity market, although the extent of these impacts remains to be seen. Historically, tax equity provides about 40% to 50% of financing for solar projects, which totaled $4 billion in 2017. A leading tax equity investor, J.P. Morgan, estimates that this total could drop by about 3% in 2018, though early signs suggest that the hit could be worse.[14] Just two weeks into the tax law's existence, up to $3 billion in tax equity deals for wind and solar were reported to be on hold.[15]

Nonetheless, taxpayers who are not tax equity investors, and directly own solar assets for use in a trade or business, may be exempted from some of the negative impacts and may benefit from the bonus depreciation. Also, while individual homeowners cannot claim depreciation on their Residential Energy Efficient Property Credit (25D) tax-credit-eligible solar systems, they can still get full value from the tax credit. This, given the loss of state and local tax deductions also under the new law, may indirectly allow these homeowners some one-time tax federal relief due to the 25D credit.

It will be many months, if not a year or more, before the Treasury Department and the IRS issue guidance which might mitigate the impacts described here. It is expected to be even longer before any technical tax correction bill is expected. For now, the combination of the new tax rules and general uncertainty are expected to have a dampening effect on tax equity investment in the solar industry.

Solar Jobs Compared to Other Energy Industries

The solar industry ranks third in total employment among energy industries. The solar workforce is over twice as large as the coal industry, over three times the size of the wind industry, and almost five times the size of the nuclear energy industry workforce. Only the oil/petroleum and natural gas industries have more employment than solar. Oil/petroleum has a 47% larger workforce, and natural gas has 3.5% more workers.[16]

These industry comparisons are based on the 2017 *U.S. Energy and Employment Report*, which tallied jobs in solar and all other energy industries. While the data in this report applies to 2016, rather than 2017, it is the most recent data available for a comparison.*[17]

Looking Ahead to 2018

The survey providing data for this year's *Census* was in the field in Q4 of 2017. On January 23, 2018, President Trump announced tariffs of 30% on imported crystalline silicon solar cells and modules from almost all countries. Analysts from GTM Research, IHS Market, and Bloomberg New Energy Finance expect those tariffs to reduce installations by about 10%. This cutback in installations is expected to reduce employment in the solar industry in 2018.

Prior to the tariff announcement, The Solar Foundation's *Census* survey had suggested that employment growth would resume at a low rate. Survey respondents had predicted that total U.S. solar industry employment would reach about 263,293 jobs by the end of 2018, which would have been a 5.2% increase year-over-year.

In 2018, firms focused on installation had expected to grow by 6.2%, adding just over 8,000 jobs, which is more than any other sector. Project development was expected to grow at a slower rate (5.2%), adding just under 1,900 jobs. Manufacturing was expected to experience about 1% growth, adding almost 400 jobs over the coming year. Sales & distribution and "other" jobs were expected to grow by 5% and 6.9%, respectively.

The predictions for 2018 employment do not reflect the outcome of the case, but rather the industry's shared uncertainty before any decision had been reached. In addition to potential solar tariffs, 2018 growth will be influenced by many unpredictable factors, including economic conditions, the new tax law, access to capital—particularly via the tax equity market—and major policy shifts at the federal and state levels.

In 2018, solar energy development is expected to keep throttling back from its 2016 record year, during which 15.1 GW were installed. New installations are to decline, from about 11.8 GW in 2017 to 10.1 GW in 2018.[18] Most new capacity will continue to come from utility-scale project development, but such deployment will remain slow in 2018. Non-residential solar installed capacity is also projected to decline in 2018.[19]

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* In addition, the *U.S. Energy and Employment Report* uses a definition of an energy job that differs from the *Solar Jobs Census*. An energy job is defined as follows: "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." Based on this definition, the solar industry employed 349,725 workers in 2017. This figure is used because it matches the report's methodology to determine the employment numbers for other energy industries. For the *Census*, The Solar Foundation applies a higher threshold to be considered a solar worker; someone must spend at least 50% of their time on solar-related work.

Solar Industry Characteristics

The *Census* found that the clear majority of U.S. solar firms and jobs (about 95%) are focused on solar PV electric generation. About 15% of firms support renewable heating and cooling, such as solar water heaters, and 6% work on projects related to concentrating solar power. About 7% of firms also support "other" technologies, with storage cited as the most frequent "other" response.*

The project development sector reported the highest gross revenues by establishment, with a median of $5 million per establishment. Manufacturing reported a median of $3 million in revenues, followed by installation ($2 million), sales & distribution ($1.5 million), and "other" ($300,000), as shown in Table 3.

Table 3: Gross Revenues By Sector

	INSTALLATION	MANUFACTURING	SALES & DISTRIBUTION	PROJECT DEVELOPMENT	ALL OTHERS
25th Percentile	$800,000	$850,000	$400,000	$1,000,000	$100,000
Median	$2,000,000	$3,000,000	$1,500,000	$5,000,000	$300,000
75th Percentile	$8,000,000	$14,250,000	$12,000,000	$22,000,000	$1,500,000

The *Census* sector employment numbers are based on what an establishment reports as its primary focus. However, many establishments focus on multiple sectors of the value chain. For example, 20% of manufacturing firms also work in sales & distribution. Another 42% of the firms primarily involved in sales and distribution also work in manufacturing. This figure likely includes U.S. sales & distribution establishments that serve overseas manufacturers. Just over half (52%) of firms primarily focus on installation; however, about a third of these installers also work in sales & distribution, with another third working in project development. Thirty percent of project developers report that they also work on installation, as shown in Table 4.

* The 2017 *Solar Jobs Census* does not include storage jobs, which can be related to other industry sectors in addition to solar. However, some survey respondents noted that they produce storage technologies in addition to other solar products.

Table 4: Focus of Solar Establishments By Value Chain

	FOCUS BY VALUE CHAIN				
	INSTALLATION	MANUFACTURING	SALES & DISTRIBUTION	PROJECT DEVELOPMENT	OTHER
Manufacturing	5%	100%	20%	5%	4%
Research & Development	3%	23%	14%	10%	23%
Sales & Distribution	26%	42%	100%	23%	8%
Installation	100%	18%	34%	34%	14%
Project Development	30%	9%	27%	100%	17%
Consulting, Engineering, Finance, Legal, or Other Services	25%	18%	40%	38%	91%

When asked to characterize their primary customers, 52% of establishments focus on households as their primary customers, followed by 45% that focus on commercial and industrial customers as their primary customers. About 24% of respondents listed solar companies as their primary customers, and 9% focus on bulk electricity markets as their primary customers, as shown in Table 5.

Table 5: Primary Customers of Solar Establishments

PRIMARY CUSTOMERS	PERCENTAGE OF SOLAR ESTABLISHMENTS
Solar Companies	23.7%
Commercial And Industrial Customers (Not Solar Companies)	45.4%
Households	51.6%
Bulk Electricity Markets	9.3%
Other	8.9%

Types of Occupations

The *Census* found that demand-side sectors (installation, sales & distribution, and project development) make up almost 78% of overall solar industry employment, with installation firms accounting for 52% of the total solar workforce. In contrast, the manufacturing sector comprised only 15% of U.S. solar jobs. When comparing employment by *occupational category* rather than by industry sector, about 37% of all solar employment is reported to be in administrative, management, and professional positions. Twenty-seven percent of jobs were found to be in installation and repair positions, 7% were in manufacturing positions, and 22% were in sales positions.*

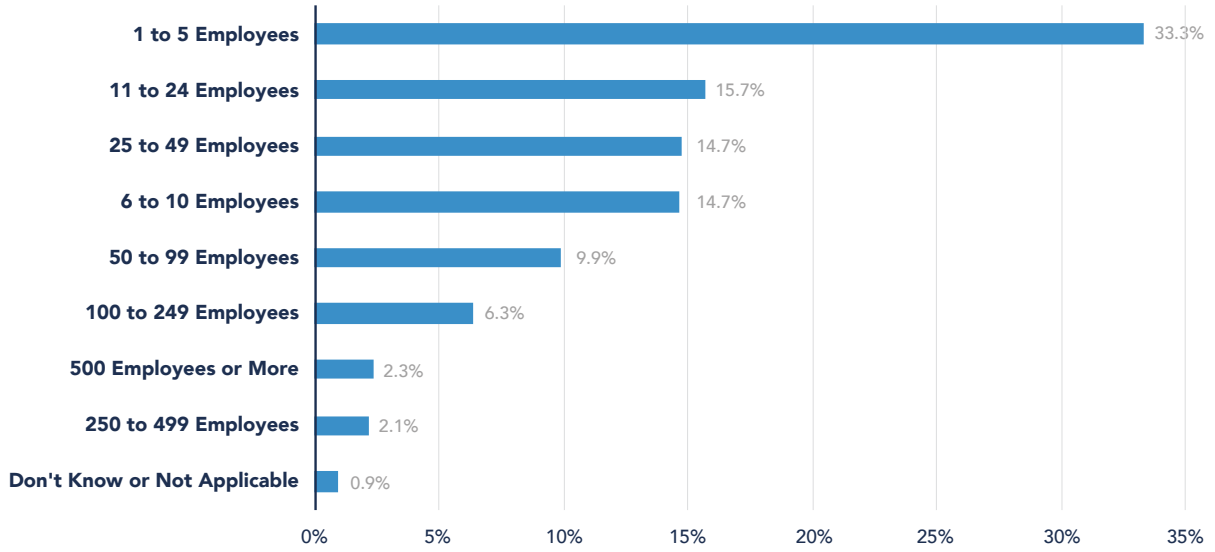
* For the *Census*, establishments identified their primary sector. Establishment employees that work at least 50% of their time on solar were counted in the sector.

Table 6: Solar Workers by Occupational Category

	PRODUCTION OR MANUFACTURING	INSTALLATION OR REPAIR	ADMINISTRATIVE	MANAGEMENT OR PROFESSIONAL	SALES	OTHER
Manufacturing	32.4%	12.4%	15.1%	13.5%	13.8%	12.8%
Sales & Distribution	10.4%	20.1%	27.5%	14.1%	21.3%	6.6%
Installation	1.2%	35.2%	20.1%	12.6%	26.5%	4.3%
Project Developers	1.4%	27.3%	15.6%	27.9%	18.7%	9.2%
Other	4.0%	9.3%	14.2%	45.6%	9.9%	17.0%
Overall	**7.2%**	**27.1%**	**19.2%**	**17.4%**	**21.7%**	**7.4%**

The *Census* survey also found that most establishments (78%) have fewer than 50 employees. About a third of establishments have five or fewer employees, while another 15% have six to 10 employees (Figure 3). Only 2.3% of establishments have over 500 employees. Most solar jobs (77%) focus on products that are widely commercially available. About 20% of jobs also relate to products that are under development, and 3% primarily work on products that are under development. When viewed by sector, most installation jobs (90%) focus on widely commercially available products, while manufacturing jobs are more balanced between products under development and those that are widely commercially available.

Figure 3: Permanent Employees By Location



Supply Chain Analysis

Most installation (63%) and project development (60%) establishments report their customers are located primarily within their state. Sales & distribution firms also predominately serve in-state customers (55%). In contrast, most manufacturing customers (61%) are primarily outside the facility's state, and 10% of establishments report customers that are primarily international. Since 2016, the proportion of in-state customers declined for all sectors. Across the industry, more and more primary customers are located in another state.

Table 7: Primary Customer Location by Value Chain

	IN-STATE	IN A BORDERING STATE	IN THE UNITED STATES, BUT OUTSIDE OF A BORDERING STATE	OUTSIDE OF THE UNITED STATES
Installation	62.66%	2.87%	34.20%	0.26%
Manufacturing	24.10%	4.82%	61.45%	9.64%
Sales & Distribution	54.76%	5.95%	36.90%	2.38%
Project Development	60.16%	7.81%	31.25%	0.78%
Other	46.53%	5.31%	44.08%	4.08%
Overall	54.50%	4.40%	38.80%	2.20%

NOTE: *Values displayed are with "Don't Know or Not Applicable" responses factored out.*

Just over a quarter of solar firms (27.5%) identified their primary vendors as in-state. About 15% primarily acquire goods and services from overseas vendors, with the remaining vendors located in other states. From 2016 to 2017, the proportion of firms that identified their primary vendors as out-of-state increased from 43% to 51%, and international vendors increased from 6% to 14%. Within two sectors—installation and project development—30% of firms identified their primary vendors as being located in-state, with most of their remaining vendors in other states. Only about 5% of installation establishments primarily purchase from overseas vendors. In contrast, 33% of sales & distribution establishments and 27% of manufacturers reported that their primary vendors are located overseas.

Table 8: Primary Supplier and Vendor Location by Value Chain

	IN-STATE	IN A BORDERING STATE	IN THE UNITED STATES, BUT OUTSIDE OF A BORDERING STATE	OUTSIDE OF THE UNITED STATES
Installation	30.27%	9.19%	55.41%	5.14%
Manufacturing	14.63%	3.66%	54.88%	26.83%
Sales & Distribution	21.76%	7.69%	37.18%	33.33%
Project Development	30.36%	3.57%	45.54%	20.54%
Other	38.43%	4.32%	43.08%	14.17%
Overall	27.50%	7.05%	50.81%	14.64%

NOTE: *Values displayed are with "Don't Know or Not Applicable" responses factored out.*

TO REBUILD PUERTO RICO'S GRID, LOOK TO SOLAR AND STORAGE

In the aftermath of several devastating hurricanes in the fall of 2017, the potential for solar energy as a clean, resilient, and flexible power source has come into the spotlight. In Puerto Rico, several months after Hurricane Maria, nearly half of the island's residents remained without power. And despite Puerto Rico's vast solar potential, renewable sources made up only about 2% of the island's electricity in 2016.[20] After the hurricane, numerous solar companies and organizations, including The Solar Foundation, took part in efforts to donate solar panels and solar and storage to the relief effort.

As the island rebuilds, the Puerto Rico Energy Commission requested advice on the future of its energy system, and 53 groups and companies responded.[21] The energy storage company AES submitted a proposal for a network of "mini-grids" that could range in size from a few megawatts to a system large enough to power the city of San Juan. Currently, fossil fuels are shipped to Puerto Rico, resulting in extremely high electricity prices. According to calculations cited in the AES proposal, island-based utility-scale solar installations over 50 MW could cost between $40 and $50 per MWh, significantly less than power coming from the island's fossil fuel plants before the hurricane.[22] A new energy system that incorporates solar and microgrids could not only be cleaner, more resilient, and more flexible, but also more cost-effective. For example, Hawaii, the state with the nation's highest electricity prices (excluding Puerto Rico), has been very successful in incorporating solar into its energy system; solar now makes up 12% of Hawaii's electricity mix.[23]

Puerto Rico recently announced the privatization of its beleaguered and bankrupt utility, PREPA. While the next steps are still unclear, the island has a unique opportunity to incorporate solar and storage technologies and build the resilient grid of the future.

SECTOR ANALYSIS

Installation and Project Development Sectors

While this year's *Solar Jobs Census* continues to list separate jobs data for installation and project development, the report combines the two sectors for the purposes of this section's analysis. This allows for the correction of any survey biases among companies that self-identified with one of the two sectors.* Installation generally refers to residential and non-residential distributed generation – that is, solar developed to help offset the host property's electricity load. Project development includes employment that works predominately on large scale systems (over 1 MW) that provide power directly to the grid.

The installation and project development sectors represent the end of the solar value chain, and together make up 66% of all solar jobs. Composed of companies that primarily install PV and other small solar energy technologies like solar space heating and cooling, the installation sector's overall job growth since 2010 was primarily driven by declining costs and federal and state policies that support solar deployment. Policies are driven by public awareness and interest in solar as a clean, no-cost fuel that moves the country toward energy security and independence.

Solar installation firms employ a wide range of specialized workers. The majority of these workers are connected to the building trades, particularly electricians, construction laborers, and plumbers. They work on smaller residential systems as well as large non-residential and utility-scale systems. The *Census* not only counts workers performing the installation, but also project support staff, including permitting, engineering, design, sales, marketing, administration, accounting, and management.

Installation is comprised of three segments: residential, non-residential and utility-scale. Utility-scale is the largest energy producing segment, with about 60% of cumulative installed capacity. The remaining 40% is split about evenly between residential and commercial.[24]

Table 9: Number of Homes Powered Per Installed System

	AVERAGE SIZE OF INSTALLATION	NUMBER OF HOMES POWERED EQUIVALENT
Residential	7 KW	1.3
Non-residential	100 KW	19
Utility-Scale	12 MW	2364

Based on the data available at the time of this writing, annual installed capacity in the residential market is expected to have declined by 13% in 2017, down considerably from the 20% growth in 2016. Market growth slowed as historically leading states such as California, Hawaii, Massachusetts, Maryland, and Nevada faced economic and policy challenges (see box, page 20). Many installer business models shifted focus from expansion to profitability, and cut acquisition costs, resulting in reduced sales. Nonetheless, other states, such as Arizona, Colorado, Florida, South Carolina, and Utah, are experiencing growth in residential deployment.[25]

Non-residential installed capacity (commercial, industrial, nonprofit, government, and community solar installations) is also expected to have grown at a much slower rate than the previous year. In 2016, non-residential capacity grew by 58%, but is expected to grow by only 17% in 2017. States such as Colorado, Hawaii, Illinois, Massachusetts, Minnesota, North Carolina, New York, and South Carolina are experiencing healthy growth. Some of this growth was spurred by firms wishing to complete projects before favorable

* Previously, the utility-scale installation jobs were tracked in the project development section of this report. The Key Findings section still tracks project development separately.

PROFILE

DANAE FLEMING

Operations Reporting Manager
SOLV, Inc., A Swinerton Company

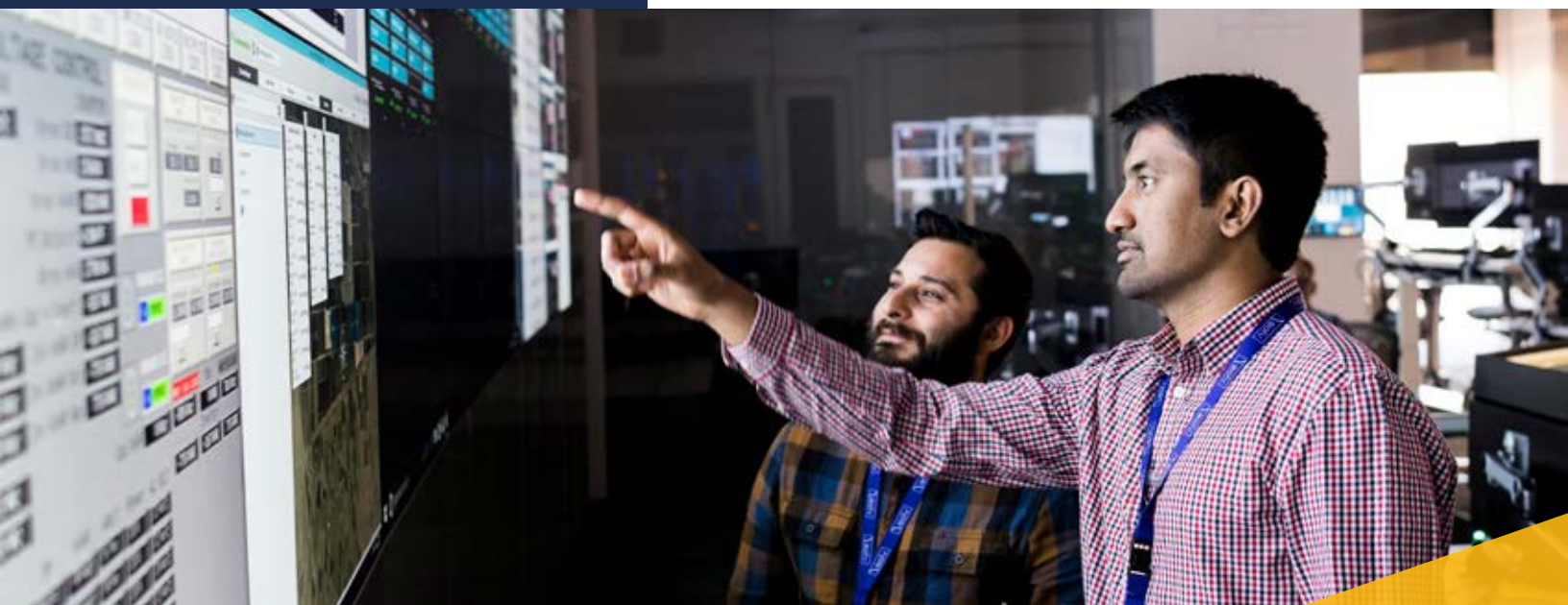
Danae is a member of the performance team at SOLV, an operations & maintenance company headquartered in San Diego. She is responsible for creating reports on solar plant performance for clients and utilities, including site performance reports, generation forecasts, and North American Reliability Corporation (NERC) reports.

"This is my fifth year in renewables," Danae says. "I started out as an intern for EDF Renewable Energy, where I was focused on wind. My degree was in information systems and I kind of fell into my career in renewables, but I love it. I am really enjoying working in solar now because I think there's so much room for technological and market growth."

Danae's work involves both technical analysis and interaction with clients. "My current role involves developing performance reports so that our clients can understand the performance of their plants and review the data in a way that is easily digestible. One thing I really love about this role is that it gives me an opportunity to go onsite and see our projects in person. It makes a world of difference to be able to see how the plant operates and meet the people who are working there. I think our field technicians are among the smartest in the industry; they're great to work with."

For others seeking a career in solar, Danae is enthusiastic about the opportunities available—no matter what your experience level. "I would advise anyone who is starting off in solar to be open to whatever opportunities come their way. I went from absolutely no experience in solar to a technical role, and then to a client-facing role. One of the best things about joining the solar industry right now is that it is evolving all the time. There is so much room for growth and for the creation of new types of job roles…maybe even a role that a company didn't have a need for last year. Don't corner yourself. Think about how your expertise and skills can provide value to your employer in new and creative ways."

> ***I would advise anyone who is starting off in solar to be open to whatever opportunities come their way.***



CALIFORNIA POLICIES MAKE FOR UNCERTAIN MARKETS

How do state policies affect the growth of solar? A lot. Policies can be critical to successful solar development. Take California, for example, where there are thousands of successful solar projects. With its high electricity rates, ample sun exposure, and supportive state legislature, California is a very strong market for solar power. But the state experienced a setback in 2017.

About 70% of California's electricity is provided by three large investor-owned utilities. Over the last couple of years, these utilities have been moving new residential solar customers from inclining block rates to time-of-use (TOU) rates. Therefore, residential rates, like commercial rates, now vary depending on the time of day.

Furthermore, the utilities have proposed significantly changing TOU periods and associated rates. In most states, the highest rates are during the day, when demand is the greatest. But since California has developed a substantial amount of solar power, the greatest need for electricity is in the early evening, after the solar power generation peak has passed. In response, the electric utilities have proposed shifting higher-priced peak times from the afternoon to the early evening and flattening out the cost differences between peak and off-peak rates. The resulting lower daytime rates will reduce the retail net metering credit for households and businesses that export solar back to the grid.

Most residential customers do not have experience with TOU rates. Consequently, installers are having difficulty explaining the complex economics to prospective customers. Solar sales have declined every time a utility shifts its service area to net metering 2.0 with TOU rates.[26] Other factors, such as rainy weather and changing industry business models, have also tripped the California market. Many residential companies have been cutting sales acquisition spending and shifting away from third-party ownership to focus more on profit and less on market expansion. Such changes have resulted in declining sales, especially in California and the Northeast.[27]

One possible solution is energy storage. More and more businesses and households are considering co-locating battery storage with their solar development. Currently, battery energy storage systems (BESS) create value by offsetting demand peaks and decreasing demand charges. They work best with tariff rates that include high demand charges, which often occurs for commercial solar. Energy storage costs are still too high to be feasible in many cases, but that is changing as costs come down.

policies and incentives expired.[28] Also, corporations are increasingly investing in off-site solar development (solar located away from their property) to meet sustainability goals.

Community solar development also helped spur non-residential growth. Community solar's 2017 market share is expected to have grown to 20%-25% of the non-residential market, up from 5% in 2015.

Utility-scale development is expected to have decreased deployment by 30% in 2017, after installed capacity in this category more than doubled in 2016. California, which led the 2016 charge in utility-scale installations, will likely display the biggest drop. Other states with retrenchments from the 2016 installation bump include Arizona, Colorado, Georgia, New Jersey, New Mexico, Nevada, and Utah. Despite the declining rate of growth, utility-scale is still expected to represent about half of 2017 deployment.[29]

Other states experienced utility-scale growth in 2017, notably Alabama, Florida, Hawaii, Indiana, Louisiana, Massachusetts, Maryland, Michigan, Missouri, Mississippi, Ohio, South Carolina, and Virginia. In some cases, this growth was driven by the construction of major projects. Since utility-scale represents the largest projects, one or two large projects, or the absence thereof, can dramatically impact a state's annual capacity additions.

PROFILE

Show your value from your service, like accountability, responsibility, teambuilding, and cohesion. These qualities will allow you to climb the ladder in solar or your chosen career.

JOHN MACCALLUM

Safety Director
Kiss Electric

John MacCallum spent the first 25 years of his career on active duty service with the U.S. Navy, where he was a Navy Seabee. Seabees are the Navy's construction force responsible for building roads, bridges, runways, barges, schools, and hospitals. As he neared his military retirement, John registered for Solar Ready Vets, a federally funded program led by The Solar Foundation that provided no-cost solar training for transitioning military personnel. After completing the training program at his base in Lakehurst, New Jersey, he was well-suited for a career in solar.

"I started out with the Navy in construction as a crew member, and over the course of my career I worked up to being in charge of several construction projects across multiple continents," John says. "By the time I retired, I was responsible for $4.2 billion worth of facilities. All of these projects and tasking were required to be OSHA (Occupational Safety and Health Administration) compliant, so I had a number of certifications related to occupational safety."

Through his solar training, John learned that his military experience translated well into a career in solar. After earning his North American Board of Certified Energy Practitioners (NABCEP) certification, John was hired by Kiss Electric, a Pennsylvania-based electric company with a growing solar division.

"I'm now the safety director for the company, both on the electric side and the solar side. I'm onsite at 90% of our solar jobs from beginning to end, and I really like that my military training and knowledge is able to directly benefit the company and our customers."

John noted that the transition from military to civilian life has been challenging, but his employer is very supportive of his needs.

"This company has been very good to me as I have adjusted to civilian life. I have been able to be open and honest with the company about my priorities and needs as a parent, so I'm able to set a more predictable schedule for my children."

As veterans exit military service and join the private workforce, John said it's important that they maintain humility, while being confident in what they can offer an employer.

"Veterans are coming into an environment with a different mindset, and that takes some time to get used to. They have to realize that civilians don't necessarily know what transferable skills veterans have from their time in the military, so you have to be patient and prove yourself." His advice to other vets? "Show your value from your service, like accountability, responsibility, teambuilding, and cohesion. These qualities will allow you to climb the ladder in solar or your chosen career."

PROFILE

In a rural area, I have found that one key factor for staying profitable in this industry and having job stability is to learn as many different types of skills as possible.

RUDY WRIGHT

Owner
Wright-Way

Rudy Wright is the owner of Wright-Way, a company that offers property management, home repairs and maintenance, real estate, green building, and solar power services in East Texas. The company was founded in 1982, first as a maid and custodial service and then as a property management and home repair company, but it was only recently that Wright-Way ventured into solar.

"Back in 2008, I was trying to get quotes for solar for my parents' house, and I wasn't getting the kind of response and information that I wanted," Rudy says. "At the time, my company was transitioning from property management to focusing more on construction, especially green building. It was clear to me that there was an opportunity here to provide more local solar options, so I looked into training, which led me to take an introductory course with NABCEP (the North American Board of Certified Energy Practitioners). Let me tell you—it was tough. I told my wife after the second day in training that I might have bitten off more than I could chew, because so many of the other people in the class were master electricians or journeymen…but I kept up with the training until I passed my NABCEP certification."

Rudy says the time he put into solar training is now paying off. "In our first five years offering solar, about half of our projects came from adding solar onto construction projects that we already had planned or from clients that we already had in the fold. 2017 was our biggest year for solar demand so far, and I think it's due to the fact that we are able to install at $2.20/watt here in Texas. Wright-Way is one of the few companies offering solar within a 100-mile radius that has been able to stay put. We don't have to mark up our solar offerings as much because we already have the clients, and we have a company that offers so many other services."

Looking to the future, Rudy says that continued training is key to making his business successful. "In a rural area, I have found that one key factor for staying profitable in this industry and having job stability is to learn as many different types of skills as possible. I started out in home repairs with an accreditation in residential management, and when I started working in solar, I found that many of the things I previously learned gave me a breadth of resources to refer back to. Training and certifications are valuable too. I am a certified green REALTOR® and a Master Certified Green Professional, as well as being HVAC and NABCEP-certified. I recommend that anyone working in solar seek out some NABCEP training. Even if you don't go for the certification, the classes are awesome."

PROFILE

SINTIA TORRES

Project Manager
Sol Systems

When Sintia Torres was earning her college degree in mechanical engineering, a group of friends encouraged her to take a look at the solar industry, noting, "There are a lot of jobs available for you when you graduate." After leaving her first job designing residential systems in California, she moved to Washington, D.C. and started work as a project manager at Sol Systems, a solar finance and development firm.

Sintia works on small commercial projects throughout the United States, including ground mounts, rooftop systems, and carports. She manages relationships with engineering, procurement, and construction firms to ensure project milestones are met. Her work requires ongoing communication with team members, as well as the use of her engineering skills.

"In my previous job as a design engineer I was by myself at a desk. Being out there talking to people, on the phone and in person -- I really enjoy that," she says. "At a certain point we all feel the pressure because occasionally there's a big issue on site that comes up and we're not sure how we're going to meet certain deadlines. But again, that's one of the fun things about the job. You have to be very patient, you have to be very understanding, and the most important thing is you have to be flexible."

As a female engineer and as a Mexican American, Sintia knows firsthand the importance of making the solar industry more inclusive. "In engineering school, there were usually one or two other women in a class of 30 to 40 people. Moving on to the solar industry, I noticed the same thing: When I'm in meetings, it's mostly white males and then me. There's definitely a need for more women and minorities in the industry." One thing that would help, she says, is for solar companies to reach out to schools and talk about the wide range of career opportunities available in solar. "That way women can say, and minorities can say, 'hey, that's something I can look into.'"

> ***In engineering school, there were usually one or two other women in a class of 30 to 40 people. Moving on to the solar industry, I noticed the same thing: When I'm in meetings, it's mostly white males and then me. There's definitely a need for more women and minorities in the industry.***

PURPA CHALLENGED

The Public Utility Regulatory Policies Act (PURPA) is a 1978 federal law that requires utilities to buy power from qualifying small energy producers when the price of that power is below what the utility pays to generate its own power, also known as "avoided cost." The law aims to provide competitive market opportunities to small energy producers so that they can enter wholesale electricity markets, which would otherwise be inaccessible.

As the cost of solar has fallen precipitously over the past several years, PURPA has enabled significantly increasing amounts of utility-scale solar to come online in new markets. PURPA has become a major driver for large-scale solar power deployment, particularly in states without Renewable Portfolio Standards or other mandates.[30] Electric utilities in these states have begun to push back, working to lower the rates that "qualifying facilities" receive and reduce the length of the contracts for those rates. The combination of these changes can flip the script so that solar projects have great difficulty in profitably developing or financing projects.

Nowhere did PURPA changes face bigger consequences for the solar market than in North Carolina, where the statute has served as a major driver for the state's widespread utility-scale solar deployment. After months of negotiation, a compromise was reached to alter the way that PURPA functions. The new rules allow utilities to have competitive bidding and lower avoided cost rates, but ensure 20-year contracts for new projects.[31]

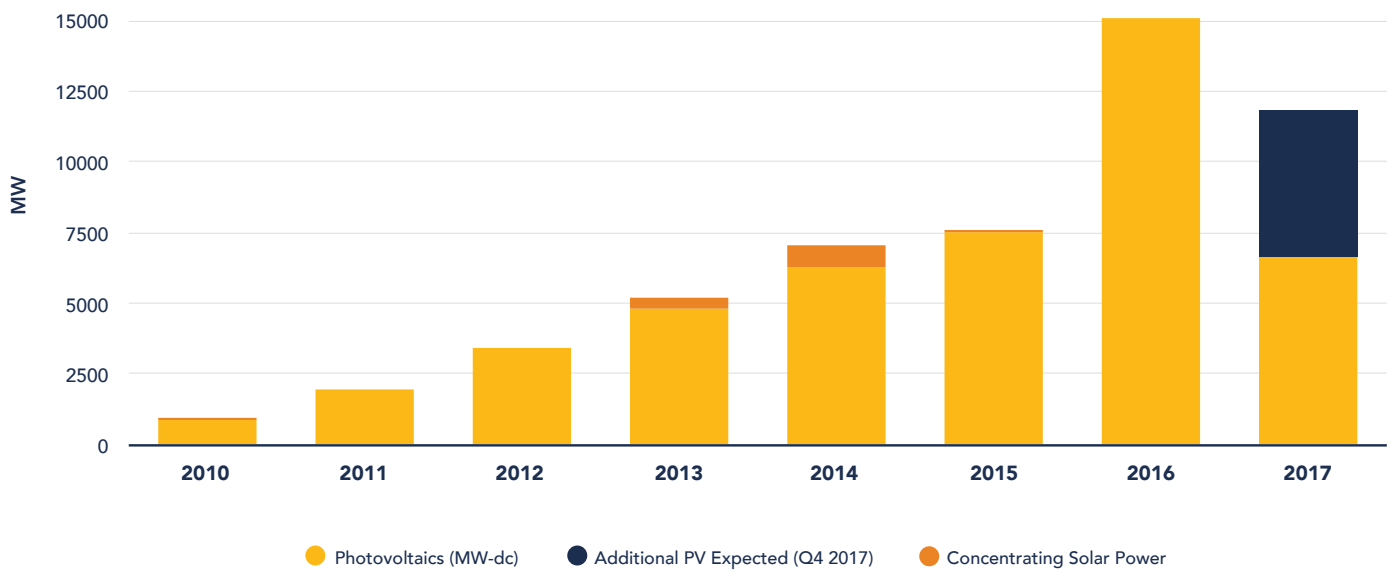
Meanwhile, in Montana, utility NorthWestern Energy asked its state utility commission to cut both the avoided cost rate and term length for PURPA projects, claiming that the existing rates would soon lead to a rush of solar projects with guaranteed 25-year power PPAs. The commission ultimately slashed the PURPA rate and reduced the term length to five years, nearly assuring that solar deployment is uneconomical under PURPA.[32] Other states faced PURPA changes in 2017 as well, including Idaho, Michigan and Georgia, with more states expected to follow suit in the coming year.

The long-term outlook for solar installations remains strong, given that unsubsidized costs of utility-scale solar are now competitive with fossil fuels. The levelized cost of energy for utility-scale solar ranges from $43/MWh to $53/MWh. By comparison, combined cycle natural gas, the lowest fossil fuel cost, ranges from $42/MWh to $78/MWh.* The competitiveness of combined cycle natural gas varies according to natural gas prices and by state. Assuming gas prices at $3.18/MMBtu for a January 2018 analysis, utility-scale solar is the lowest cost source of electricity throughout Colorado; in most of Missouri, Illinois, Wisconsin, and Minnesota; and in large parts of Iowa and Nebraska.† Even with generally higher costs per kilowatt hour (kWh), solar power costs are more predictable over the long-term than those of fossil fuels, and therefore, solar is sought by utilities and other firms to round out volatile energy portfolios.

* LCOE is from Lazard Levelized Cost of Energy Analysis and 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.

† Levelized Cost of Electricity in the U.S. by County, interactive map, The Energy Institute at The University of Texas at Austin. The Solar Foundation assumed capital cost of $1.04/W for utility-scale solar PV and combined cycle natural gas cost of $3.18/MMBtu. Externalities were excluded. http://calculators.energy.utexas.edu/lcoe_map/#/county/tech

Figure 4: Annual Solar Power Capacity Installations, 2010-2017



Costs

The costs of solar installations continued to decline in 2017, but at a more moderate pace than in 2016. Costs plummeted in 2016 due to a global supply/demand imbalance of some solar system components. Residential costs, which decreased 20% in 2016, decreased 3-4% in 2017 to $2.88/W. Non-residential and utility-scale solar prices dropped about 8% and 10% to $1.55 and $1.04/W, respectively, depending on the technology.[33] More recently, in Q3 2017, prices increased 1-2%, a change attributed to rising module prices and uncertainty over the pending Section 201 trade case.[34]

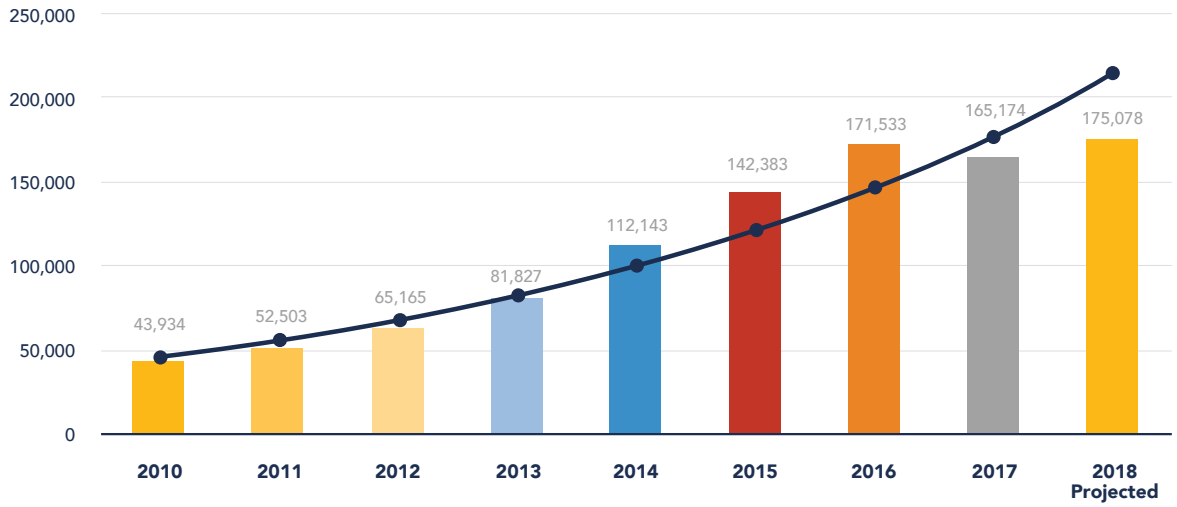
Non-hardware costs, or "soft costs," such as customer acquisition, labor, permitting, and interconnection, remained unchanged from 2016 to 2017. Nonetheless, the decline in hard costs meant that soft costs made up a greater proportion of total costs. Soft costs represented 68% of residential system costs, and 57% and 37% of non-residential and utility-scale costs, respectively.[35]

Installation Employment Trends

The solar installation and project development sector reported a total of 165,174 jobs, a decline of 3.7% in 2017, as shown in Figure 5. Over the long term, the sector has experienced robust growth, with over three times the number of jobs in 2017 compared to 2010, and more than twice the number of jobs as reported in 2012, when the *Census* began counting project development jobs. Prior to 2017, the sector was growing 20% or greater annually. It is projected to grow by 9,900 jobs, or 6%, in 2018.

Compared to residential and small commercial installations, utility-scale development requires more in-house employees and outsourced workers and contractors, as well as a wider range of skill sets, including civil engineers, land surveyors, and power plant operators. Permitting, finance, and land acquisition are more complex, requiring more—and often higher paid—administrative and professional workers. Utility-scale employers tend to be larger and highly efficient companies, with specialized labor for each component of the project.

Figure 5: Solar Installation and Project Development Employment Growth 2010-2017



Installer Efficiency

The number of solar installation jobs depends to a large extent on installer efficiency rates, or the number of workers required to install 1 MW of solar. Installer efficiency rates vary between the residential, non-residential, and utility-scale segments. To obtain a better picture of installer efficiency throughout the industry, The Solar Foundation conducted interviews with leaders from 30 installation and project development companies. Although a broader analysis would be necessary to provide statistically significant data, this small sample study provided strong qualitative data and helpful estimates on labor efficiency.

Based on this analysis, residential installations require five field employees to install one MW of solar. "Field employees" refers to workers and electricians who physically install a solar system. This does not include sales, design, administrative, or other staff that support the installation. For non-residential and utility-scale systems, the number of field employees decreases to three jobs per MW and two jobs per MW, respectively. Residential installations typically need to be custom designed, which requires that more time be dedicated to setting up and removing equipment, driving to and from sites, and other tasks. Consequently, residential installations are less efficient than those occurring in other market segments. Non-residential and utility-scale systems are larger, but involve more streamlined construction processes that require more specialized skill sets. As a result, these installations require fewer employees per unit installed.

Table 10: Installation Jobs per MW Installed

Residential "Field" Jobs Per MW	4.82
Non-Residential "Field" Jobs Per MW	3.06
Utility "Field" Jobs Per MW	2.42

According to the representatives interviewed, installer efficiency has improved over recent years due to improved hardware, such as racking and inverters, which speed up the process of installing solar systems. For example, new inverters are larger and require less wiring. The wattage of panels has also increased, meaning that installations require fewer panels for the same amount of capacity. Several employers pointed to investments in installer training as important to improving the efficiency of their teams. Employers also detailed that they were able to become more efficient as they better understood and navigated local policy frameworks.

When considering not only the companies that participated in the interviews, but all installation and project development employees counted in the *Census*, the number of jobs per MW drops to 14.* This includes installation-focused employees, as well as sales professionals, administrators, and all other staff. In line with personal accounts from solar installers, this calculation demonstrates improving job efficiencies over the past several years. However, the overall 2017 figure is slightly higher than the 2016 figure of 11 jobs per MW. This is likely the result of explosive growth of more efficient utility-scale solar segment in 2016.

Manufacturing Sector

Solar manufacturing remains critical to the overall solar value chain throughout the United States. Solar energy systems are comprised of hundreds of components, such as wafers, cells, racking, modules, and inverters, as well as the components required to manufacture these items. Some solar manufacturers are vertically integrated, while others specialize in one or two aspects of the value chain. Many manufactured goods, such as modules, are largely imported. Other products, such as polysilicon, are almost entirely exported. Of the 15.3 million gigawatts of modules shipped in 2016, about 83% were imported, and 7% were manufactured domestically, with most of the remainder from existing inventories.[36] According to GTM Research, "there are 14 crystalline-silicon cell and/or module manufacturers in the U.S."[37]

Manufacturing activity goes well beyond the production of solar panels; in fact, the majority of solar manufacturers in the United States do not produce wafers, cells, or modules. When asked what solar energy components their companies manufacture, 34% of respondents chose mounting structure hardware, 22% modules, 12% cells, 11% inverters, 6% wafers, and 44% other items, as shown in Table 11.† Some respondents manufacture components such as dual axis trackers, tracker jacks, racking attachments, and inverter skids. Other manufactured products include balance of systems hardware, batteries, combiner boxes, controls, polysilicon, sensors, software, and test equipment. Others reported manufacturing solar thermal components such as solar water pump controls, solar thermal collectors, and components for solar pool heaters.[38] The *Census* includes only U.S.-located establishments, but this can include both foreign and domestic headquartered companies. As respondents were asked which components their company manufactures, the percentages can include components manufactured both inside and outside of the U.S.

Table 11: Manufacturing Sector by Solar Energy Component Focus

SOLAR COMPONENT	PERCENT OF MANUFACTURERS
Wafers	6.4%
Cells	11.5%
Modules	22.4%
Inverters	10.9%
Mounting Structure Hardware	34.0%
Other	43.6%

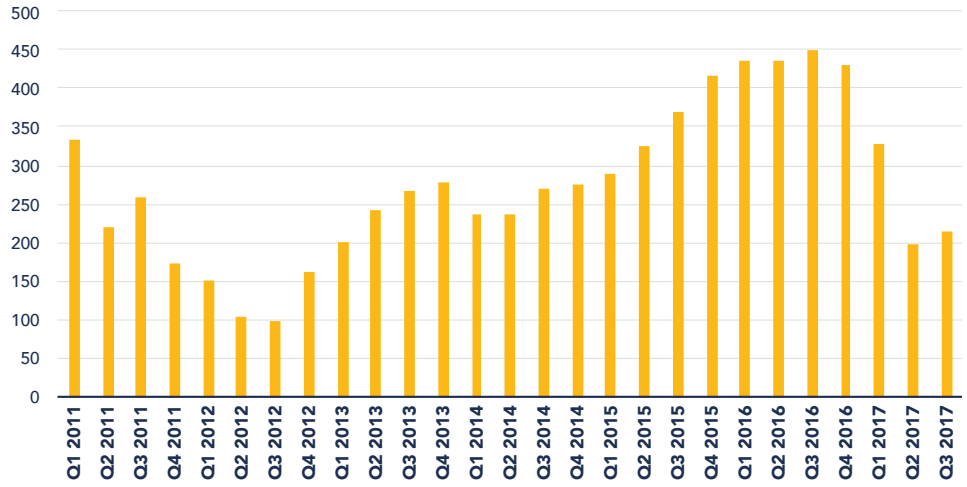
* This extrapolation was made using The Solar Foundation's jobs numbers and installed capacity projections from the *U.S. Solar Market Insight® Q3 2017* report, GTM Research, A Wood Mackenzie Business/SEIA. In last year's report, the calculation to determine jobs per MW used installation jobs over residential and commercial installed capacity, differing from the calculation in this report. Given concerns about how utility-scale installers self-identify themselves in the survey, The Solar Foundation switched the approach to a new calculation. This report uses both project development and installation jobs over overall installed capacity.

† Since some manufacturers produce more than one item, the total percentage adds up to more than 100%.

Domestic module production decreased 44% for the first three quarters of 2017 compared to the same period in 2016. Historically, module production has fluctuated based on shifts in supply and demand. 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 6. As the market shifted toward a more balanced supply and demand, production recovered through 2016. Production has since dropped off as a result of layoffs associated with several bankruptcies (see box, page 29). Module prices declined through the first quarter of 2017, but began rebounding as suppliers built potential tariffs into their prices, while also dealing with a tight supply in global wafers which drove up material prices.[39]

Despite the recent slowdown in module production, other domestic module manufacturers, such as Solaria (California), SolarTech Universal (Florida), Seraphim Solar (Mississippi), and China Sunergy (California) are looking to expand.[40] In 2017, Tesla and Panasonic began module production at their Gigafactory 2 in Buffalo, New York. After spending $177 million to retool its Ohio plant, First Solar expects to begin production of its Series 6 solar panel in the second quarter of 2018.[41] JinkoSolar just announced that it intends to invest $410 million in a new manufacturing facility in Jacksonville, Florida.[42]

Figure 6: U.S. Domestic Solar Module Production, 2011-2017

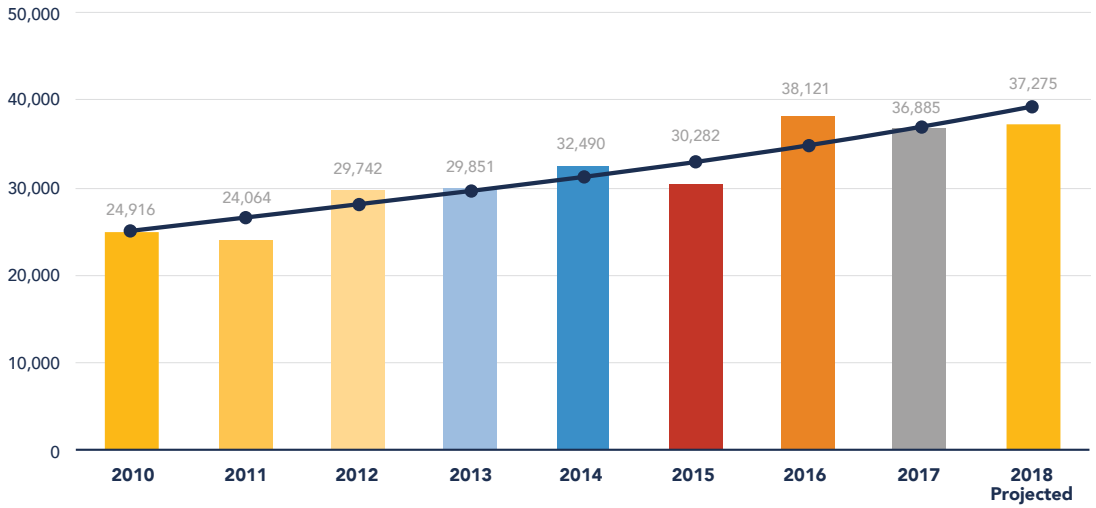


Source: GTM Research, A Wood Mackenzie Business/SEIA U.S. Solar Market Insight®

U.S. solar component manufacturing is facing an uncertain future. Polysilicon (not counted in the *Census*) is produced in three U.S. plants. Production is declining given that the chief export market, China, has imposed very high tariffs on polysilicon imported from the United States. Wafer production was largely discontinued in the United States when SunEdison closed its Oregon plant. Cell production decreased considerably from 2016 as the two largest crystalline silicon cell manufacturers in the U.S. encountered difficulty in 2017: Suniva declared bankruptcy, along with SolarWorld's parent company. U.S. inverter production is declining, with the closing of two major facilities at the end of 2016.[43]

Manufacturers currently employ 15% of the solar workforce, or 36,885 solar workers, a decrease of 1,236 jobs (3.2%) since November 2016. By comparison, U.S. manufacturing grew by 1.6% in 2017.[44] Manufacturing activities often occur at facilities that build some solar components but don't meet the 50% *Census* threshold that defines a solar job. If these part-time solar manufacturing jobs were tallied, there would be 42,391 total solar manufacturing jobs.

Figure 7: Solar Manufacturing Employment Growth, 2010-2017



Employees spending at least 50% of their time on solar-related work

SOLAR COMPANY AND STOCK PERFORMANCE

Following SunEdison's bankruptcy two years ago, 2017 saw several more high-profile solar company bankruptcies. Sungevity filed for Chapter 11 bankruptcy in March after laying off 400 workers at its facilities in California and Missouri.[45] The company struggled to access adequate financing after a non-traditional "reverse merger" path to going public fell through.[46] Other residential installers followed suit. NRG shuttered its home solar unit.[47] The residential solar market contracted year over year.[48]

Meanwhile, some domestic manufacturers struggled to compete. Suniva filed for bankruptcy protection in April after laying off 131 employees and closing its cell factory in Georgia and barely opened module factory in Michigan. The company later filed a Section 201 trade petition, blaming inexpensive module imports for its inability to compete.[49] SolarWorld AG, the German parent company of SolarWorld Americas, filed for insolvency and later joined Suniva's trade petition.[50] And thin-film manufacturer Stion closed shop, after years of struggling to avoid bankruptcy, leading to 200 jobs lost.[51]

Solar stocks reflected the sluggish demand and market uncertainty throughout the year, as solar stock performance was turbulent in spite of a record-high market.[52]

Still, some solar companies thrived. First Solar posted outstanding earnings and a steadily rising stock price; the company's thin-film technology will not be impacted by Section 201 solar tariffs. SunPower also saw a bump in its stock price. Meanwhile, Vivint enjoyed more profitability than some of its residential installation competitors as the company transitioned its focus to system sales versus leases and targeted higher-margin customers.[53]

HOW THE TRADE RULING COULD IMPACT THE SOLAR INDUSTRY

In April 2017, domestic solar cell and module manufacturer Suniva filed a petition with the U.S. International Trade Commission (USITC), invoking Section 201 of the Trade Act of 1974. Following bankruptcy, Suniva petitioned for relief against crystalline silicon PV (CSPV) module and cell imports from all countries. The company cited a need for blanket safeguards against low global prices for solar equipment. A month later, SolarWorld Americas Inc., a U.S. subsidiary of German-owned manufacturer SolarWorld, joined Suniva as a co-petitioner in the trade case. The companies requested a $.78/W minimum import price on modules and $.40/W tariff on imported cells in the first year. Unlike typical trade cases that often deal with countries and companies that violate specific trade rules, the Trade Act of 1974 gives the president unilateral power to impose tariffs if increasing imports are deemed to be hurting U.S. manufacturers by the USITC.

On September 22, 2017, the ITC voted unanimously that the petitioner companies experienced serious injury because of imports. In November 2017, the ITC submitted an official trade remedy report to the president. The commissioners made different recommendations, though all recommended tariffs were less than half of those requested by Suniva and SolarWorld. Unlike the blanket tariffs requested by the petitioners, the commissioners' remedy recommendations excluded Canada, Singapore, and all Free Trade Agreement partners aside from Mexico and South Korea.* During the proceedings, most of the domestic solar industry expressed opposition to the tariffs. The Solar Energy Industries Association (SEIA) argued that the trade case would benefit only a select few companies, while detrimentally impacting the rest of the industry by raising costs and making it more difficult to reach cost parity with other energy sources.

On January 22, 2018, the Trump administration announced that it would impose a 30% tariff on imported solar cells and modules. Tariffs will decline to 25% in the second year, 20% in the third, and 15% in the fourth and final year. Each year, the first 2.5 GW of cells imported will be exempt from the tariff. This tariff amount falls below the recommendations by members of the ITC, but there is still likely to be a significant impact on module prices, industry expansion, and jobs growth. Tariffs are scheduled to go into effect on February 7, 2018. According to MJ Shiao, head of Americas research for GTM Research, the announced tariff levels are likely to increase solar module costs by 10 to 12 cents per watt, based on current U.S. import prices of 35 to 40 cents per watt.[54] A GTM analysis finds the tariff is expected to slow the residential market by 9.9%, the non-residential market by 10.7%, and the utility-scale market by 12% between 2018 and 2022.[55] SEIA forecasts a loss of up to 23,000 jobs in 2018 as a result of the decision.[56]

Due to this issue's prominence and potential effect on business expansion and job growth, this year's *Census* survey included questions relating to the trade case. Importantly, the survey was administered during October and November 2017, well before the president announced his decision. In the survey, 86% of solar establishments indicated that if trade restrictions were imposed, their businesses would be impacted negatively. Moreover, 71% of respondents said they had already felt negative effects from the case in 2017, likely due to the uncertainty over the final decision. Project development establishments were most likely to already feel adverse effects before the decision, with 88% being affected negatively in 2017.

A large majority of respondents across all sectors said they expected negative impacts from the trade case decision, including 86% of manufacturing locations. Project development and installation companies would likely feel the adverse effects of trade restrictions through higher costs for solar projects and sales. Additionally, a majority of U.S. manufacturing establishments represent companies that focus on components other than wafers, cells and modules, such as racking, inverters, storage systems, and even the equipment used to manufacture solar components. These companies may be adversely

* U.S. FTA Partner Countries include: Australia, Bahrain, Chile, Colombia, Costa Rica, Dominican Republic, El Salvador, Guatemala, Honduras, Nicaragua, Israel, Jordan, Korea, Morocco, Canada, Mexico, Oman, Panama, Peru, Singapore.

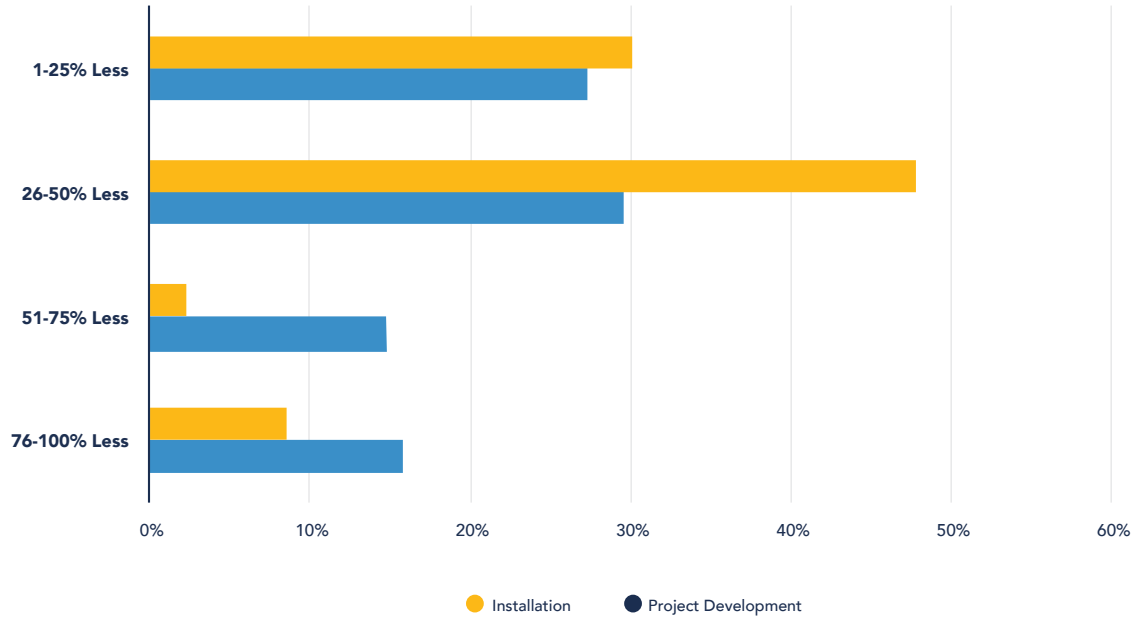
affected because they, like other sectors, perceive that an increase in cost will reduce demand for solar and for their manufactured products.

Table 12: Expected Impact of Trade Restrictions on Imported Solar Cells and Modules

	OVERALL	INSTALLATION	PROJECT DEVELOPERS	MANUFACTURING	SALES AND DISTRIBUTION	OTHER
Severe Negative Impact	48.3%	47.7%	56.3%	53.8%	42.1%	35.5%
Moderate Negative Impact	36.8%	35.5%	37.3%	32.5%	39.5%	50.4%
No Impact	8.9%	11.1%	3.2%	7.5%	9.2%	9.9%
Moderate Positive Impact	3.6%	3.4%	1.6%	3.8%	6.6%	3.3%
Strong Positive Impact	2.4%	2.3%	1.6%	2.5%	2.6%	0.9%

This year's survey also included a question for project developers and installation establishments regarding the predicted impact that trade restrictions would have on installed capacity. The survey found that 78% of project developers would plan a decrease in solar installations if trade restrictions were imposed, while 70% of installation establishments also predicted a decrease. Sixty-one percent of project developers and 78% of installation locations predicted that installations would drop more than 25% per year if trade restrictions were enacted.

Figure 8: Predicted Drop in Solar Installations as a Result of Trade Case



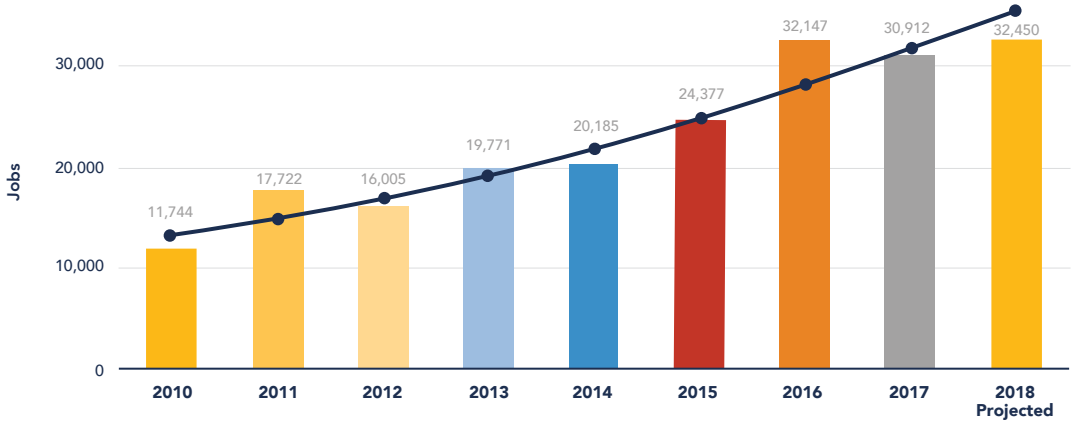
According to the survey, 66% of solar companies foresee an increase in the cost of doing business because of potential trade restrictions. Thirty-nine percent of all responding companies fear an adverse effect on company financing. This sentiment was felt particularly strongly among project developers, a majority of which (53%) responded that company financing opportunities would be detrimentally affected.

Sales and Distribution Sector

The sales and distribution sector is made up primarily of wholesale and retail trade establishments. These establishments 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. The *Solar Jobs Census* delineates companies by the activities at each business location to gather the most accurate employment information. Thus, much of the data for this section includes information from sales offices and distribution centers that are part of larger companies across other segments of the value chain.

Solar establishments primarily engaged in sales and distribution employ 12% of the solar workforce, or 30,912 solar workers. This represents a decrease of 3.8%, or 1,235 jobs, since 2016. By comparison, the nation's overall retail and wholesale trade employment decreased by 0.4% and increased by 1.2%, respectively, from 2016 to 2017.[57] Employers expect to increase sales & distribution employment by 5% in 2018, adding 1,538 jobs.

Figure 9: Solar Sales Employment Growth, 2010-2017



Employees spending at least 50% of their time on solar-related work

RISE IN SOLAR SCHOOLS SAVES MONEY AND PROVIDES LEARNING OPPORTUNITIES

With installation costs plummeting, American schools are switching to solar energy at a rapid pace, reducing their electricity bills and freeing up resources to invest in education. There are now 5,489 K-12 schools in the United States that use solar energy, nearly double the total solar capacity that was installed at schools in 2014, according to a report released this year by The Solar Foundation, Generation 180, and SEIA.

The dramatic growth in solar school adoption has been driven by rapidly declining installation costs. The average price of a solar school installation has dropped 67% in the last 10 years, and 19% in 2016 alone. Nearly 4 million students in the U.S. attend schools with solar power, with a combined capacity of 910 MW, an increase of 86% over 2014. The amount of electricity these schools produce annually is 1.4 million MWh, or enough to power over 190,000 homes.

The report, *Brighter Future: A Study on Solar in U.S. Schools, 2nd Edition*, is a comprehensive study on solar at K-12 schools nationwide. As a follow-up to the first study released in 2014, this report captures the accelerating trends of solar adoption in U.S. schools. There is good reason that more school districts are making the solar choice: Solar energy can provide a myriad of benefits for schools. This includes vast financial savings, educational opportunities, emergency response and resilience options, and opportunities for students to get involved in social action and environmental stewardship.

PROFILE

When I found Aurora, where I could apply my interest in programming to a problem that I cared about, I knew it would be a great fit.

AURORA SOLAR

Software Engineers in the Sun

Founded in 2013 by two Stanford University graduate students and based in Palo Alto, California, Aurora Solar produces software that calculates how many solar panels will fit on a property, predicts how much energy they will produce, and analyzes the financial returns from the installation. The algorithms that Aurora has developed enable residential and commercial solar installers to calculate shading with a high degree of accuracy, create detailed system designs, and provide detailed sales proposals without visiting the site, saving time and reducing soft costs.

The Solar Foundation spoke to four engineers who said Aurora offers the same career opportunities and challenges as leading software companies, with the added benefit of helping to sustainably power the world through solar energy. "In many ways, working at Aurora is like working at any other Silicon Valley tech startup," says Meseker Yohannes, who has worked at Aurora since its founding in 2013. "The main difference is that what I do here is infused with the sense that it is making solar energy cheaper and more efficient."

For Meseker and his colleagues, core skill requirements include a software development background as well as advanced math. "Certain projects that I've worked on, such as our visual design tools, have required a lot of geometry and trigonometry, and others have required knowledge of more classical computer science concepts," Meseker says.

Matt Stevens, an Aurora employee since 2014, says he wanted to pursue a career in renewable energy but wasn't sure how to do that as an engineer. "Originally, I didn't think I would work in solar because I wasn't interested in semiconductors and electronics, but that was only because I didn't know how diverse the solar sector actually is. When I found Aurora, where I could apply my interest in programming to a problem that I cared about, I knew it would be a great fit."

Michael Klocker, a software engineer at Aurora since 2015, said he was drawn to the solar industry out of "a mixture of curiosity, personally trying to go solar, and too many Elon Musk videos." For others looking for a similar career, he recommends taking the initiative to learn new skills. "Program as much as possible, show your code to others, read books, and talk to smart people."

Anna Kuznetsova, who joined Aurora in 2017, wanted to combine her skills in math and statistics with her interest in environmental science and policy. Her advice to job seekers is to learn about the wide variety of career paths available in solar, then find an opening that matches your background and interests. "Don't be discouraged if you don't know how solar panels or wind turbines work," she says. "You don't need to be an electrical engineer or a chemical engineer to get involved and make meaningful, world-changing contributions in the renewable energy industry."

DAN SILVER

PROFILE

Panasonic
***President*, Eco Solutions Division of North America**

Dan Silver oversees sales and marketing for residential solar power and storage at Panasonic, along with other product areas such as indoor air quality and factory cordless power tools. He manages around 70 employees, including about eight who work mainly on solar. Dan leads the marketing team for Panasonic's HIT solar panels, which are designed for high efficiency, maximum output, strong heat coefficient, and longevity. They are currently produced overseas, but manufacturing will soon shift to the Tesla Gigafactory 2 in Buffalo, New York.

A Panasonic employee for 33 years, Dan joined the company after he spent a year in Kyoto during college and became fluent in Japanese. "My first real job was doing sales on the West Coast working for the automotive division. We were selling radios, speakers, and some air conditioning to Toyota. Interestingly enough, Toyota also had a joint division with General Motors in Fremont, California (New United Motors Manufacturing, Inc.), and that's now the Tesla car factory."

After rising through the ranks and holding a wide variety of management positions, Dan started becoming more involved in the solar business around two years ago. Compared to other products he's been involved in, such as shavers, large video displays, and microwaves, "Solar seems to move quicker and have more ups and downs, and even the paradigm of how you sell changes quickly," he says. "But any opportunity I have to make the company move faster, I welcome."

He's also noticed that solar attracts people who care deeply about renewable energy and are driven to succeed. "The pace of solar is certainly one thing that makes it unique, as is the dedication of many in the industry to the cause of clean energy," he says. "Yeah, they want to make money and they want to make sure their margins are good, but at the end of the day they also want to go green and they want to get to net zero [emissions]."

When looking to hire employees, Dan says he values their ability to collaborate and learn from each other. "We look for trustworthy team members who are willing to go beyond their expertise to add value to the whole picture. In my area, that's really the collaborative effort between the sales, engineering, and marketing people." That means the sales team needs to have input into the marketing message, he says, and the marketing team should be directly collaborating with sales. "Some sales people will say, 'just give me the product, I'll sell it,' but that's not who we're looking for. Some marketing people will say, 'let me do the marketing, I'm not interested in making sales calls,' but that's also not who we're looking for."

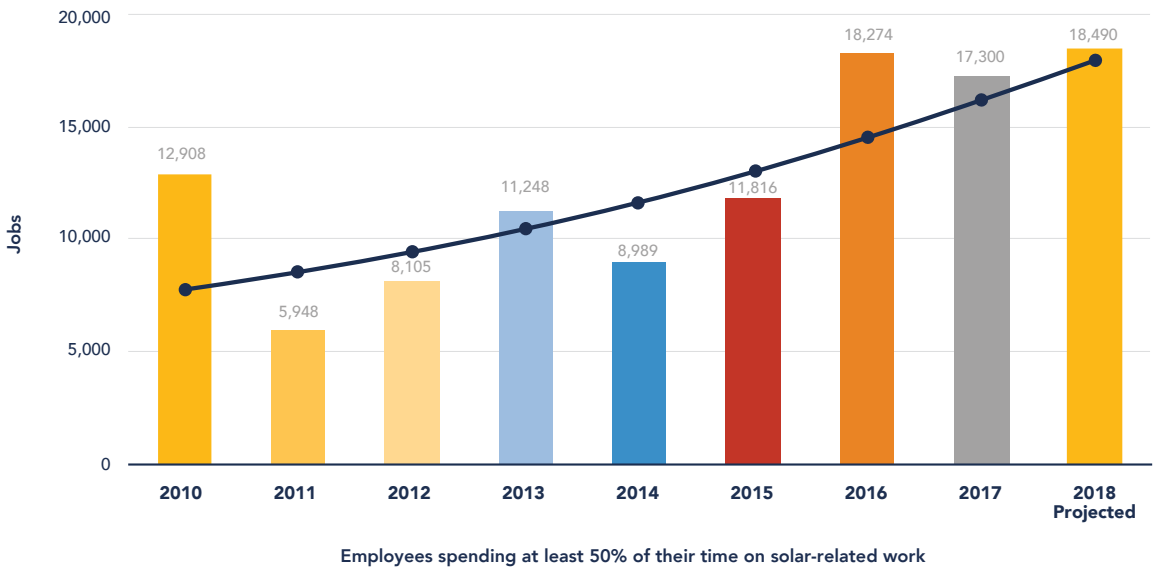
His advice to those starting out in the solar industry, or the business world in general, is to learn a lot about what one's colleagues are doing at a broad variety of positions in the company, from sales and marketing to engineering and finance. "To succeed I think it takes flexibility, a high level of collaboration, and willingness to get one's hands involved in many sides of the business. It also takes, as they say, grit and a sense of adventure."

"To succeed I think it takes flexibility, a high level of collaboration, and willingness to get one's hands involved in many sides of the business. It also takes, as they say, grit and a sense of adventure.

Other Solar Employment

About 7% of the solar workforce, or 17,300 workers, are engaged in activities not covered by the other four sectors, including academic research, government oversight, research & development, nonprofit advocacy, finance, architecture, consulting, law, and communications. Employment in the "other" category declined by 5.33% in 2017, a loss of 974 jobs. This sector is expected to resume growth in 2018, increasing by 1,190 jobs (7%) by November 2018.

Figure 10: Solar "Other" Employment Growth, 2010-2017



SOLAR INVESTMENT OUTLOOK

Despite the fact that capital costs for solar energy development are 25% lower than they were two years ago, 2017 saw the second-highest ever figure invested in solar globally. Global solar investments totaled $160.8 billion, which was an increase of 18% over the previous year's total. Just over half of these investments ($86.5 billion) were made in China, which is estimated to have installed between 50 and 60 GW of solar—nearly double its deployment from the prior year.[58] In the United States, investment rose just 1% to total $56.9 billion.

A strong appetite for solar investments globally led the sector to attract 48% of total funding across clean energy technologies. Global venture capital investments in solar companies reached $1.6 billion in 2017 via 99 deals, up 30% from the $1.3 billion raised through 78 deals in the prior year.[59] Key U.S. venture capital investments included $130 million for U.S. solar service provider Sunlight Financial,[60] $55 million for developer Silicon Ranch,[61] and $25 million deals each for thin-film manufacturer Siva Power and financial provider Spruce Finance.[62] Long term, analysts predict that solar investment will grow faster than that of other technologies, to reach almost $1.5 trillion annually by 2040.[63]

PROFILE

MARINA SHAPIRO

Chief Financial Officer
Nautilus Solar Energy

Marina Shapiro is the chief financial officer for Nautilus Solar Energy, a New Jersey-based company that develops, finances, and constructs distributed solar projects throughout North America. Marina joined the company back in 2009, when it was a team of three, and she has remained a core team member as Nautilus grew to 30 employees.

"I came from traditional public accounting. What attracted me to Nautilus was the fact that it was a small company and it was in renewable energy, which I was interested in, and the company was able to create a lot of jobs through its projects," Marina says. "The space has been challenging and volatile at times, but it has allowed me the opportunity to work through the challenges and see firsthand how solar projects benefit the communities across the country. When you combine financial, mathematical, and traditional accounting skills, and understanding the tax code, you are able to create value for your customers. And I love our customers!"

Marina enjoys that her job allows her to creatively problem solve and get involved in every step of the project development and finance process.

"In my job I handle every facet of finance within the company, including both the financial aspects of the projects and the company's finances. We have deployed more than $750 million of capital into solar projects, and I am responsible for raising, structuring, and deploying this capital. I have to put the pieces of the puzzle together, from engineering to construction to working with banks. I sit in the midst of the storm and ensure that all of those elements are working together so that a project can be successful."

As one of her company's earliest employees, Marina has witnessed the solar industry's tremendous job growth as opportunities expanded for professionals with varied backgrounds and skill sets. When pursuing a career in solar, Marina notes that a strong work ethic is one of the most important qualities to possess.

"Perseverance and hard work are necessary. This is a highly rewarding, growing industry, but it's very challenging and you have to be willing to learn on the job. You might walk in and say 'I don't know,' and that's okay. After 10 years, I am still figuring things out and learning myself. An important component here is wanting to problem solve and being willing to learn as you go. Working for a smaller company is beneficial because you get exposure to everything, from development, to construction, finance, and asset management. Our team members really get to experience it all."

"Perseverance and hard work are necessary. This is a highly rewarding, growing industry, but it's very challenging and you have to be willing to learn on the job.

DEMOGRAPHIC ANALYSIS

In September 2017, The Solar Foundation released the *2017 U.S. Solar Industry Diversity Study* in collaboration with the Solar Energy Industries Association's (SEIA's) Women's Empowerment Committee.[64] This first-of-its-kind study assessed the representation of women, people of color, veterans, and the LGBTQ community in the U.S. solar workforce. The study found the solar workforce is more diverse than comparable American industries. However, far more needs to be done to make solar an inclusive industry that is representative of the greater U.S. population.

This year's *Solar Jobs Census* survey found that 35% of employers track new and existing employee gender, ethnic and racial diversity, and/or veteran status. This is an 8% increase from the 27% of employers that tracked this information earlier in 2017, based on the *U.S. Solar Industry Diversity Study* survey administered in May. This upward trend within a short time period is a positive signal that more solar companies are formally tracking employee demographics, a first step in making the industry more inclusive, equitable, and competitive.

Table 13: Solar Worker Demographic Breakdown, 2014-2016

	2014 % OF WORKFORCE	2015 % OF WORKFORCE	2016 % OF WORKFORCE	2017 % OF WORKFORCE	2017 TOTAL
Women	21.6%	23.9%	28.0%	26.9%	67,204
Latino/Hispanic	16.3%	11.3%	17.2%	16.8%	42,138
American Indian or Alaska Native	-	-	1.1%	1.0%	2,582
Asian	7.0%	8.7%	9.1%	8.4%	20,958
Black or African American	6.0%	5.2%	6.6%	7.4%	18,527
Native Hawaiian or Other Pacific Islander	-	-	1.3%	1.2%	2,948
White	-	-	73.6%	73.7%	184,545
Two or More Races	-	-	8.3%	8.3%	20,711
Veterans	9.7%	8.1%	9.0%	8.6%	21,599
55 and Over		18.5%	11.2%	11.4%	28,498

NOTE: *The Solar Foundation began tracking more comprehensive demographic data in 2016.*

However, the representation of women and people of color in the solar industry has seen little change since 2016. In 2017, women represented 27% of the solar workforce, down 1% from 2016. This lack of continued upward movement is likely due to the small contraction in solar jobs over 2017, particularly in sectors with greater female representation, such as sales & distribution.

In 2017, states with large Latino/Hispanic populations, such as California and Texas, and states with large Asian populations, such as California and Hawaii, saw declines in solar jobs. As a result, these demographic groups were slightly less represented in the industry compared to 2016. Meanwhile, states with large African-American populations, such as the District of Columbia and several Southeastern states, saw solar job growth, likely causing the boost in African-American representation from 6.6% in 2016 to 7.4% in 2017.

Table 14: Solar Worker Demographics by Sector and in Comparison to Other Industries[65]

	WOMEN	LATINO/ HISPANIC	ASIAN OR PACIFIC ISLANDER	BLACK OR AFRICAN AMERICAN	VETERANS	OLDER WORKERS (55+)
Solar Manufacturing	29.5%	20.1%	15.9%	8.5%	12.0%	16.7%
U.S. Manufacturing	28.9%	16.1%	6.8%	10.0%	N/A	N/A
Solar Sales & Distribution	32.9%	15.3%	10.3%	5.5%	5.0%	8.5%
Wholesale Trade	29.5%	17.6%	6.0%	8.4%	N/A	N/A
Solar Installation	24.7%	16.9%	7.1%	7.8%	8.5%	9.6%
Construction	9.1%	28.9%	1.9%	5.8%	N/A	N/A
Solar Project Developers	25.1%	15.7%	7.8%	6.5%	8.1%	10.3%
Oil and Gas Extraction	20.2%	14.5%	2.3%	6.2%	N/A	N/A
Solar Other	35.4%	16.7%	12.1%	4.1%	6.1%	19.8%
Coal Mining	4.0%	1.7%	0.9%	2.9%	N/A	N/A
Solar Industry Overall	**26.9%**	**16.8%**	**10.5%**	**6.0%**	**8.6%**	**11.4%**
Total U.S. Workforce	**46.8%**	**16.7%**	**6.1%**	**11.9%**	**6.8%**	**22.7%**

When the solar industry demographics are broken down by sector, the "other" sector has the largest percentage of women, at 35%, followed closely by sales & distribution, at 32%. The installation sector has the lowest female representation, at 25%. People of color and veterans are most highly represented in the manufacturing sector. Workers older than 55 are most well-represented in the manufacturing and "other" sectors.

Although women have far lower representation in the solar industry than in the overall U.S. workforce, solar is more comparable to the overall workforce in terms of racial diversity. Solar is also more racially and gender diverse than comparable energy sectors, such as coal and oil and gas extraction.[66] Veterans make up around 9% of the solar industry, which is 2% more than the overall U.S. workforce.

Many solar companies, though not a majority, have also adopted strategies to improve workplace diversity. According to this year's *Census* survey, 38% of solar establishments have adopted specific strategies, policies, or programs to improve workplace diversity. Installation companies were most likely to adopt diversity programs, with 41% replying that they had done so.

As documented in the *Solar Industry Diversity Study*, a diverse workforce is strongly correlated with financial performance across industries. For example, a new report released in *Financial Management* in December 2017 looks at the performance of 3,000 publicly traded companies over 13 years. The study concludes that companies that were more diverse tended to be more successful, innovative, and resilient in the face of financial downturns.[67] The solar industry has much to gain from hiring and retaining a more diverse and equitable workforce.

WORKFORCE DEVELOPMENT

The U.S. solar workforce includes a wide variety of occupations and covers many skill sets. Solar workers install modules on homes and businesses, work in factories, oversee large utility projects, and serve as sales and administrative professionals. The solar industry also has low barriers to entry, is open to all education levels, and presents strong opportunities for advancement and career development.

Wages

Solar industry wage information offers insight into labor supply and demand, as well as a comparison to the overall U.S. economy. In 2016, The Solar Foundation researched wages through online classified job postings. This year's report instead used data from the 2017 *Census* survey, and therefore includes wage numbers that are self-reported by solar establishments. Consequently, 2017 wage figures are comparable to 2015 numbers, but differ greatly from 2016 numbers.

Based on this survey, the median reported wage for mid-level installer positions for both installation and project development companies is $21 per hour. For installation companies alone, the median mid-level installer wage is $20, and for project development companies, the median wage is $25. This difference is attributed to the fact that project development firms focus on utility-scale and non-residential solar systems, which require some workers to have more specialized skill sets. The median wages for supervisory roles in the installation and project development sectors are $30 and $38, respectively.

The median wage for a mid-level assembly or production worker in the manufacturing sector is $20, increasing to $30 for supervisors or foremen. Median wages for both mid-level solar installers and assembly workers are above the national median hourly wage of $17.09.[68]

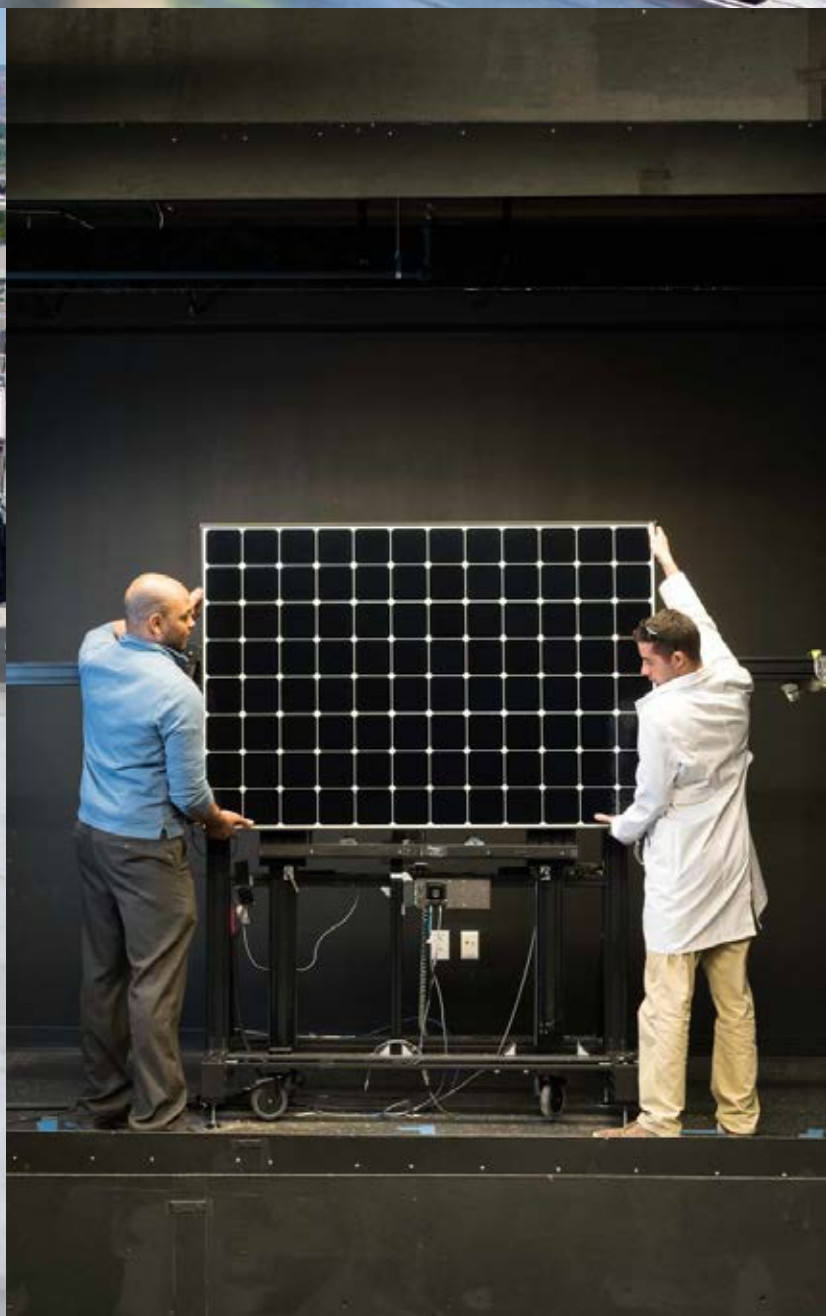


Table 15: Median Installer Wages

	INSTALLATION	PROJECT DEVELOPMENT	INSTALLATION AND PROJECT DEVELOPMENT
Entry-Level Wage	$15.00	$16.22	$15.00
Mid-Level Wage	$20.00	$25.00	$21.00
Senior/Supervisor Wage	$30.00	$38.00	$30.00

Table 16: Median Production Worker Wages

	MANUFACTURING
Entry-Level Wage	$15.00
Mid-Level Wage	$20.00
Senior/Foreman Wage	$30.00

PROFILE

MONICA SCANTLEN

Senior Recruiter
EnergeiaWorks

Monica Scantlen recruits employees in the solar and other renewable energy industries for EnergeiaWorks, a recruiting firm that is exclusively focused on renewables. Working remotely from Austin, Texas (the company is headquartered in New Jersey), Monica interviews job seekers for a wide range of positions and skill levels. "I love the variety that comes with recruiting for this industry," she says. "I'm talking to engineers, I'm talking to estimators, I'm talking to project developers -- all the way from general managers down to technicians."

Monica says candidates are often surprised to learn about the diversity of jobs available in solar. "You might be a structural engineer, and solar companies would take these skills and have you look at the structural integrity of PV systems. You might be an electrical engineer, and an inverter organization is looking for someone with your background. You might be a business development manager with a very successful sales background, and now you're looking to move into the solar industry. And I've worked with programmers and accountants who really want to move into the industry because they believe in and support renewable energy."

Monica has found the most successful candidates are those with a genuine passion for renewables. "Those are the ones who tend to really thrive, because it becomes their passion and not just a place to work." She adds that the solar industry is very collaborative, so candidates need to be willing to step out of their narrow fields and team up with colleagues across an organization.

For solar companies that have difficulty finding qualified employees, Monica says moving quickly through the recruiting and interview process is key. "This is such a tight job market that we're constantly telling our clients, if you are interested in a candidate, you've got to move quickly. If companies are not quick to respond, they may lose out on someone who could have been the perfect hire." And when a company finds a great candidate, they shouldn't delay sending the job offer! She adds, "Companies need to be actively out there networking, making sure they're at industry conferences and trade shows, meeting those people that could be potential hires down the road."

Monica also recommends that companies partner with an executive search firm, which is a good way to recruit "potential candidates who are not actively looking for a new role or on the job boards, but who might be interested if it's the perfect job."

"Companies need to be actively out there networking, making sure they're at industry conferences and trade shows, meeting those people that could be potential hires down the road.

Experience and Education Requirements

While a majority of solar establishments include experience as a hiring requirement, the number of employers requiring experience dropped from 67% in 2015 to 55% in 2017. Over the three-year period, the most drastic decrease occurred in the project development sector, which went from 80.4% requiring experience in 2015 to 41% in 2017.

In 2017, fewer survey respondents indicated that their companies required a bachelor's degree or higher for employment, from 32% in 2016 to 21% in 2017. This year-over-year decrease in education requirements occurred across all sectors. Between 2016 and 2017, there was no change in the number of solar employers that required vocational or technical credentials.

Table 17: New Hire Experience and Education Requirements

	WITH EXPERIENCE			2017		
	2015	2016	2017	% WITH BACHELOR'S DEGREE OR HIGHER	% WITH VOCATIONAL OR TECHNICAL CERTIFICATE OR CREDENTIAL	% WITH ASSOCIATE'S DEGREE OR CERTIFICATE FROM ACCREDITED COLLEGE
Overall	**67.0%**	**64.5%**	**54.8%**	**21.3%**	**18.8%**	**9.6%**
Installation	62.2%	61.2%	56.3%	6.9%	24.0%	4.7%
Manufacturing	65.0%	62.5%	45.5%	29.9%	12.1%	11.6%
Sales & Distribution	65.1%	66.2%	62.4%	32.0%	9.7%	7.2%
Project Development	80.4%	61.6%	41.4%	29.1%	16.8%	12.0%
Other	79.1%	76.3%	64.3%	53.0%	10.7%	26.8%

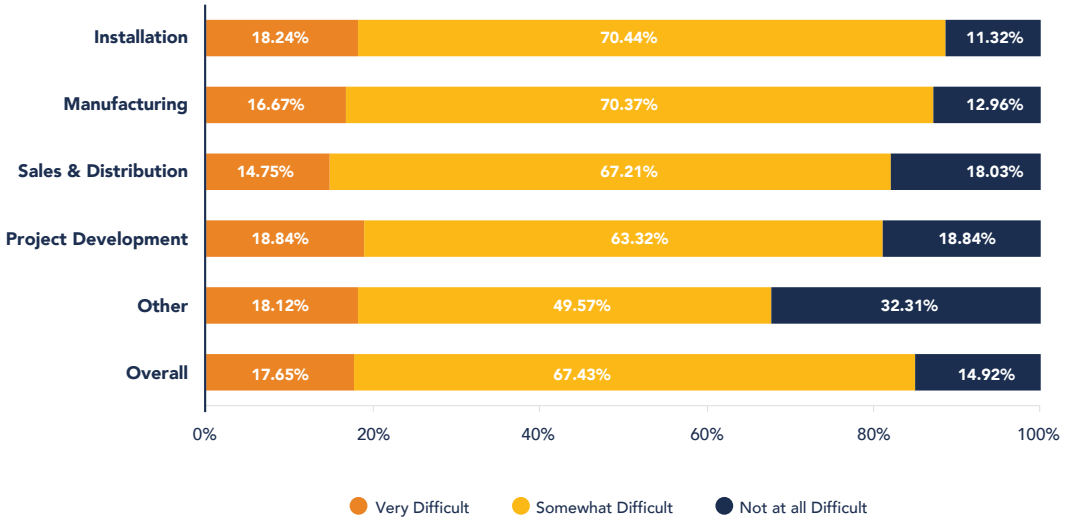
When qualified applicants join the solar industry as entry-level solar installers, there are staggering opportunities for rapid advancement and pay raises. According to an in-depth case study examining several major solar installers, entry-level installers were typically promoted at least once within six to 12 months of hire and saw an average increase in pay of 45% after promotion.[69]

Hiring Difficulties

An important metric for understanding potential gaps and surpluses in the solar labor market is employers' reported difficulty in hiring. The gap between solar workforce supply and demand, and difficulty hiring qualified new employees, creates inefficiencies and increases soft costs associated with solar installations.

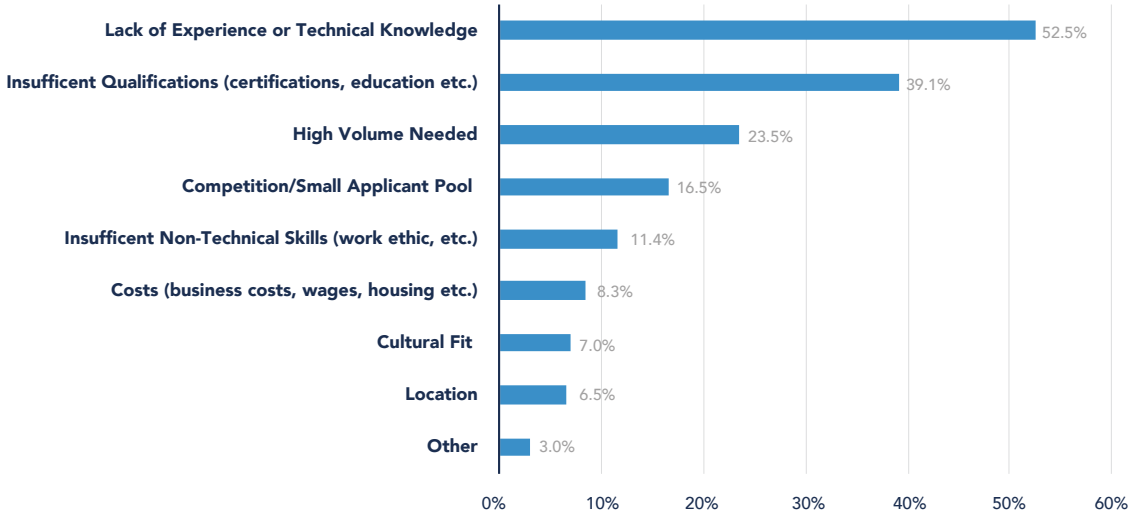
In the *Solar Jobs Census* survey, 18% of solar employers reported that it was very difficult to find qualified candidates to fill open positions, which is a decrease from 22.7% reporting such challenges in 2016. However, the broader measure for hiring difficulty, incorporating both "very difficult" to hire and "somewhat difficult" to hire responses, increased from 80% in 2016 to 85% in 2017. The percentage of establishments reporting no difficulty in hiring declined to just under 15%. The installation sector documented the most difficulty, with 89% of installation companies indicating it was either somewhat or very difficult to hire new employees. Notably, given the low national unemployment rate and growth in the construction industry, most industries experienced similar difficulties with hiring in 2017.[70]

Figure 11: Hiring Difficulty by Sector



The three primary reasons reported for hiring difficulty are lack of relevant experience or technical knowledge among the candidate pool, insufficient qualified applicants (certifications or education), and the high volume of workers needed. These factors were cited by around 52%, 39%, and 24% of respondents respectively.

Figure 12: Most Significant Reasons for Reported Difficulty Hiring



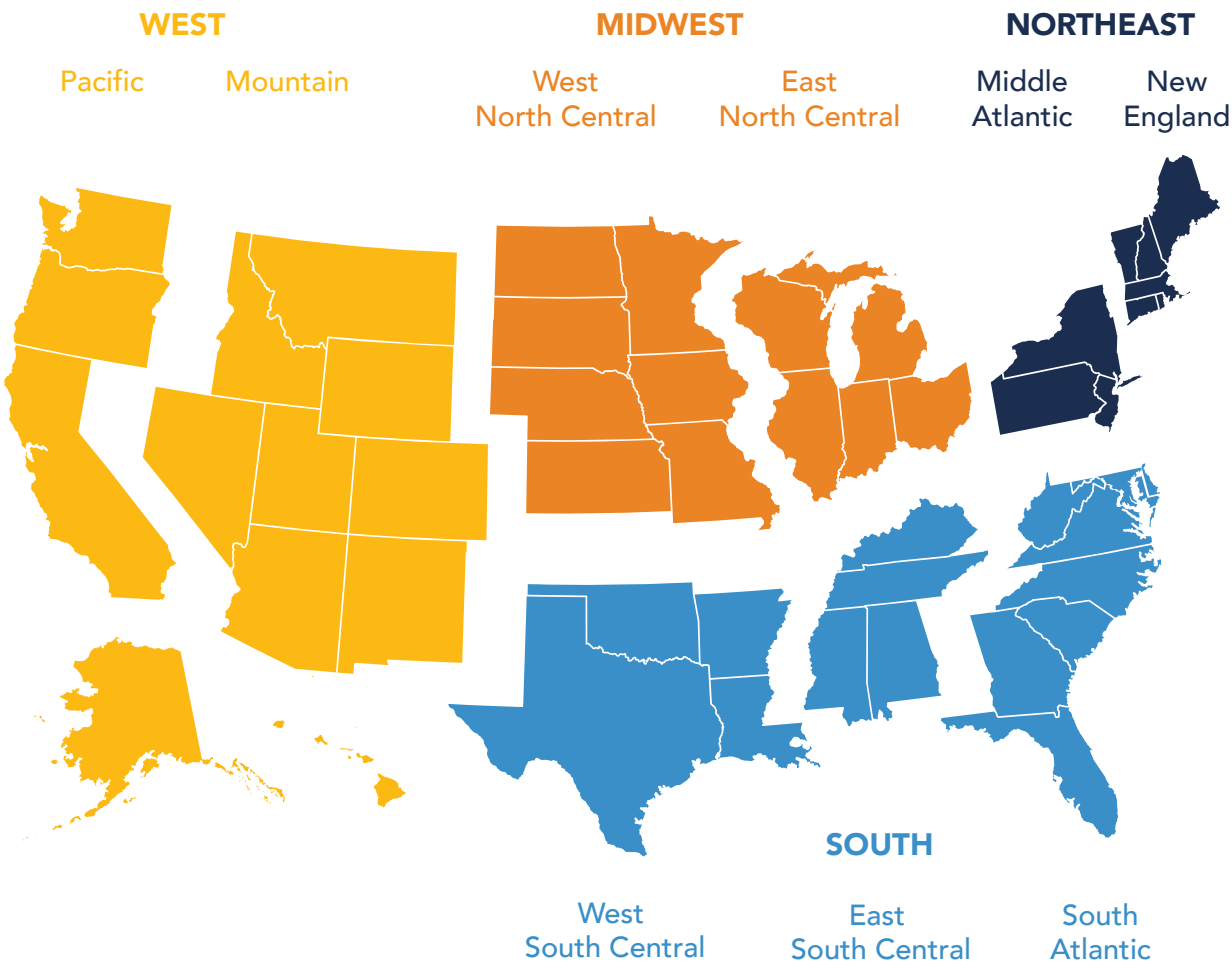
Solar workforce needs also vary state by state. Although the number of solar jobs declined in major states like California, the industry continued to expand in states with markets that were more recently established. Employers located in states with emerging solar markets that are experiencing rapid growth reported more hiring difficulties. For example, in Minnesota, where solar jobs grew by 48% and installed capacity increased rapidly in 2017, 33% of employers reported that it was very difficult to find qualified employees. This differed greatly from long established markets like California, where only 16% of employers cited significant difficulty hiring.

Breaking down the results by geographic region, solar establishments in the West North Central, West South Central, and East South Central regions reported the most significant hiring difficulty, with around 29% of establishments in each region reporting that it was very difficult to hire qualified candidates. In 2016, West North Central had the most difficulty hiring, followed by the Mid-Atlantic region. Hiring difficulties in the South may have been the result of growing pains due to the rapidly expanding solar industry in many Southern states.

Table 18: Hiring Difficulty By Census Region

	U.S. CENSUS DIVISIONS								
	NEW ENGLAND	MIDDLE ATLANTIC	EAST N. CENTRAL	WEST N. CENTRAL	SOUTH ATLANTIC	EAST S. CENTRAL	WEST S. CENTRAL	MOUNTAIN	PACIFIC
Very Difficult	13.03%	11.64%	16.78%	29.28%	19.18%	29.37%	29.54%	10.76%	17.78%
Somewhat Difficult	72.73%	71.80%	70.13%	63.87%	68.15%	70.63%	53.98%	73.25%	66.03%
Not at all Difficult	14.24%	16.57%	13.09%	6.85%	12.68%	0.00%	16.48%	15.99%	16.19%

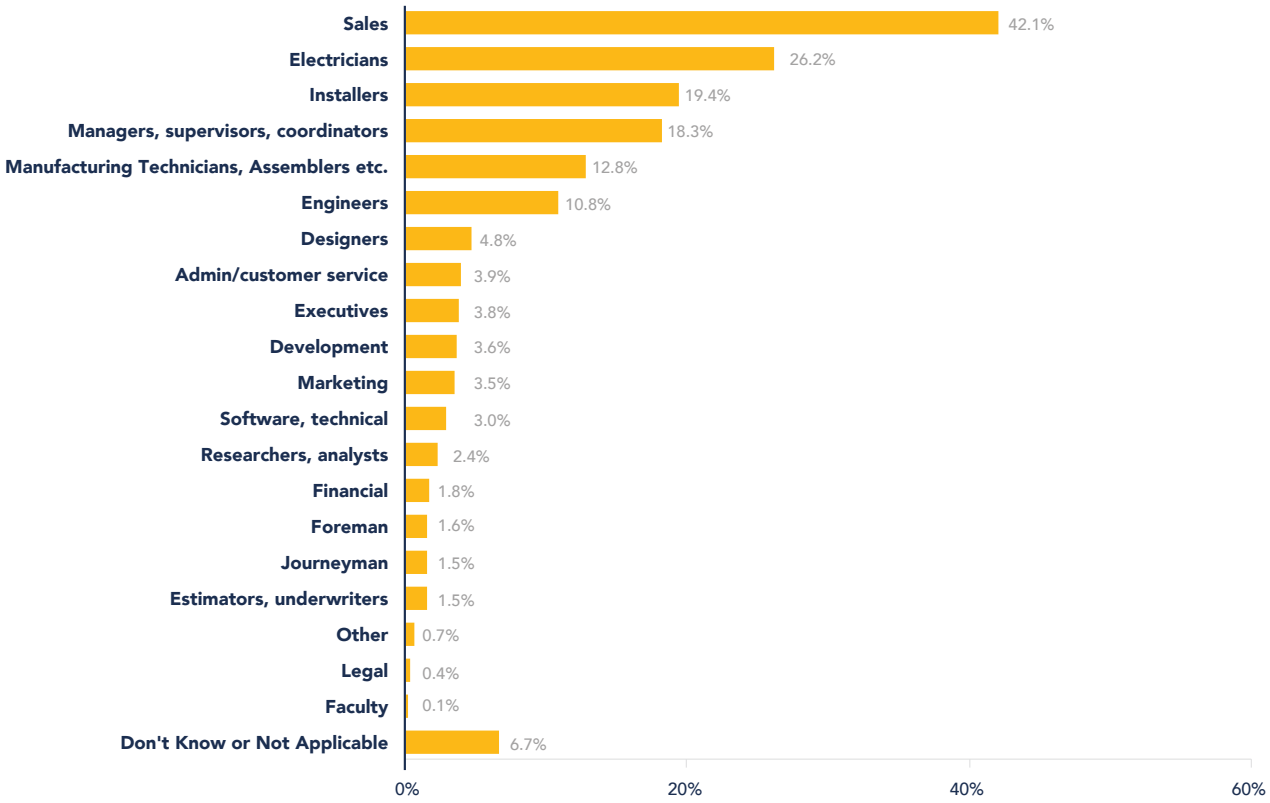
Figure 13: U.S. Census Divisions



The Solar Training Network, a U.S. Department of Energy-funded program led by The Solar Foundation, published a 2017 report which examined hiring challenges in the solar industry and recommended best practices for attracting qualified workers. The report, *Solar Training and Hiring Insights 2017*, found that 65% of solar employers reported that difficulty finding qualified workers led to increased costs, while 68% said that hiring difficulties impacted their company's ability to grow.[71] The report also showed that companies that invest more in post-hire training had lower installation labor costs on average. With continued and expanded investments in training, companies have the potential for enhanced labor efficiencies, improved safety standards, and higher quality installations.

Installation companies were the most likely to cite the high volume of hires needed as a primary reason for hiring difficulties. In some states that have seen a residential solar boom, customer acquisition is an increasing challenge and cost for solar companies.[72] Given these customer acquisition challenges and some states' rapidly growing solar industries, high quality sales professionals are in demand. Below, figure 14 details that the most difficult position to hire for is sales professional, with 42% of solar establishments citing this as the most challenging vacancy. Electrician is the second most difficult position to fill, likely due to strict electrician licensing requirements in some states.

Figure 14: Most Difficult Positions to Fill



CONCLUSION AND RECOMMENDATIONS

The solar industry's long-term growth has been rapid and significant. As annual *Census* surveys have documented, the industry's expansion has led the solar workforce to grow by 168% within seven years. In 2017, however, solar employment experienced its first decline since The Solar Foundation began tracking jobs in 2010. As we have seen, this reflects a slowdown from the record-setting industry expansion seen in 2016. Uncertainty regarding the Section 201 trade case, as well as other policy unpredictability, also contributed to the decline. But despite the roughly 4% decrease in solar jobs in 2017, 29 states and the District of Columbia saw solar job growth, including many states with emerging solar markets. While the industry faces major short-term challenges--including the impact of new tariffs--the declining price of solar installations, along with continued interest in decarbonization, resilience, and financial savings at the commercial, state, and local levels, all point to a strong long-term outlook for solar.

Positive Trends

Utilities, corporations, governments, and end consumers all have incentives to deploy solar, and new models and trends allow them to do so. Due to the plummeting cost of solar energy, utility-scale solar is competitive with other energy resources in many states, and as a result is expanding into states without RPS mandates and PURPA rules. In fact, voluntary procurement was the primary driver of 57% of utility PV PPAs signed in 2017.[73]

Strong customer demand from U.S. corporations and other non-residential ratepayers is another increasingly positive sign for solar energy in the near term. As of this report's release, 119 influential companies have made 100% renewable power commitments.[74] In Q3 2017, the non-residential PV segment (the commercial or C&I sector) was up 22% from Q3 2016.[75] Corporations like Walmart, Target, and Apple are deploying solar at a rapid rate.[76] Additionally, community choice aggregations and community solar programs are expanding, allowing local governments and end-consumers greater access to solar for their electricity needs and also contributing to the increase in non-residential solar.* Finally, state and local incentives continue to support all segments of solar around the country.

Technological advances and price drops in battery storage present new opportunities for solar co-located with storage. An increasing focus on resilience has consumers, businesses, and governments examining microgrid systems focused around solar, storage, and other distributed resources.[77] In the longer term, digitalization will allow for more flexibility and smoother integration of distributed energy like solar into the electricity system.

Potential Barriers to Growth

In the short term, policy uncertainty and the effects of the Section 201 trade case will likely have an adverse effect on the industry. As detailed in this report, a majority of solar companies predict negative effects on their business as a result of the trade case. Additionally, policy uncertainty and a lack of multi-year RPS policies and solar carveouts may hamper growth in some states. On the business side, residential installers in established solar markets cite customer acquisition as an increasing challenge. A scarcity of funding opportunities for research & development activities may hinder innovation and the development of more efficient solar technologies.

Still, in the long term, the opportunities will likely outweigh the barriers. A new focus on grid resilience, energy storage, and smart grids is emerging as America's energy system adjusts to meet modern needs. This paradigm shift will bring with it ample opportunities for solar to cement its place as a flexible, reliable, clean, secure, preferred energy source that will power the country for years to come.

* Non-residential solar includes corporate, government, and community installations.

RECOMMENDATIONS

Promote Stability and Predictability in Federal, State, and Local Policies

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 that provide the multi-year certainty needed to leverage project financing. Policies such as the ITC and accelerated depreciation, state-level RPSs, SRECs, PURPA, and net metering help support a vibrant solar market, and the stable continuation of these policies will help to support stable job and capacity growth.

Local governments can also play a key role in reducing solar soft costs and making it easier for consumers to go solar. Permitting and inspection programs, for example, play a significant role in installation costs and are within a local government's ability to improve and streamline. Municipalities and counties can work with local utilities to cut red tape and make the installation process faster and more efficient. Through the SolSmart program, 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 (more information at SolSmart.org).

Local-level decarbonization goals and policies could influence solar energy growth in the coming years. 2017 saw a record number of cities and states committing to 100% clean energy goals. At time of this report's release, 188 mayors across the United States have pledged their support for a community-wide transition to 100% renewable energy, and several U.S. cities have already reached that goal.[78]

Additionally, programs that allow loans to follow the home rather than the owner (such as property assessed clean energy, or PACE) could help serve consumers who, for various reasons, do not remain in their homes for the number of years that may be required for full payback of their systems.

Encourage Consumer Energy Choice

According to a 2016 Pew Research Center survey, almost nine in ten U.S. adults favor expanding the use of solar power.[79] Despite this nearly unanimous level of public support, solar is not a practical option for many Americans to use in their homes. Some prospective customers may rent rather than own their properties, and others may not have roofs suitable for solar. Consumers should be given more energy choices that allow them to benefit from solar energy in a variety of ways.

Many states are adopting approaches to provide these choices. For example, California has expanded the use of consumer choice aggregation, which allows local governments to pool their electricity load and provide more clean energy sources to interested customers. Minnesota has seen a recent upsurge in community solar. New York, Maryland, and Illinois all have ambitious plans for a scale-up of their own community solar programs. These types of policies meet consumer demand and let localities and end-consumers play an active role in choosing the energy they consume.

Importantly, the community solar market has the potential to serve lower-income populations, who have historically lacked access to clean power options. Lower-income households face several inherent barriers to going solar. These barriers include being less likely to own their roofs, 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 and extend the benefits of solar to all Americans. States around the country are experimenting with different ways to provide all communities with access to solar.

Support Early Stage Research and Development, Finance, and Commercialization

In recent years, solar energy has made a rapid ascent as the fastest growing global energy source. To ensure solar continues to become more efficient, cost effective, and competitive, crucial investments should be made in research & development. According to energy and environment expert Varun Sivarum, the solar industry is subject to "technology lock-in."[80] Public policies have encouraged the broad use of silicon solar and contributed to its rapid expansion. At the same time, this has supported the dominance of silicon cells over other potentially more effective technologies.

Given the uncertain returns on R&D investments, private sources are often reluctant to provide funding. This suggests an increased need for public sector support of early stage research and commercialization on new and more efficient solar technologies and applications. Other countries including China are prioritizing R&D as an important part of their solar policies.[81] U.S. investments in research and development should be prioritized to maintain a competitive edge and contribute to innovation, both in the industry and within the broader global clean energy economy.

Expand Solar + Storage as an Essential Component of Resiliency and Reliability Strategies

In the aftermath of the devastation from hurricanes in Texas, Florida, and Puerto Rico, as well as increased awareness of cyber and physical risks to the grid, discussions of resiliency and grid reliability have come into the spotlight. Solar + storage technology can play a foundational role in making communities more resilient to natural disasters and other risks. In Puerto Rico, for example, solar has provided power to emergency relief centers and hospitals, and many hope it will be an important part of efforts to rebuild the grid there (see text box, p17). Local officials have expressed interest in developing a system of solar-powered microgrids on the island.[82]

Solar can help to prevent power outages by providing emergency power sources for critical facilities. If designed properly, solar + storage systems can provide a grid-independent power source during outages. Solar can supply power to remote areas, and is flexible enough to be a mobile or temporary power source. It can also come online quickly, and provide sustaining energy for longer periods of time, unlike diesel generators that have limited fuel supplies. A large network of distributed energy generation like solar can also mitigate energy security concerns by reducing reliance on a single regional power source. Microgrids and critical facilities that incorporate solar + storage should become a key part of local, state, and federal resilience strategies.

Prioritize Industry Training Programs in States with Rapid Jobs Growth

Despite the contraction in solar jobs in 2017, a large majority of employer respondents to the *Census* survey indicated that they experienced some difficulty finding qualified employees last year. The lack of experience and training among candidates was listed as among the largest obstacles to hiring. As a result, solar companies and training providers should seek new opportunities to train new entrants to the solar industry, particularly in regions with new and rapidly expanding solar markets.

According to the *Solar Training Hiring and Insights* study conducted by The Solar Foundation's Solar Training Network, only 34% of solar employers surveyed provided a formal on-the-job training program.[83] In the same survey, two-thirds of employers said it would be highly valuable to have a standardized, industry-wide training program involving system installation and connection, system components, and electricity basics. Third-party training providers, local organizations, 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 microgrids.

Improvements can also be made in how solar companies recruit candidates. For recruitment, solar companies most commonly prefer to post jobs online and on social media sites, or advertise by word of mouth.[84] To expand the applicant pool, firms could expand to include underutilized resources like workforce development boards and local economic development organizations. Recruiting at high schools, vocational schools, universities, and community colleges could also improve the quality, diversity, and size of the applicant pool. 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, support for solar on K-12 schools should be prioritized. Solar on schools can not only cut schools' costs significantly, but also provide educational opportunities and introduce students to career opportunities in the field.

APPENDIX A: SOLAR JOBS BY STATE*†

STATE	2017 SOLAR JOBS	2016 SOLAR JOBS	YEAR/YEAR GROWTH	SOLAR JOBS RANK	SOLAR JOBS PER CAPITA RANK	2017 RATIO OF SOLAR WORKER TO OVERALL WORKFORCE	2016 RATIO OF SOLAR WORKER TO OVERALL WORKFORCE
AK	72	64	12%	51	50	1:4,721	1:5,325
AL	488	530	-8%	44	49	1:3,987	1:3,629
AR	284	271	5%	47	51	1:4,250	1:4,415
AZ	8,381	7,310	15%	6	10	1:322	1:359
CA	86,414	100,050	-14%	1	3	1:198	1:168
CO	6,789	6,004	13%	9	8	1:389	1:429
CT	2,168	2,174	0%	30	20	1:785	1:777
DC	1,294	1,180	10%	33	6	1:593	1:643
DE	549	363	51%	42	21	1:813	1:1,225
FL	8,589	8,260	4%	5	35	1:977	1:988
GA	4,310	3,924	10%	15	34	1:1,011	1:1,087
HI	2,715	3,194	-15%	26	5	1:240	1:202
IA	815	563	45%	38	42	1:1,929	1:2,778
ID	654	611	7%	41	36	1:1,107	1:1,145
IL	3,571	3,718	-4%	20	41	1:1,682	1:1,601
IN	2,775	2,700	3%	25	32	1:1,096	1:1,110
KS	538	467	15%	43	47	1:2,560	1:2,953
KY	1,293	1,202	8%	34	40	1:1,462	1:1,560
LA	2,668	2,922	-9%	27	22	1:715	1:653
MA	11,530	14,582	-21%	2	7	1:313	1:243
MD	5,324	5,429	-2%	13	13	1:506	1:490
ME	713	572	25%	40	26	1:882	1:1,091
MI	4,134	4,118	0%	17	33	1:1,056	1:1,044
MN	4,256	2,872	48%	16	16	1:682	1:991
MO	2,609	2,380	10%	28	30	1:1,080	1:1,171
MS	923	883	4%	37	38	1:1,223	1:1,269
MT	208	168	24%	48	44	1:2,272	1:2,783
NC	7,622	7,112	7%	7	17	1:572	1:602
ND	145	175	-17%	49	45	1:2,905	1:2,426
NE	1,375	1,585	-13%	32	18	1:716	1:618
NH	1,051	1,184	-11%	36	15	1:633	1:553
NJ	7,106	6,056	17%	8	14	1:580	1:669
NM	2,522	2,929	-14%	29	9	1:323	1:276
NV	6,564	8,371	-22%	10	2	1:203	1:154
NY	9,012	8,135	11%	3	29	1:1,045	1:1,139
OH	6,518	5,831	12%	11	24	1:832	1:919
OK	739	814	-9%	39	46	1:2,142	1:1,930
OR	3,965	4,509	-12%	18	12	1:482	1:415
PA	3,848	3,061	26%	19	39	1:1,523	1:1,890
RI	1,064	1,176	-10%	35	11	1:458	1:410
SC	2,829	2,772	2%	24	23	1:726	1:726
SD	485	478	2%	45	25	1:897	1:906
TN	4,411	3,548	24%	14	19	1:668	1:816
TX	8,873	9,396	-6%	4	37	1:1,359	1:1,257
UT	6,170	4,408	40%	12	4	1:233	1:316
VA	3,565	3,236	10%	21	31	1:1,090	1:1,184
VT	1,535	1,767	-13%	31	1	1:205	1:176
WA	3,433	3,681	-7%	22	28	1:977	1:891
WI	2,921	2,813	4%	23	27	1:994	1:1,021
WV	311	381	-18%	46	48	1:2,219	1:1,820
WY	144	152	-6%	50	43	1:1,946	1:1,851

* Appendix A in *Census* 2016 incorrectly labeled solar jobs per capita as ratio of "Solar Worker to Overall Workforce." 2016 data for this category is included in this appendix to correct this error.

† The Solar Foundation intended to include solar jobs data for Puerto Rico in this year's *Census*. However, due to power outages on the island during the survey period, we were unable to garner enough responses to provide statistically significant data. We look forward to including this data in future reports.

APPENDIX B: METHODOLOGY

The *National Solar Jobs Census* methodology is aligned with the U.S. Department of Labor Bureau of Labor Statistics' (BLS) methodology for its Quarterly Census of Employment and Wages and Current Employment Statistics (CES). Like the BLS, this study uses survey questionnaires and employer-reported data, though *Solar Jobs Census* surveys are administered by phone and email, as opposed to mail. This included approximately 59,300 phone calls and over 35,000 email invitations.

The *National Solar Jobs Census 2017* includes data gathered between October and November 2017 from known and potential solar energy establishments or locations. The survey was administered by BW Research Partnership to a known universe of solar employers that included 9,488 separate establishments, and was derived from the Solar Energy Industry Association's National Solar Database. Of these establishments, 2,389 provided information about their solar activities (or lack of solar activities), and 1,842 completed full or substantially completed surveys.

The survey was also administered to a stratified, clustered, random sampling of 168,305 establishments nationwide from various industries that are potentially solar-related. 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 5,930 establishments. Of these, 207 establishments qualified for full surveys.

Since responses to the survey are often not representative by industry, a weighting adjustment (by size of segment) is applied to the primary value chain of the responding location. This prohibits inaccuracy of responses by value chain (over-representation or under-representation) and ensures an accurate read of employment and other responses within the survey. This level of sampling rigor provides a margin of error of +/-1.25% for the national jobs numbers.

Since 2010, The Solar Foundation has defined a solar job as one held by a worker spending at least 50% of his or her time on solar-related work. Census findings have consistently shown that roughly 90% of these workers (89% in 2017) spend 100% of their time on solar-related work.

ENDNOTES

1 "Short-Term Energy Outlook." U.S. Energy Information Administration, 9 Jan. 2018, https://www.eia.gov/outlooks/steo/report/electricity.php.

2 Quarterly Census of Employment and Wages. Bureau of Labor Statistics, Q2 2017, https://data.bls.gov/cew/apps/table_maker/v4/table_maker.htm#type=1&year=2017&qtr=2&own=0&ind=10&supp=0.

3 *Electric Power Monthly*. U.S. Energy Information Administration, 24 Jan. 2018, https://www.eia.gov/electricity/monthly/.

4 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

5 Ibid.

6 *Global Solar Demand Monitor: Q4 2017*. GTM Research, December 2017, https://www.greentechmedia.com/research/report/global-solar-demand-monitor-q4-2017.

7 Beetz, Becky. "BNEF releases 2018 clean energy predictions," *PV Magazine*, 17 Jan. 2018, https://www.pv-magazine.com/2018/01/17/bnef-releases-2018-clean-energy-predictions/.

8 Publicover, Brian. "China's capacity additions approach 50 GW mark in 2017," *PV Magazine*, 4 Jan. 2018, https://www.pv-magazine.com/2018/01/04/chinas-capacity-additions-approach-50-gw-mark-in-2017/.

9 *Global Solar Demand Monitor: Q4 2017*. GTM Research, December 2017, https://www.greentechmedia.com/research/report/global-solar-demand-monitor-q4-2017.

10 *Renewable Power Generation Costs in 2017*. International Renewable Energy Agency, January 2018, http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017.

11 Hoium, Travis. "2018 Could be Another Record Year for Solar Energy," *The Motley Fool*, 5 Dec. 2018, https://www.fool.com/investing/2017/12/05/2018-could-be-another-record-year-for-solar-energy.aspx.

12 *Renewable Power Generation Costs in 2017*. International Renewable Energy Agency, January 2018, http://www.irena.org/publications/2018/Jan/Renewable-power-generation-costs-in-2017.

13 Lazard Levelized Cost of Energy Analysis - Version 11.0. Lazard, November 2017, https://www.lazard.com/media/450337/lazard-levelized-cost-of-energy-version-110.pdf.

14 Norton Rose Fulbright. (Producer). (2018). *Cost of capital: 2018 outlook* [Video webinar]. Retrieved from http://www.webcaster4.com/Player/Index?webcastId=24015&uid=4265077&g=29ad67c5-83ab-496a-981a-1ee306259e35&sid.

15 Eckhouse, Brian and Chris Martin. "Seeking renewables financing? Trump's tax plan made it harder," *Bloomberg*, 1 Jan. 2018, https://www.bloomberg.com/news/articles/2018-01-12/seeking-renewables-financing-trump-s-tax-plan-made-it-harder.

16 *U.S. Energy and Employment Report. U.S. Department of Energy*, Jan. 2017.

17 *U.S. Energy and Employment Report.* U.S. Department of Energy, Jan. 2017. https://energy.gov/downloads/2017-us-energy-and-employment-report.

18 "U.S. Solar Outlook-Initial Reactions to Section 201 Decision: Impact Analysis by State and Segment." GTM Research, Jan. 2018.

19 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

20 Puerto Rico. U.S. Energy Information Association, https://www.eia.gov/state/?sid=RQ.

21 Foehringer Mercant, Emma. "Puerto Rico Energy Commission Lays Out Rules for a Future Microgrid Landscape." *Greentech Media*, 8 Jan. 2018. https://www.greentechmedia.com/articles/read/puerto-rico-energy-commission-island-microgrid#gs.7hgdxas

22 "Comments of the AES Companies." Puerto Rico Energy Commission, 2017, http://energia.pr.gov/wp-content/uploads/2017/12/IN20170002A30-COMENTARIOS-AES.pdf.

23 Roselund, Christian. "Solar is Meeting More than 10% of Electric Demand in Three States." *PV Magazine*, 12 Dec. 2017, https://pv-magazine-usa.com/2017/12/12/solar-is-meeting-more-than-10-of-electric-demand-in-three-states/.

24 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

25 Ibid.

26 "Turmoil in Residential Solar." *PV Magazine*, July 26, 2017, https://pv-magazine-usa.com/2017/07/26/turmoil-in-residential-solar/

27 "The Top 5 Solar Stories of 2017." *PV Magazine*, December 22, 2017, https://pv-magazine-usa.com/2017/12/22/the-top-5-solar-stories-of-2017/

28 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

29 Ibid.

30 Farrell, John. "PURPA: A quiet death or longer life after 40 years of wholesale electricity competition?" *Greentech Media*, 17 Sept. 2017, https://www.greentechmedia.com/articles/read/a-quiet-death-or-longer-life-after-40-years-of-wholesale-electricity-compet#gs.dD_NAu8.

31 Warren, Chris. "The national debate unfolding over PURPA and solar power." *Greentech Media*, 28 Aug. 2017, https://www.greentechmedia.com/articles/read/national-debate-purpa-solar-power#gs.tooxrk0.

32 Lutey, Tom. "Hot mic records troubling conversation about solar regulations." *The Billings Gazette*, 27 June 2017, http://billingsgazette.com/news/government-and-politics/hot-mic-records-troubling-conversation-about-solar-regulations/article_8499a49d-e281-5dd7-aae7-aecccfa0394e.html.

33 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017. Note: Utility-scale costs are an average of fixed-tilt and single-axis tracking.

34 Ibid.

35 Ibid.

36 *Annual Photovoltaic Cell/Module Shipments Report*. U.S. Energy Information Administration, Jan.2018, https://www.eia.gov/renewable/monthly/solar_photo/pdf/renewable.pdf.

37 *Did Trump's Solar Tariffs Just Launch a US Manufacturing Renaissance? Greentech Media*, 24 Jan. 2018, https://www.greentechmedia.com/articles/read/trump-solar-tariffs-manufacturing-renaissance#gs.Hq3LFB0.

38 "Annual Photovoltaic Cell/Module Shipments Report." U.S. Energy Information Administration, January 2018, https://www.eia.gov/renewable/monthly/solar_photo/pdf/renewable.pdf.

39 *U.S. Solar Market Insight Q4 2016*. Solar Energy Industries Association and GTM Research, 2016.

40 Pickerel, Kelly. "U.S. Solar Panel Manufacturing Is Not Dead." Solar Power World, 31 Jul. 201, https://www.solarpowerworldonline.com/2017/07/u-s-solar-panel-manufacturing-not-dead/.

41 *First Solar Shows Off Production Line Under Development for New Panels*. The Toledo Blade, 5 Dec. 2017, http://www.toledoblade.com/Energy/2017/12/05/First-Solar-shows-off-production-line-under-development-for-new-panels.html.

42 "Breaking: JinkoSolar confirms plans to Invest $410 million in Jacksonville, Florida." *PV Magazine*,29 Jan. 2018, https://pv-magazine-usa.com/2018/01/29/breaking-jinkosolar-confirms-plans-to-invest-410-million-in-jacksonville-florida/

43 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

44 *Current Employment Statistics*. Bureau of Labor Statistics, 5 Jan. 2017.

45 Stafford, Diana. "Company that expected to create hundreds of jobs in Kansas City has cut majority of its staff." *Kansas City Star*, 9 March 2017, http://www.kansascity.com/news/business/technology/article137544248.html.

46 Spector, Julian. "Struggling Sungevity lays off workers after merger falls through." *Greentech Media*, 17 Feb. 2017, https://www.greentechmedia.com/articles/read/struggling-sungevity-lays-off-workers-after-merger-falls-through.

47 Lacey, Stephen. "NRG fully exits the home solar installation business." *Greentech Media*, 15 Feb. 2017, https://www.greentechmedia.com/articles/read/nrg-sheds-the-final-remnants-of-its-home-solar-business#gs.n2z1auc.

48 *U.S. Solar Market Insight Q3 2017*. GTM Research and Solar Energy Industries Association, 14 Dec. 2017, https://www.seia.org/research-resources/solar-market-insight-report-2017-q4.

49 Roselund, Christian. "Breaking: Suniva petition could start new global solar trade war." *PV Magazine*, 26 April 2017, https://www.pv-magazine.com/2017/04/26/breaking-suniva-petition-could-start-new-global-solar-trade-war/.

50 Pyper, Julia. "SolarWorld files for insolvency, citing 'ongoing price erosion.'" *Greentech Media*, 10 May 2017, *https://www.greentechmedia.com/articles/read/solarworld-files-for-insolvency-citing-ongoing-price-erosion#gs.=bqlW6Q*.

51 Pyper, Julia. "American solar manufacturer Stion to 'discontinue operations.'" *Greentech Media*, 17 Oct. 2017, https://www.greentechmedia.com/articles/read/american-solar-manufacturer-stion-discontinue-operations-layoffs#gs.Bl9SwC4.

52 Hoium, Travis. "Solar stocks are ridiculously cheap again." *The Motley Fool*, 14 Oct. 2017, https://www.fool.com/investing/2017/10/14/solar-stocks-are-ridiculously-cheap-again.aspx.

53 Hoium, Travis. "Why shared of Vivint Solar Inc. popped 59% in 2017." *The Motley Fool*, 15 Jan. 2018, https://www.fool.com/investing/2018/01/15/why-shares-of-vivint-solar-inc-popped-59-in-2017.aspx.

54 Pyper, Julia. "Trump Administration Issues 30% Solar Panel Import Tariff." *Greentech Media*, 22 Jan. 2018, https://www.greentechmedia.com/articles/read/breaking-trump-admin-issues-a-30-solar-tariff#gs.j7KjTSY.

55 Roselund, Christian. "Section 201 solar tariffs to be felt across market segments." *PV Magazine*, 30 Jan. 2017, https://pv-magazine-usa.com/2018/01/30/gtm-research-effects-of-section-201-solar-tariffs-to-be-felt-across-markets/.

56 *President's Decision on Solar Tariffs is a Loss for America*. Solar Energy Industries Association, 22 Jan. 2016, https://www.seia.org/news/presidents-decision-solar-tariffs-loss-america

57 *Current Employment Statistics*. Bureau of Labor Statistics, 5 Jan. 2017.

58 "Runaway 53 GW solar boom in China pushed global clean energy investment ahead in 2017." *Bloomberg New Energy Finance*, 16 Jan. 2018, https://about.bnef.com/blog/runaway-53gw-solar-boom-in-china-pushed-global-clean-energy-investment-ahead-in-2017/.

59 "Solar industry corporate funding Surges Up 41% with $12.8 billion in 2017, Reports Mercom Capital Group," *Mercom Capital Group*, 8 Jan. 2018, http://mercomcapital.com/corporate-funding-up-41-percent-in-solar-industry-with-$12.8-billion-in-2017.

60 Pyper, Julia. "BNEF: Clean energy investments down 17% year-over-year in Q1 2017." *Greentech Media*, 11 April, https://www.greentechmedia.com/articles/read/bnef-clean-energy-investments-down-17-year-over-year-in-q1-2017.

61 Clover, Ian. "Solar corporate funding activity increases by 100 in Q1 finds Mercom Capital." *PV Magazine*, 11 April 2017, https://www.pv-magazine.com/2017/04/11/solar-corporate-funding-activity-increases-by-100-in-q1-finds-mercom-capital/.

62 Djordjevic, Maria. "Solar markets see increase in total funding in first half of 2017." *PV Magazine*, 9 Aug. 2017, https://www.pv-magazine.com/2017/08/09/solar-markets-see-increase-in-total-funding-in-first-half-of-2017/

63 "Runaway 53 GW solar boom in China pushed global clean energy investment ahead in 2017." *Bloomberg New Energy Finance*, 16 Jan. 2018, https://about.bnef.com/blog/runaway-53gw-solar-boom-in-china-pushed-global-clean-energy-investment-ahead-in-2017/.

64 *2017 U.S. Solar Industry Diversity Study*. The Solar Foundation, September 2017, www.TheSolarFoundation.org/diversity.

65 For Ethnic and Racial Demographics: "Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity." Bureau of Labor Statistics, 2017. https://www.bls.gov/cps/cpsaat18.htm
For Veterans and Older Workers: "Employment status of the civilian noninstitutional population by age, sex, and race." Bureau of Labor Statistics, 2017, https://www.bls.gov/cps/cpsaat48.htm.

66 "Employed persons by detailed industry, sex, race, and Hispanic or Latino ethnicity." Bureau of Labor Statistics, 2017, https://www.bls.gov/cps/cpsaat18.htm.

67 Mayer, Roger and Jing Zhao. "Do Pro-Diversity Policies Improve Corporate Innovation?" *Financial Management*, December 2017, http://onlinelibrary.wiley.com/wol1/doi/10.1111/fima.12205/abstract.

68 "National employment and wage data from the Occupational Employment Statistics survey by occupation." Bureau of Labor Statistics, May 2016. https://www.bls.gov/news.release/ocwage.t01.htm.

69 *Solar Hiring and Training Insights 2017*. The Solar Foundation, April 2017, SolarTrainingUSA.org.

70 *2017 Hiring Outlook*. The ExecuSearch Group, 12 Jan., 2017, http://www.execu-search.com/~/media/Resources/pdf/2017_Hiring_Outlook_eBook.

71 *Solar Hiring and Training Insights 2017*. The Solar Foundation, April 2017, SolarTrainingUSA.org.

72 Westoff, Eric, "Costs to Acquire Residential Solar Customers Are High and Rising." *Greentech Media*, 6 Jul. 2017, https://www.greentechmedia.com/articles/read/costs-to-acquire-us-residential-solar-customers-are-high-and-rising#gs.EPvICwc.

73 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

74 "Companies." RE 100, http://there100.org/companies. Accessed January 2018.

75 *U.S. Solar Market Insight Q3 2017*. Wood Mackenzie, Limited, and the Solar Energy Industries Association (SEIA®), 2017.

76 "Solar Means Business 2016." Solar Energy Industries Association, 19 Oct. 2016, https://www.seia.org/solar-means-business-report.

77 Palazzi, Titiaan, Laurie Guevara-Stone. "The Importance of Distribution-Scale Solar for Grid Resilience." Rocky Mountain Institute, 22 Sept. 2017, https://www.rmi.org/news/importance-distribution-scale-solar-grid-resilience/.

78 "Mayors for 100% Clean Energy." Sierra Club, 2018, https://www.sierraclub.org/ready-for-100/mayors-for-clean-energy.

79 Kennedy, Brian. "Americans Strongly Favor Expanding Solar Power." Pew Research Center, October 5, 2016, http://www.pewresearch.org/fact-tank/2016/10/05/americans-strongly-favor-expanding-solar-power-to-help-address-costs-and-environmental-concerns/.

80 Sivarum, Varun. "Unlocking Clean Energy." Issues in Science and Technology, Winter 2017, http://issues.org/33-2/unlocking-clean-energy/.

81 Ball, Jeffrey et al. "The New Solar System."Steyer-Taylor Center for Energy Policy and Finance, 21 Mar. 2017, https://law.stanford.edu/publications/the-new-solar-system/.

82 Cheslow, Daniella, "Hurricanes blew away Puerto Rico's Power Grid. Now Solar Power is Rising to fill the Void." Pittsburgh Post-Gazette, 5 Jan., 2018, http://www.post-gazette.com/powersource/consumers-powersource/2018/01/05/Hurricanes-blew-away-Puerto-Rico-s-power-grid-Now-solar-power-is-rising-to-fill-the-void/stories/201801040264.

83 *Solar Hiring and Training Insights 2017*. The Solar Foundation, April 2017, SolarTrainingUSA.org.

84 *2017 U.S. Solar Industry Diversity Study*. The Solar Foundation, September 2017, www.TheSolarFoundation.org/diversity.

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