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BEFORE THE ARIZONA CORPORATION COMMISSION

SUSAN BITTER SMITH, CHAIRMAN
BOB STUMP, COMMISSIONER
BOB BURNS, COMMISSIONER
TOM FORESE, COMMISSIONER
DOUG LITTLE, COMMISSIONER

IN THE MATTER OF THE APPLICATION OF UNS ELECTRIC, INC. FOR THE ESTABLISHMENT OF JUST AND REASONABLE RATES AND CHARGES DESIGNED TO REALIZE A REASONABLE RATE OF RETURN ON THE FAIR VALUE OF THE PROPERTIES OF UNS ELECTRIC, INC. DEVOTED TO ITS OPERATIONS THROUGHOUT THE STATE OF ARIZONA, AND FOR RELATED APPROVALS.	**DOCKET NO. E-04204A-15-0142** **DIRECT TESTIMONY OF MARK FULMER (RATE DESIGN AND COST OF SERVICE)**

The Alliance for Solar Choice hereby provides notice of filing the Direct Rate Design and Cost of Service Testimony of Mark Fulmer in the above-referenced matter.

Respectfully submitted this 9th day of December, 2015.

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Contents

I. Introduction

Q: Please state your name.

A: Mark Fulmer.

Q: Did you provide testimony on behalf of The Alliance for Solar Choice (TASC) in this proceeding on November 6, 2015.

A: Yes.

Q: What is the purpose of this testimony?

A: In this testimony I address the reasonableness of UNS's proposed residential three-part rate and Rate Riders 10 and 11.

Q: Please summarize your conclusions.

A: First, while it may allow a utility to more easily collect its revenue requirement, UNS's proposal to place all residential and small commercial distributed generation (DG) customers onto a three-part rate (Rider 10) is fundamentally flawed in numerous ways. As such it must be rejected.

Second, UNS's proposal to credit DG exports at a rate that can change based on the price of a power purchase agreement (PPA) for power purchased by a different utility that may have very different attributes than UNS is unreasonable and should be rejected. The current policy of banking credits month-to-month should be continued.

Third greater use of optional time of use (TOU) rates, be they for full-service

customers in addition to customers with DG, can reflect cost causation as well as send customers price signals to which they can actually respond. As such, if one were to choose, it is better to encourage greater use of optional TOU rates than to pursue residential demand charges.

II. There Are Fundamental Policy Problems With UNS's Proposal

Q: Please summarize UNS's proposed residential rate design changes for DG customers.

A: First, UNS is proposing to create two "three-part" residential rates: RES-01 Demand and RES-01 Demand TOU. These rates would consist of (1) a monthly customer charge, (2) a per-kilowatt-hour (kWh) energy charge, and (3) a charge based on the peak demand of the residential customer that occurred during the billing period (Table 1). These two rates would be optional for standard residential customers, but residential DG customers whose systems are installed after June 1, 2015 would be required to take service under one of the three-part rates.

Table 1. Proposed Three-Part Residential Rates

	RES-01 Demand	RES-01 Demand TOU
Basic Service Charge	$20/mo.	$20/mo.
Demand Charge		
0 – 7 kW	$6.00/kW	$6.00/kW
Over 7kW	$9.95/kW	$9.95/kW
Energy Charge		
All	$0.054260/kWh	
Summer on-peak		$0.111110/kWh
Summer off-peak		$0.043900
Winter on-peak		$0.108960
Winter off-peak		$0.043579

Second, UNS is proposing Rider 10, Net Metering for Certain Partial Requirement Service (NM-PRS), to take effect on June 1, 2015. Rider 10 applies to:

> ...any Customer with a facility for the production of electricity on its premises using Renewable Resources, a Fuel Cell or Combined Heat and Power (CHP) to generate electricity, which is operated by or on behalf of the Customer, is intended to provide all or part of the Customer's electricity requirements, has a generating capacity less than or equal to 125% of the Customer's total connected load at the metered premise. (Rider 10, sheet 710)

Thus it applies to ALL customers with qualifying behind-the-meter DG, regardless of whether or not that customer exports any electricity to the grid. Rider 10 also requires that customers with DG must be on a demand-based rate. Lastly, Rider 10 requires that, "If at any time within a billing month the Customer's generation facility's energy production exceeds the energy consumed by the Customer, the Customer's bill for the same billing period shall be credited for the excess generation priced at the approved Renewable Credit Rate" (Rider 10 sheet 710-1). Thus this Rider is not technically "net-metering," which under FERC PURPA standards requires that excess generation be used to offset "electric energy provided by the electric utility to the electric consumer during the applicable billing period."[1] In addition, the Corporation Commission's own Net Metering Rules set forth that net metering involves a kWh for kWh credit for exported energy.[2]

Rider 11 specifies the Renewable Credit Rate at which DG customers would be compensated for excess generation. The Renewable Credit Rate would be set at "the rate equivalent the most recent utility scale renewable energy Power Purchase Agreement (PPA) connected to the distribution system of the Company's affiliate, Tucson Electric

[1] *See*, Section 1251 (a) of the Energy Policy Act of 2005.
[2] *See*, R14-2-2306(D)

Power Company."

Q: What concerns do you have about how the Renewable Credit Rate in Rider 11 is set?

A: I have five concerns. First, DG solar can provide greater benefit to the grid than utility-scale generation[3]; therefore the price of utility-scale resources is not an accurate or appropriate proxy and would not adequately compensate the system owner for the DG solar system's output.

Many of these benefits, such as potential transmission and distribution savings, apply also when solar DG is compared to central solar stations. As I pointed out in more detail in my November 6th testimony in this docket, DG solar offers a distinct benefit to the utility and its ratepayers and offsets the variability issues inherent in utility scale solar. The fact that DG is distributed makes it a more reliable and steady source of power than even smaller utility scale projects.[4] In addition, solar DG offers the same emissions savings as central solar PV, but without the potential habitat, visual and cultural impacts associated with utility-scale solar plants. For example, the Department of Energy's SunShot Vision study from February 2012 draws from the draft *Solar Programmatic Environmental Impact Statement (Solar PEIS) on Solar Energy Development on BLM-Administered Lands in the Southwestern United States* to note that the primary ecological and other land-use impacts of solar development relate to land used for utility-scale PV

[3] E.g., "Deployment of Distributed Generation for Grid Support and Distribution System Infrastructure: A Summary Analysis of DG Benefits and Case Studies" Prepared for NYSERDA by Pace Energy and Climate Center and Synapse Energy Economics 2011; "A Regulator's Guidebook: Calculating the Benefits and Costs of Distributed Solar Generation", Interstate Renewable Energy Council 2013.

[4] See, Testimony of Mark Fulmer, November 6, 2015, at 13:19-15:16.

and concentrating solar (rooftop installations have negligible direct land-use impacts).[5] Even with the most careful land selection, utility-scale solar development may have significant local land-use impacts, especially in areas of the southern United States where there is large potential for solar.[6] The impacts of utility-scale solar development include direct impacts, such as soil disturbance, habitat fragmentation, and noise, and indirect impacts, such as changes in surface water quality because of soil erosion at the construction site.[7]

Q: What are your second and third concerns?

A: Second, the Rider 11 rate is set based upon a transaction of a different utility: the most recent renewable PPA with Tucson Electric Power (TEP). While TEP is an affiliate of UNS, it is not UNS. This begs the question, "why not Arizona Public Service (APS) or Salt River Project (SRP) or even Nevada Power, whose load center (Las Vegas) is closer to the bulk of UNS's load than Tucson is?"

Third, the potential variability of this payment rate is concerning. It can change significantly from year-to-year, depending upon the resource needs of TEP and the PPAs it enters into to meet those needs. If UNS is treating excess generation more like a supply resource, which I believe it is with this proposal by applying a utility scale electricity purchase price to much smaller solar DG electricity, pricing the supply at an uncertain value is not fair. I cannot imagine that a developer of a utility-scale solar project would enter into a contract with a provision to base the PPA price upon the price of a contract entered into by a different utility and a third-party solar provider, which would change

[5] "The SunShot Vision Study," Department of Energy, February 2012 (DOE 2012) p. 170
[6] *Ibid.*
[7] *Ibid.*

unpredictably the next time that utility entered into a new PPA. Under these conditions, a utility-scale project would likely not even be able to secure financing. This kind of variability and uncertainty is not even appropriate for a feed-in-tariff. Certainly, if UNS is committed to treating its residential customers as if they are for profit PPA providers, it should be prohibited from forcing terms on those residential customers that a PPA provider would outright reject.

Q: What is your fourth concern with Rider 11?

A: Fourth, the value of renewable power is not the same across technologies. TEP might acquire through a PPA with a geothermal project, which could provide baseload power and thus likely have a lower price than solar, even though solar provides power during times of high system load when power is more valuable. Or it might be tied to a wind project, whose generation profile would also differ from that of solar PV and thus provide a different—and likely lower—value to the utility.

Q: What is your fifth concern?

A: Last, I understand there to be concerns around taxation of income derived from exported power sold to the utility in this manner, as well as potentially jeopardizing access to the federal solar tax credit. TASC has raised these concerns when similar proposals have been raised both in Arizona and elsewhere.[8]

Q: What is the impact of Rider 11 on a UNS customer contemplating DG?

[8] Reply Comments of The Alliance For Solar Choice, Solar Energy Industries Association And California Solar Energy Industries Association On Party Proposals, Appendix C. Submitted to the California Public Utilities Commission in Rulemaking 14-07-002. September 15, 2015.

A: Not knowing at what rate the customer would be compensated for any power he or she exports adds a serious layer of uncertainty in the decision-making process of whether or not to adopt solar DG. As described above, the Rider 11 rate will be based on a utility-scale project that contributes fewer benefits to UNS's system than DG, such as reductions to line losses and peak load, and potential deferral of transmission, distribution, and generation investments.[9] As a result, the Rider 11 rate will undervalue the electricity that customers generate with DG solar. Further, as proposed, Rider 11 will likely act more like a ratchet, ever going down. This obviously creates a problem for someone considering an investment in a fixed asset.

Moreover, I know of no contracts for utility-scale power with pricing based on a contract between an unrelated entity and a utility serving a different jurisdiction. A plant subject to such a pricing scheme could never get financed. Applying this to DG-generated power is just as unreasonable.

Q: How does UNS justify its three-part rate and proposed requirement that DG customers be on it?

A: UNS witness Dukes states that a "Demand charge should provide customers with a price signal that accurately reflects the cost of system resources that must be available to serve the individual peak load"[10] He further states that such a rate design will move some of the so-called "fixed" costs into a rate component that DG customers must pay.[11]

[9] *See* footnote 3.
[10] Dukes at p. 17.
[11] *Ibid.*, at p 23.

Q: Do you find this rationale compelling?

A: No. UNS's arguments supporting the three-part rate focus solely on cost recovery and do not consider other ratemaking factors and objectives.

Q: What other factors must be reviewed when considering a major rate changes such as this?

A: A major concern that I have is that the arguments for the three-part rate, as well as its design, are based on a shortsighted view of costs and cost causality. In UNS's cost-causation world, there are two kinds of costs: sunk (fixed) and variable. The only variable costs are those associated with the operating costs of power plants. As Mr. Dukes states in his testimony, "The only completely avoidable cost is the variable cost related to the energy production, primarily fuel, purchased power and any O&M costs directly related to energy production or procurement."[12] Everything else is sunk and treated as fixed.[13]

Q: Do you agree that all costs that are not associated with fuel and power plant O&M are fixed?

A: No. While perhaps this division of variable and fixed costs may be true in the short run, in the long run it clearly is not. Costs that are now sunk were based on assumptions of the future. For example, in proposing to purchase Gila Bend, UNS did not simply consider the cost of the plant.[14] If the cost of capacity were the only consideration, UNS could have acquired a simple-cycle combustion turbine for less. But UNS instead chose a plant whose capital costs, which as soon as the ink is dry on the contract becomes a

[12] Dukes at p. 10.
[13] *Ibid.*
[14] UNS Integrated Resource Plan, pp. 245-247.

sunk fixed costs, are higher in order to reap the benefit of lower operating (variable) costs in the future.

In the time running up to the purchase of a capacity asset, the prudent utility will look at its needs in the future and consider all the options for meeting those needs in a least-cost fashion, be it fossil generation, demand response, energy efficiency, or something else. That is the heart of integrated resources planning.

Considering only very short-term costs in ratemaking ignores the long view. If you can take actions NOW that can save ratepayers money (or reduce risk or meet some other planning goal) in the future, at higher costs today, they are likely the correct actions to take.

In order to make those kinds of decisions with respect to ratemaking, long-run avoided costs must be considered. Even through reducing the load on a distribution circuit now might not change its immediate costs, it very well might extend its life or mitigate the need to install a greater capacity line in the future.[15] This long-run marginal cost view is already being used in Arizona to evaluate energy efficiency investments, not the fixed-variable split being proposed here for ratemaking.

By not taking the longer view and fixating on short run avoided costs and cost recovery in their ratemaking, UNS will be implementing rates that may allow it to more easily collect its return on investment at the expense of higher rates in the future. While this may be beneficial to UNS, it is detrimental to its ratepayers.

Q: While UNS focused on cost recovery by proposing residential demand charges, what are some of the other factors that should be considered in making rates?

[15] *See* footnote 3.

A: Mr. Duke cites to the authoritative text on rate design, John Bonbright's *Principle of Public Utility Rates*, on a number of "foundational principles." These include simplicity, understandability, public acceptability, free from controversies as to proper interpretation, avoidance of undue discrimination, efficiency to discourage wasteful use of service, revenue stability, and effectiveness in yielding total revenue requirement.[16] I find that UNS has focused on the last two listed here—revenue stability and yielding total revenue requirement, at the expense of some of the other principles. As I discuss throughout this testimony, UNS's proposal to double the monthly customer charge and require new DG customers to be on a three-part rates violates the principles of understandability, public acceptability, avoidance of undue discrimination, and wastefulness.

III. UNS's Riders 10 and 11 Are Discriminatory Towards DG Customers

Q: Is requiring DG customers to be on one of the two RES-01 DEMAND tariffs fair?

A: I do not believe so. Even setting aside my general concerns with a residential three-part rate, the way that UNS is applying it via Rider 10 is unreasonable.

First, it is discriminatory towards those customers who have chosen to use a particular technology in their home. It doesn't matter if they never export power to the grid, they would still be required to take service on a tariff that may not—and likely will not—be in their best interest. In essence, UNS is proposing to "look behind the meter" into someone's home (or at minimum on their roof) to see if they are using a particular technology and then force them onto a different rate. This strikes me as unreasonably

[16] Dukes at pp. 8-9.

invasive of customers' privacy.[17] UNS does not require customers with particularly efficient (or inefficient) appliances to register and be placed on a special rate. Doing so for customers who take a different action that changes their metered electricity profile is not reasonable.

Furthermore, as UNS witnesses have pointed out, there are other low-usage customers who may not be paying what UNS characterizes as their fair share of utility costs: apartments, small efficient homes, seasonal residences and vacant homes.[18] From a kilowatt-hour per month perspective, without looking into the home, these customers are not distinguishable. As witness Dukes has pointed out, "approximately two-thirds of the bills issued in the last 4 years to residential customers (applying the current RES-01 rate) did not provide fixed cost recovery equivalent to the class average."[19] While UNS is partially addressing this concern through its proposed increase in monthly customer charges, from $10 to $20 per month, a lack of fixed cost collection is also the major rationale for requiring DG customers to be on a three-part tariff. But since there are a significantly greater number of customers with similarly less-than-average usage who would not be subject to Rider 10, applying it only to customers with DG is clearly discriminatory. Residential customers with DG do not constitute a separate rate class, and as such should not be treated as one.

[17] The only exception to this is when something on the customer-side of the meter could affect safety. Hence it is appropriate for interconnection but not for billing.
[18] Dukes at p. 11.
[19] Dukes at p. 13.

IV. UNS's Analysis Supporting Rider 10 Is Misleading

Q: How does UNS Witness Dukes characterize the impact of the proposed RES-01 DEMAND tariff on residential customers who install solar PV after June 1, 2015?

A: Mr. Dukes shows the average bill for a customer using an average of 500 kWh per month, 900 kWh/month; 1,200 kWh/month and 1,500 kWh/month under four cases: RES-01 full requirements (i.e., no DG); RES-01 with net metering and banking, RES-01 excess power purchased per Rider 11, and RES-01 DEMAND plus Riders 10 and 11.[20] He then focuses on the percentage bill savings experienced under the proposed rates for customers with solar DG, characterizing them as "significant."[21] In presenting the information this way, he is implying that the impacts are not great and would not dramatically impact the economics of installing DG.

Q: Would the economics of installing DG be dramatically changed under the UNS proposal?

A: Yes. This is clearly seen by looking at the same data Mr. Dukes used in his tables in two other ways. First, rather than comparing the DG customer bill under the UNS proposal to the bill with no DG, it is illuminating to compare the bill for a customer with DG under the current tariff to that under the proposed tariff. This comparison is shown in Figure 1 and Table 2. As the figure shows, for most DG customers, their UNS bills would be more than double under the proposed tariffs as compared to continuing to allow net metering (with banking). Numerically, the annual UNS bill for a small user (500

[20] Dukes at p. 29.
[21] Dukes at pp. 29-30.

kWh/mo. average) would be nearly $240 more under the proposal relative to NEM with banking (status quo). For a large user (1,200 kWh/mo.), for whom solar DG would likely be more attractive, the rate difference is over $530 per year.

Figure 1. Annual Average Bill for a Customer with Solar DG

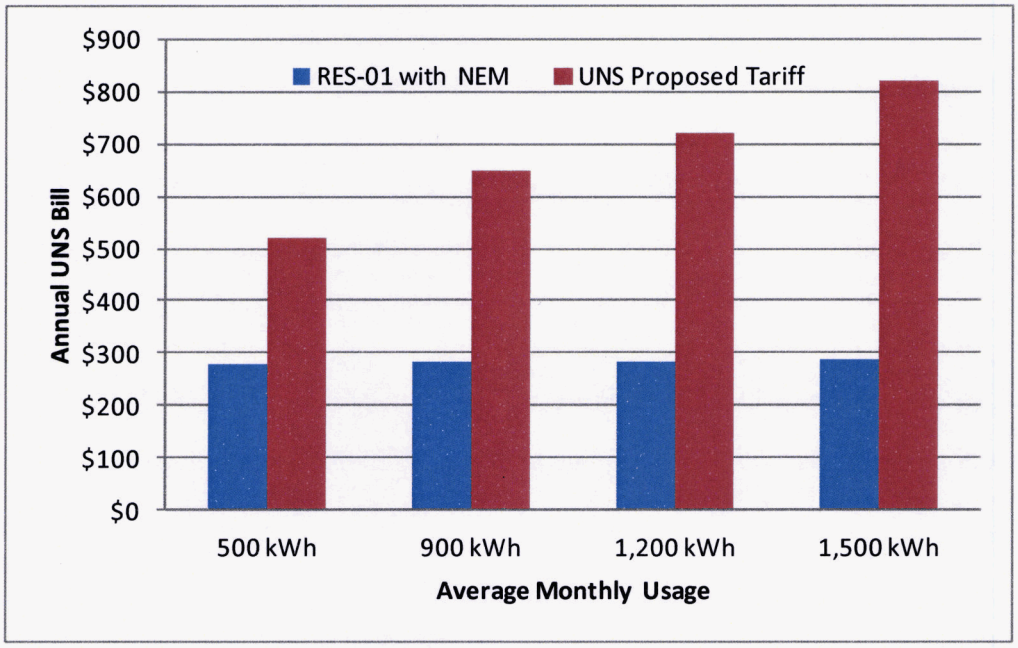


Table 2. Impact on Residential DG Customer's UNS Bill Under Company Proposal (relative to RES-1 with NEM and banking)

Average Monthly Usage	Increase in DG Customer Bills Under UNS's Proposal	
	Percent	Annual
500 kWh	85%	$238
900 kWh	130%	$367
1,200 kWh	154%	$437
1,500 kWh	186%	$532

Q: Isn't it true that UNS's proposed Rider 10 won't be raising anyone's rates as it only applies to future customers with solar?

A: No. UNS's rate changes are proposed to affect any DG customer who made the decision to supply a portion or all of their own power after June 1, 2015. Consequently, should the Commission approve the change, anyone who has chosen to self-generate after that date until the time of the tariff change would see increased rates.

Q: Do the results of the proposed rate changes on future DG customers appear gradual, fair or prudent?

A: No. I have never seen a utility commission approve a rate structure that says all new customers of a certain type will pay more than double the amount of existing customers taking the same service. For example, it is almost impossible to imagine a commission approving a rate on all new residential customers resulting in those new customers paying upwards of 185% more than existing ones.

Q: How else might a customer considering solar DG or a solar DG provider look at this?

A: When considering the financial impact of a solar DG system, a key factor is the bill savings that can be achieved. Paramount to this is identifying the price at which the solar system would need to achieve in order to break even with utility service. In other words, if the levelized cost of the DG system (or, if owned by a third party, the lease rate) is less than the offset retail rate, then it might make financial sense; if not, then not.

If the prospective customer was able to take service under UNS's proposed RES-

01 rate, the breakeven price for electricity from the DG solar unit would be approximately 10.5¢/kWh.[22] Under RES-1 DEMAND it would be 38% less at 6.5¢/kWh. As I will discuss in the next section, this difference can make a profound impact on the viability of rooftop solar.

V. UNS's Proposal Will Likely Have Large Impact On PV Adoption

Q: Mr. Dukes noted that there were a number of other utilities in the U.S. that have three-part residential rates containing a demand charge. Were these three-part residential tariffs optional or mandatory?

A: In all the jurisdictions identified by Mr. Dukes but one, the residential three-part rate was voluntary.[23]

Q: Did any of the utilities cited require customers with DG to take service under the three-part rate?

A: Yes. Here in Arizona, starting earlier this year, Salt River Project (SRP) began requiring all customers installing new DG system to take service under a new Tariff, E-27. Although the new tariff was approved by the SRP Board in February 2015, it was applied retroactively to when the rate was initially proposed, December 8, 2014.

Q: How does SRP's E-27 tariff compare to UNS's proposal for customers with DG?

A: Table 3 shows SRP's E-27 rates and UNS's proposed RES-01 DEMAND. SRP's rate differs from the UNS proposal by (a) having higher monthly charges; (b) differentiating

[22] Energy Delivery Charge for usage over 400kWh/month plus Power Supply Charges plus riders.
[23] The exception is Black Hills Power (Wyoming).

energy and demand rates by season; (c) using the highest demand during the peak period as the demand billing determinant; (d) having higher peak-demand rates while at the same time measuring demand over 15 minutes rather than one hour; (d) having two time-of-use periods (on-peak and off-peak) for energy charges. It is similar to UNS's proposal in that the SRP E27 avoidable energy charges are low (4-6¢/kWh) and effective fixed charges are relatively high.

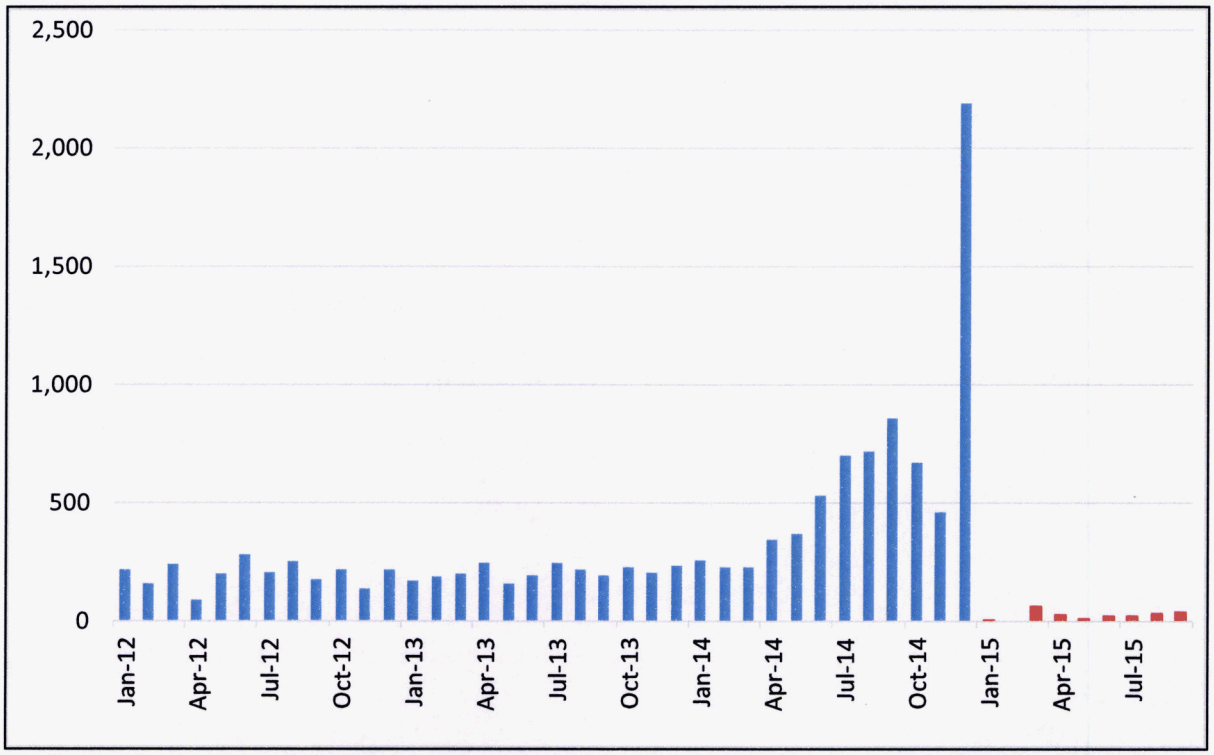
Table 3. SRP E-27 and UNS's Proposed RES-01 Demand plus Rider 10

Utility & Tariff	Months	Monthly Charge ($/mo.)	On-peak energy ($/kWh)	Off-Peak Energy ($/kWh)	On-Peak demand ($/kW)	Max. Demand (Tier 1) ($/kW)	Max. Demand (Tier 1) ($/kW)
SRP E-27	**Summer (Jul-Aug)**	$30.94	0.0633	0.0423	$17.52	N/A	N/A
	Shoulder (May, Jun, Sep, Oct)	$30.94			$14.63	N/A	N/A
	Winter (Nov-Apr)	$32.44			$5.46	N/A	N/A
UNS RES-1 Demand TOU	**Summer (May-Oct)**	$20.00	0.1111	0.0439	N/A	$6.00	$9.95
	Winter (Nov-Apr)	$20.00	0.1090	0.0436	N/A	$6.00	$9.95

Q: Has this new rate affected the adoption of residential solar DG in the SRP territory?

A: Yes, it has had a dramatic if not catastrophic effect. Figure 2 shows the monthly applications for solar DG submitted to SRP from 2012 through September, 2015. In 2012 and 2013, there were, on average, 201 applications for solar DG per month. In 2014, but for December, there were on average 486 applications per month. In the first nine months of 2015, the number of applications plummeted to 24 per month, a 95% decrease. One month in 2015, in fact, experienced zero applications.

Figure 2. SRP Solar DG Applications



Source: www.ArizonaGoesSolar.org. Accessed November 24, 2015

The dramatic number of applications in December was due to individuals wanting solar DG but knowing that it would not be cost-effective if they were placed on the new rate. In fact, ALL of the December 2014 applications occurred in the first eight days of the month, with a majority being submitted on December 8.

Clearly, rates that collect much of the revenue through monthly fixed charges and quasi-fixed demand charges can decimate, and in SRP territory has decimated, the market for distributed solar. I firmly believe that if UNS's proposal is adopted, a similar plunge in residential DG will be experienced in its territory.

VI. Customers Will be Confused

Q: Do you believe that customers will understand demand charges?

A: I am skeptical that customers, particularly residential and small commercial ones, will be able to understand demand charges. Residential consumers have experience with their energy use, in kilowatt-hours, because that is the basis on which they have been billed in the past. They do not have experience with the concept of demand, measured in kW, which is the rate at which a customer uses energy as a function of time. In mathematical terms, it is the first derivative of energy use with respect to time.

Q: What evidence do you have that customers will not understand demand charges?

A: In 2013, the three major investor owned electric utilities in California commissioned a customer survey as part of the CPUC's comprehensive rulemaking proceeding on residential rate design.[24] The survey found "Possible that concept was confusing and respondents did not understand that it varies based on kW demand levels, which made demand charges appear low relative to monthly service fee."[25] This lack of understanding of rates in general is reflected elsewhere, where barely half of California consumers realized that they were on a tiered rate plan.[26] This despite the fact that California has had default tiered residential rates since the late 1980's.

Furthermore, customers have also shown a strong preference for simplicity in their rates. In a survey conducted for San Diego Gas & Electric Company concerning rates for DG, when asked what they would prefer if NEM was not available, only 17% of

[24] California Public Utilities Commission, Rulemaking 12-06-013. June 21, 2012.
[25] Hiner and Partners, Inc. "RROIR" Customer Survey, April 16, 2013. at p. 22. Submitted as part of California Public Utilities Commission, Rulemaking 12-06-013.
[26] *Ibid.* at p. 7.

customers preferred demand charges, making demand charges one of the least preferred options.[27] When queried about the choice factors preferences (i.e., what they would like in a solar rate), 57% stated save money, 39% said simple, and 34% said "fits my habits and lifestyle."[28] UNS's proposal is clearly out of step with the second and third choice factor preferences. It is not simple, and in order to meet the first factor—save money—would, as discussed later, likely require unrealistic and/or potentially expensive changes in habits and preferences.

Q: What does witness Dukes say about the price signals that demand charges send?

A: Mr. Dukes says that a "...Demand Charge should provide customers with a price signal that accurately reflects the cost of system resources that must be available to serve their individual peak load. They then can make proper usage and equipment purchase decisions that would reduce that portion of their bill while producing system benefits."[29]

Q: Do you find this to be reasonable?

A: No. First, as I have already discussed, the demand charge may reflect the cost of current system resources, it does not reflect the long run marginal cost of providing those system resources. Second, also as discussed, most of those costs are not to meet an individual's peak but the system peak that reflects load diversity. In fact, for some solar customers, maximum demand may occur during off-peak hours. Thus, the price signal being sent is inappropriate: reduce demand at times where there already is plenty of capacity. Third, I do not believe that a demand charge will provide a signal upon which customers can take

[27] Hiner & Partners, Inc. "Solar (NEM) Rate Preferences Survey Results," Prepared for SDG&E. June 2015, at p. 7.
[28] *Ibid.* at p. 17.
[29] Dukes at p. 17.

concrete action to reduce their demand charge. I expect that aside from an air conditioner or perhaps an electric water heater, customers do not have a good idea of what appliances have a large kilowatt demand and as such are unable to accurately monitor their use. Additionally, some appliances, such as refrigerators, run or cycle automatically, eliminating the ability of a customer to anticipate or control their associated demand.

Furthermore, in order to reduce a demand charge, the customer must not operate high demand appliances at the same time, consistently throughout the billing period. For example, the demand charge will be assessed on the one instance during the month where a customer has the air conditioner (or in the winter a heat pump or other electrical heating system), hair dryer, and laundry all running at the same time. Essentially, a customer will have to be conscious of their individual appliance use, and the appliance use of every member of their household at all times, in order to have any impact on the demand charge. One slip-up and the customer will be paying a high demand charge. As such, while a demand charge might send an economists' "correct price signal," it is not an easily actionable one that people can change their behavior in response to. It is one thing to send a price signal; it is another thing to have that price signal be one that customers can effectively react to in a positive manner.

Q: Mr. Dukes also says that the demand charge will help improve a customer's load factor and thus save them money.[30] Is this reasonable?

A: No. Mr. Dukes' arguments are implicitly based on customers increasing their load factor by decreasing their demand. Given that customers cannot easily reduce their peak demand, this argument is not sound. The easiest and primary way that customers can

[30] Dukes at pp. 24-26.

improve their load factor is to consume more power. This result would incent customers to use more electricity, as each unit decreases their average cost. For example, under the RES-1 demand tariff, a customer using 900 kWh in a month with a maximum demand of 5 kW would be paying an average rate of 10.7¢/kWh. If they simply left their lights on more or their computer or TV on, their usage could increase to (for example) 1200, which would lower their average rate to 9.6¢/kWh. "The more you use, the more you save," is not a message that I believe UNS should be sending.

Q: Mr. Dukes points out that "Customers continue to have more options to save in the future when technology can help them manage and reduce demand."[31] He follows this statement with a hypothetical of a customer installing device(s) that would ensure that the pool pump and air conditioner do not operate simultaneously. What issues does this raise?

A: It raises three issues applicable to all residential customers, not just those with DG. First, enabling devices can help customers react to a demand charge. With this I agree. However, it also assumes that the customer has both the financial means to install such a device as well as a home to which it could be applied. Lower-income customers cannot likely afford such equipment. Second, his simple example of a customer with a backyard pool suggests that such demand charge-avoiding technologies would, at least initially, be available only to those with financial means. Third, such devices would face the classic split-incentive problem that energy efficiency programs experience.[32] A landlord would be the likely party paying for any building energy management systems while their

[31] Dukes at p. 26.
[32] Arizona Corporation Commission Decision No. 74885, at p. 22. Docketed December 31, 2014.

tenants would be the ones reaping the savings (through no action of their own). As such, the landlord has no financial incentive to install such devices. Thus while enabling devices are good in theory and may play a role in the future, they cannot be counted upon to assist customers in managing demand charges in 2016.

Q: How do mandatory demand charges affect those considering solar DG?

A: A three-part rate, especially coupled with an uncertain buyback rate for excess generation, makes it much more difficult for a homeowner to determine if solar makes financial sense. Such rate design makes it nearly impossible for customer to calculate the benefit of their investment. In particular, what should they assume about demand charges? They would require a great deal of data on their own consumption patterns, as well as different panel orientations, to do a proper analysis, and such an analysis would be based on past energy demand patterns. Future demand patterns may be wildly different as families grow and appliances change.

Compare the situation that those with DG would be in under the new tariffs to the situation that every other UNS customer would be in if they were considering the purchase of any single other energy saving piece of equipment. Customers looking to upgrade their heat pump, their refrigerator, their stove, their hair dryer, or even their lightbulbs could reasonably calculate their bill savings and therefore the value of their investment, but those looking to save energy with solar would no longer be able to calculate their bill savings and would have to guess about the benefit of such an investment. On their face, these proposed tariffs appear to be aimed at singling out solar technology for negative financial treatment.

Q: Does UNS propose any programs to educate customers about the three-part rate?

A: No. It is unconscionable to propose such a radical change in rates without public participation hearings or without supporting it with some kind of education effort. As discussed above, demand charges can be confusing and difficult to respond to. If UNS is permitted to implement the residential demand rates, even if they are not mandatory for customers with DG, then a customer education program plan should be submitted to and approved by the Commission prior to the rate's implementation.

VII. Time-of-Use Rates Are Superior to Three-Part Rates

Q: You do not support demand charges for residential customers. Do you have an alternative to more effectively align rates and utility costs?

A: In general, I believe that well-designed optional time of use rates are a better tool to send capacity-related prices signals to residential and small commercial customers. First, from a customer's point of view, they are much more easily understood than demand charges. Older customers should still remember earlier telephone rate designs, where prices were higher during the daytime and lower during the nighttime hours and on weekends. Explaining that electricity rates are more expensive during the summer late afternoons and evenings should be much simpler than trying to communicate the notion of what is effectively the first derivative of energy (kWh), which is power (kW).

Second, customers can much more readily respond to time of use rates. Knowing that the electricity they purchase during peak hours is more expensive, they can take easy and appropriate steps to reduce their usage and thus, in aggregate, reduce UNS's peak demand. As noted earlier, in order to get a positive financial response (i.e., a bill

reduction) to a demand charge, expensive equipment must be purchased and even then action must be consistently taken each and every hour by multiple members of a household. One slip-up and the reductions enacted every other day are for naught. Customers who realize this will likely ignore the demand price signal and treat it as a "fixed" element of their bill. But with an optional peak-period TOU rate, even though any individual home might not reduce every hour of every afternoon, averaged across all customers, demand reductions will occur.

Third, time-of-use rates can reflect utility cost causation. UNS has already determined hours of peak system demand and can adjust its on-peak rates to reflect capacity-related costs.

Fourth, demand charges can be counter to conservation. Once peak demand has been hit, a customer is less incentivized to conserve throughout the month as their incremental usage has less impact on their bill.

Fifth, time of use rates already existence, which would limit the need for customer education programs.

Q: UNS expresses concern about collecting certain costs from low-use customers. Is there a better alternative than a demand charge to do this?

A: Yes. A minimum bill provision, combined with a purely volumetric energy rate, could be effective in collecting the appropriate fixed costs from ALL low-use customers, and not just those with DG. A minimum monthly bill amount could be set that collects a reasonable amount of UNS's fixed charges. If at the end of the monthly billing cycle a customer's bill (based on their usage and the volumetric rate) is less than the minimum

bill amount, then the customer pays that minimum. This allows UNS to collect a minimum amount, from all low-use accounts, be they part-year residences, vacant buildings, those with DG or other.[33]

Q: Have you calculated what an appropriate minimum bill would be for UNS?

A: No, I have not. I raise it here as an example of a rate that would meet UNS's primary concern of revenue collection, but also be easily understood and send actionable price signals to ratepayers for conservation.

VIII. Miscellaneous

Q: Does TASC have a position on UNS's proposed Lost Fixed Cost Recovery Mechanism (LFCR)?

A: While I am not an attorney, I know it is TASC's position that the LFCR mechanism violates the Arizona Constitution and that it as an illegal rate making mechanism. As a result, TASC believes the LFCR cannot be permitted to continue moving forward and UNS's proposal in that regard must be rejected. Moreover, TASC's position is that any previous amounts collected under this illegal device since UNS's last rate case must be returned to UNS's ratepayers to avoid an illegal result. I am not offering this answer in an effort to explain or support TASC's position but rather simply to state the fact that this is TASC's position. TASC will be briefing the legal issues supporting this position as part of the hearing process.

[33] Provisions of course should be made for low-use low-income customers.

Q: Can solar DG have a positive impact on Arizona's economy?

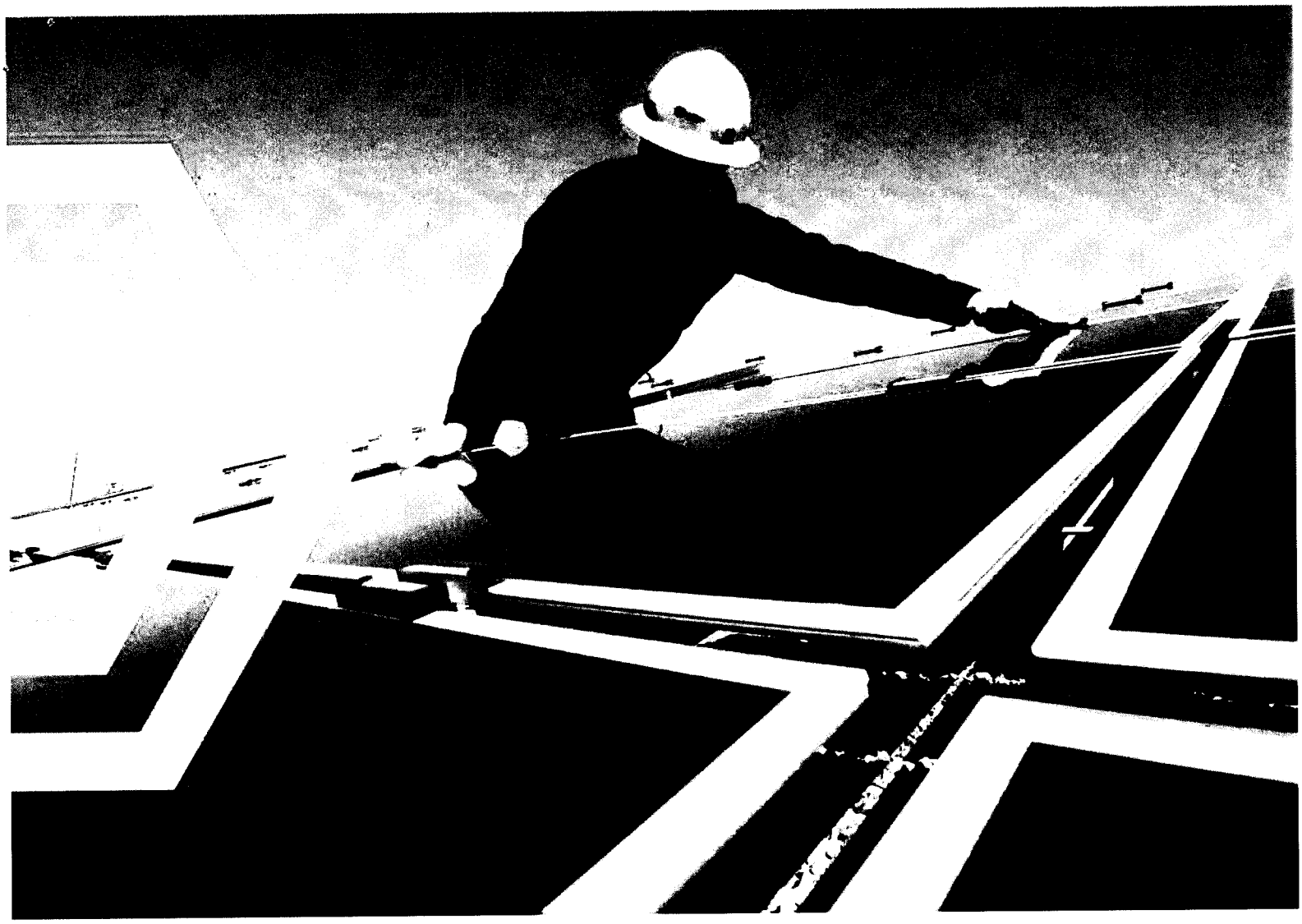
A: I believe that it can, and in fact already does. Attached as Exhibit MEF-2 is the *2014 National Solar Jobs Census*, conducted by The Solar Foundation and the George Washington University. The report found that in 2014 the solar industry was adding workers at a rate nearly 20 times the overall economy and that solar industry employment had increased by over 20% from 2013.[34] Of the nearly 120,000 solar installer jobs nationwide, over 83% are dedicated to installing primarily residential and small commercial systems.[35] Continuing to foster solar DG in Arizona will allow the continued expansion of well-paying jobs in the UNS service territory and throughout the state.

Q: Does this conclude your testimony?

A: Yes.

[34] *2014 National Solar Jobs Census*, at p.1.
[35] *Ibid.*, at 15.

Exhibit MEF-2



National Solar Jobs Census

GW Solar Institute

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RESEARCH PARTNERSHIP

JANUARY 2015

Acknowledgements

The Solar Foundation® (TSF) is a national 501(c)(3) nonprofit organization whose mission is to increase understanding of solar energy through strategic research that educates the public and transforms markets. In 2010, TSF conducted its first *National Solar Jobs Census* report, establishing the first credible 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, TSF has conducted an annual *Census* in each of the last five years to track changes and analyze trends.

TSF would like to acknowledge and thank its research partners and sponsors. Without their foresight and leadership, this report would not have been possible.
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Other sponsors and key contributors to this year's *Census* effort include: Energy Foundation, William and Flora Hewlett Foundation, Tilia Fund, SolarCity, SunPower, SunEdison, GTM Research/SEIA for providing survey respondents with the *U.S. Solar Market Insight: 2013 YIR* report, and Cornell University's School of Industrial Labor Relations for validating the original *Census* methodological framework.

We also want to thank all the solar employers that participated in the survey. Your responses were critical in providing us with accurate and timely data.

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Executive Summary

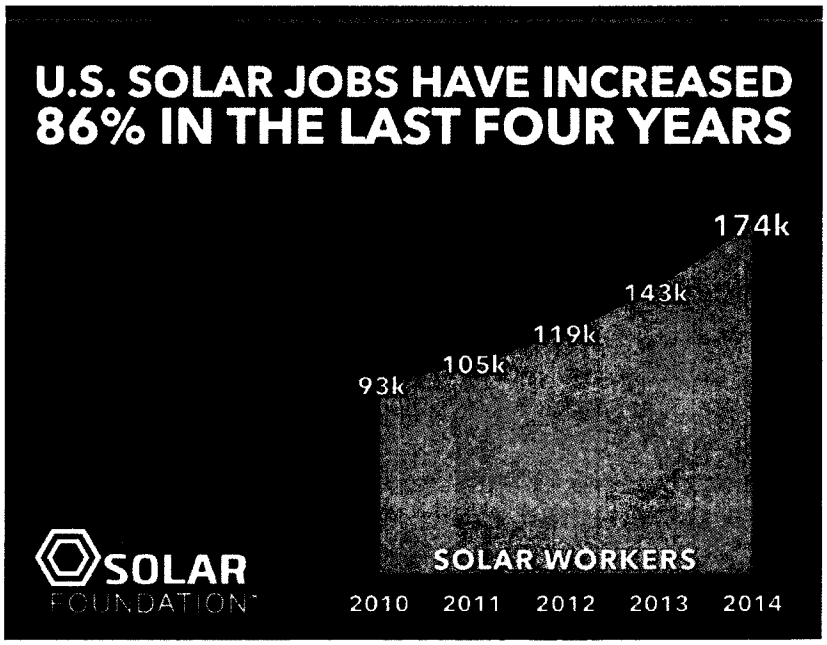
The Solar Foundation's *National Solar Jobs Census 2014* is the fifth annual update of current employment, trends, and projected growth in the U.S. solar industry. Data for *Census 2014* is derived from a statistically valid sampling and comprehensive survey of 276,376 establishments throughout the nation, in industries ranging from manufacturing, to construction and engineering, to sales. Rapid change in this industry has warranted annual examinations of the size and scope of the domestic solar labor force and updates on employers' perspectives on job growth and future opportunities.

This year's *Census* found that the industry continues to exceed growth expectations, **adding workers[1] at a rate nearly 20 times faster than the overall economy and accounting for 1.3% of all jobs created in the U.S. over the past year. Our long-term research shows that solar industry employment has grown by 86% in the past five years, resulting in nearly 80,000 domestic living-wage jobs.** The installation sector, made up of men and women placing these systems in service, crew managers or foremen, system designers and engineers, and sales representatives and site assessors, remains the single largest source of domestic employment growth, more than doubling in size since 2010.

With leading market analyses continuing to project record-breaking increases in annual installed solar capacity before the 30% federal investment tax credit (ITC) expires at the end of 2016, it is very likely that the national solar workforce will continue growing at its remarkable pace in the short term. However, if the ITC reverts to the 10% level in 2017, solar employment growth is likely to slow or may even experience significant job losses.

As of November 2014, the solar industry employs 173,807 solar workers, representing a growth rate of 21.8% since November 2013. Since *Census 2013*, U.S. businesses added more than 2 million jobs, a growth rate of 1.1%, meaning employment in the solar industry grew nearly 20 times faster than employment in the overall economy. Over the next 12 months, employers surveyed expect to see total employment in the solar industry increase by 20.9% to 210,060 solar workers.

1 In this survey, solar employees are defined as a worker that spends at least 50% of their time on solar-related work. However, we have consistently found that 90% or more of these workers spend 100% of their time on solar-related work.



This report includes up-to-date information on the solar industry, quantifying employment growth since last year's study and trends since the publication of *Census 2010*. These research findings also provide stakeholders with current information on the potential for further growth and the factors that are likely to impact the industry over the coming years. Based on the observed growth in solar employment in this and previous *Census* reports, we draw the following conclusions.

As of November 2014:

- **Solar industry employment increased by nearly 22% since November 2013, which is almost twenty times the national average job growth rate.** There are 173,807 solar workers in the U.S., up from 142,698 for the previous year. 2014 was the second consecutive year in which solar employment both grew by approximately 20% or more and exceeded Census growth projections.

- **Employment in the U.S. solar industry increased nearly 86% over the past four years.** Since the first *National Solar Jobs Census* was published by The Solar Foundation in September 2010, the solar industry increased 85.9%, adding over 80,000 workers.

- **Solar is a major source of new U.S. jobs.** Of the more than 31,000 new solar jobs added since November 2013, 85 percent are new jobs (rather than existing positions that have added solar responsibilities), representing approximately 26,600 new jobs created.

- **The solar industry created 1.3% of all new U.S. jobs.** One out of every 78 new jobs created in the U.S. since Census 2013 was created by the solar industry – representing 1.3% of all new jobs.

- **The solar industry expects to add over 36,000 solar jobs over the next 12 months.** If realized, this 20.9% growth rate would make 2015 the third consecutive year that annual solar job growth was near or above twenty percent. This estimate compares with a projected 1% increase in employment in the overall economy over the next year.

- **Of the 173,807 solar workers in the United States, approximately 157,500 are 100% dedicated to solar activities.** The "all-solar" percentage of workers is effectively unchanged since 2013.

- **The U.S. solar industry is becoming more efficient, to less than 15.5 jobs per megawatt of installed capacity.** This is down from 19.5 jobs per megawatt in 2012.

- **Including indirect and induced impacts, the solar industry supports approximately 700,000 U.S. jobs.** *Census* data include occupations critical to meeting domestic installation demand. These include most of the direct jobs and many of the indirect jobs in the solar industry, with the exception of some indirect jobs in the component and materials supply chain. Those jobs, combined with induced impacts of the industry, support an additional 531,200 jobs, bringing the total employment impact for the U.S. solar industry to over 705,000.

- **Wages paid to solar workers remain competitive with similar industries and provide many living-wage opportunities.** Solar installers pay an average wage of $20-24 per hour, with the mean wage for these workers rising by 1.6% over the previous year. Manufacturers pay their assemblers nearly $18 per hour, while internal sales people at these firms earn approximately $44 per hour. Overall, salespeople have a wide range of pay, from about $30 to more than $60 per hour, and solar designers receive between $30-40 per hour.

- **Solar workers are increasingly diverse.** Demographic groups such as Latino/Hispanic, Asian/Pacific Islander, and African American, along with women and veterans of the U.S. Armed Forces now represent a larger percentage of the solar workforce than was observed in *Census 2013*. These higher percentages, coupled with overall growth in solar employment, means workers from these groups are growing in number as well as percentage of the workforce. Women account for over 37,500 solar workers – 21.6% of total – up from around 26,700 in 2013. Nearly 17,000 veterans are employed by solar establishments, compared with just over 13,000 the previous year.

National Solar Jobs Census 2014 continues to demonstrate that the U.S. solar industry is having a positive and growing impact on the national economy and supports jobs across every state in the nation.

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

The findings presented herein are based on rigorous survey efforts that include 66,986 telephone calls and over 25,655 emails to known and potential solar establishments across the United States, resulting in a maximum margin of error for employment-related questions of +/- 2.03%.

Unlike economic impact models that generate employment estimates based on economic data or jobs-per-megawatt (or jobs-per-dollar) assumptions, the *National Solar Jobs Census* series provides statistically valid and current data gathered from actual employers. This analysis also purposefully avoids artificially inflating its results with questionable multiplier effects often found in analyses of other industries.

About The Solar Foundation®

The Solar Foundation® (TSF) is an independent 501(c)(3) nonprofit organization whose mission is to increase understanding of solar energy through strategic research that educates the public and transforms markets. TSF is considered the premier research organization on the solar labor workforce, employer trends, and the economic impacts of solar. It has provided expert advice to leading organizations such as the National Academies, the Inter-American Development Bank, the U.S. Department of Energy, and others during a time of dynamic industry growth and policy and economic uncertainty.

While TSF recognizes that solar energy is a key part of our energy future, it is committed to excellence in its aim to help people fairly and objectively gauge the value and importance of these technologies.

About BW Research Partnership

BW Research is widely regarded as the national leader in labor market research for emerging industries and clean energy technologies. In addition to the *Census* series, BW Research has conducted rigorous solar installation and wind industry labor market analysis for the National Renewable Energy Laboratory, wind energy and energy retrofit studies for the Natural Resources Defense Council, a series of comprehensive clean energy workforce studies for the Commonwealth of Massachusetts, Illinois, Vermont, Florida, Pennsylvania, Iowa, and California and numerous skills and gap analyses for community colleges, workforce investment boards, state agencies, and nonprofit organizations.

BW Research provides high-quality data and keen insight into economic and workforce issues related to renewable energy, energy efficiency, transportation, recycling, water, waste and wastewater management, and other environmental fields. The principals of the firm are committed to providing research and analysis for data-driven decision making.

Overview

The Solar Foundation's *National Solar Jobs Census 2014* is the fifth annual review of the size and scope of the U.S. solar industry's employment landscape, and represents the most significant analysis of solar labor market trends to date. This year's *Census* survey went out to more than 55,000 U.S. business establishments and includes data gathered from more than 7,600 of them, with full survey completions from over 2,000 solar establishments. The data illustrate a rapidly growing industry that is gaining strength and efficiency while showing no signs of slowing down in the near term.

Between November 2013 and November 2014, solar employment grew nearly 20 times faster than the overall economy. U.S. businesses added more than 2 million jobs since *Census 2013,* a growth rate of 1.1%.[2] **One out of every 78 new jobs created in the U.S. since *Census 2013* were created by the solar industry – 1.3% of all jobs.[3]**

Solar employment reached 173,807 jobs (at 25,491 locations) as of November 2014, an increase of 85.9% from September 2010 to November 2014. This has been driven largely by the massive growth in the demand for solar energy systems over the same time frame; rising from 929 megawatts (MW) installed in 2010 to 7,243 MW expected in 2014.[4] Global demand, which drives much of domestic manufacturing, has grown from just over 17,000 MW in 2010 to an estimated 50,000 MW in 2014.[5]

Installation firms account for nearly 56% of all solar jobs, while manufacturing accounts for almost 19%. Collectively, demand-side sectors (installation, sales and distribution, and project development) make up 76% of overall solar industry employment.

2 Class of Worker Employment EMSI 2014.3, see methodology for further information on data sources

3 Current Employment Estimates, Bureau of Labor Statistics, for period of Nov 2013 - Oct 2014, Revised Jan 9, 2015.

4 SEIA/GTM Research Solar Market Insight Q3 2014

5 REN 21 Global Status Report 2014; IEA Solar Thermal Electricity Technology Roadmap 2014

Table 1: 2014 Sector Employment

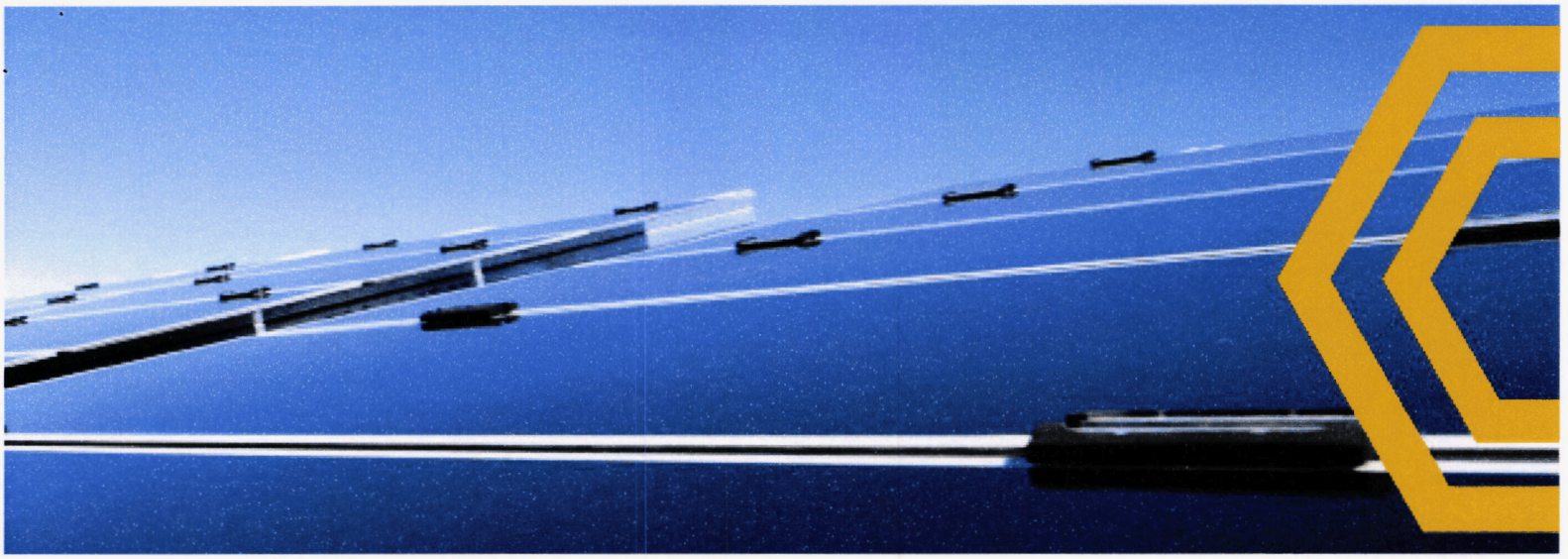
	Employment	% of Total Employment
Installation	97,031	55.8%
Manufacturing	32,490	18.7%
Sales & Distribution	20,185	11.6%
Project Developers	15,112	8.7%
All Other	8,989	5.2%
Total	173,807	100.0%

Solar firms added more than 31,000 jobs since *Census 2013*, representing 21.8% growth in employment from November 2013. Installers were responsible for 27,373 of these new jobs, or 88% of total growth. However, all sectors, with the exception of "Other," grew over the past year.

Table 2: 2010 – 2015 (Projected) Sector Employment[6]

	2010	2011	2012	2013	2014	Projected 2015
Installation	43,934	48,656	57,177	69,658	97,031	118,942
Manufacturing	24,916	37,941	29,742	29,851	32,490	37,194
Sales & Distribution	11,744	13,000	16,005	19,771	20,185	25,480
Project Developers	no category	no category	7,988	12,169	15,112	18,004
All Other	12,908	5,548	8,105	11,248	8,989	10,439
Total	93,502	105,145	119,016	142,698	173,807	210,060

6 Due to rounding, yearly sector employment may not sum to overall yearly total.



While "Other" is a catchall category that includes various critical supporting elements of the solar industry, it is notable that early stage investments (Seed, Series A, and Series B), from both public and private sources, are down sharply over the past several years.[7] This lack of funding is likely negatively impacting employment at companies in research and development.

While solar energy still represents only 1% of total US electricity generation, the solar installation sector is already larger than well-established sectors of fossil fuel generation, such as coal mining (93,185 jobs). In addition, the solar installation sector added nearly 50% more jobs in 2014 than the total created by both the oil and gas pipeline construction industry (10,529) and the crude petroleum and natural gas extraction industry (8,688).[8]

Solar employers' reported projected growth of 20.8% in 2015 is nearly eight times greater than the growth expected in the oil, gas, and coal industries over the same period. Moreover, the solar industry will add roughly the same number of jobs in the coming year as the much larger fossil fuel industry.[9] While the growth projection of solar employers may seem overly optimistic, consider that solar employers have exceeded their predictions in each of the last two years by 2.7% and 6.2%, respectively.

Since 2010, installation firms have added more than 50,000 jobs, representing more than 120% employment growth. Solar sales establishments have added 8,500 jobs while manufacturers have increased their payrolls by 7,500 workers, with growth rates of 72% and 30%, respectively.

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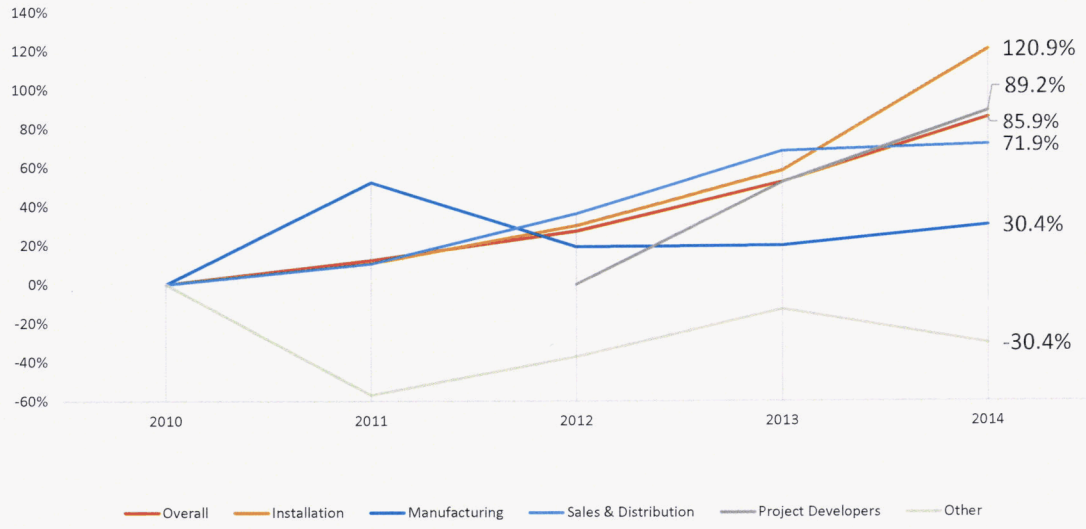
7 Cleantech Group i3 data, reviewed December 19, 2014.

8 EMSI Class of Worker Employment 2014.3. Note that applying industry-wide employment change from 2012 through 2014 (8.1% decline) in coal mining to the National Mining Association's 2012 report's findings of 144,580 non-transportation jobs (which are excluded from this *Census'* solar employment total) results in 133,870 coal mining jobs, which is 23% smaller than U.S. solar employment.

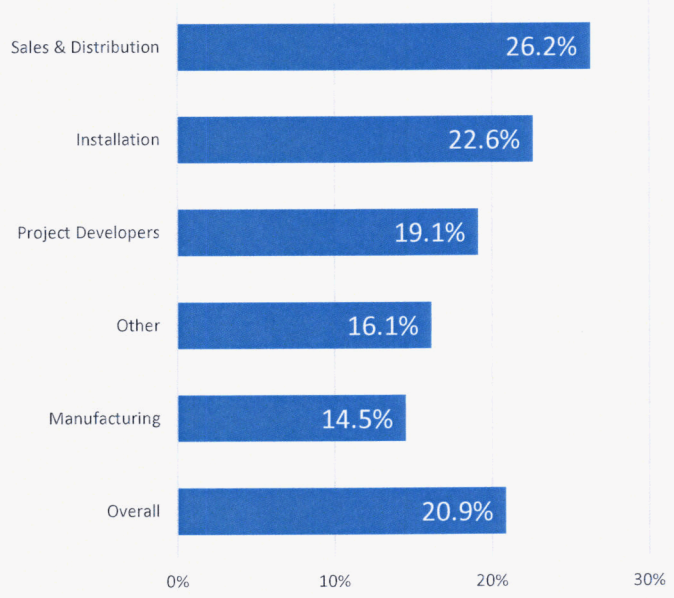
9 *Id.* The 21 NAICS industries that make up the oil, gas, and coal industries are projected to add 37,206 jobs over the period, up 2.7%.

Figure 1: Solar Employment Growth From 2010-2014 (Overall and by Sector)[10]



Employers expect to see total employment in the solar industry reach 210,060 solar workers (a 20.9% increase) by the end of 2015. This compares with only 1% employment growth projected overall in the U.S. over the same period. Solar sales firms expect the fastest percentage growth at 26.2% (adding almost 5,300 jobs), while installation firms expect to add almost 22,000 jobs over the coming year (22.6% growth).

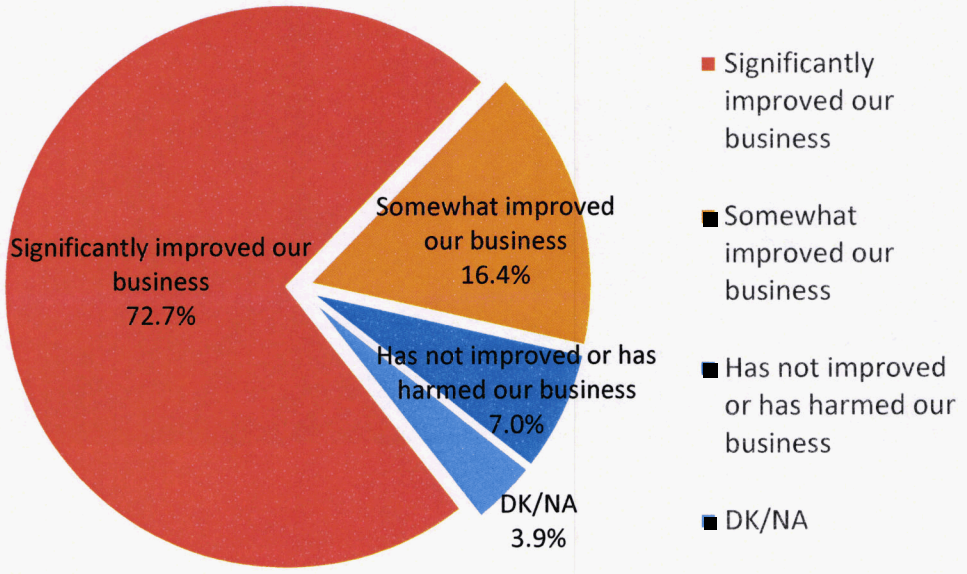
Figure 2: Expected Solar Employment Growth From 2014-2015 (Overall and by Sector)



10 Project Developer growth is set to 2012, the first year the category was used.

About three out of every four businesses state that the 30% Investment Tax Credit (ITC), an income tax credit for renewable installations, has significantly helped their business.

Figure 3: Perceived Effect of the ITC on Solar Businesses



However, nearly 40% of all respondents believed that lowering the ITC to 10% after 2016 for commercial projects and eliminating the ITC for residential projects would not impact their workforce. This is possibly due to a large number of companies that work in sectors not eligible for the tax credit, including manufacturers, companies that primarily sell products and services abroad and companies that sell solar pool heaters (which don't qualify for the ITC). In addition, some respondents were in states that expect to be least impacted by scheduled changes to the ITC or are facing more pressing challenges to market growth from other policy or regulatory changes. Moreover, solar installers, which make up the largest solar sector and accounted for 88% of job growth in the past year, felt the ITC was vital to their sector.

The solar industry is becoming increasingly diverse. A greater percentage of women, minorities and veterans of the United States Armed Forces were employed by solar firms in 2014 as compared to 2013. Employers were also asked to report about their workers' union membership for the first time since 2012. Approximately 6.2% of the solar workforce belong to a union, totaling nearly 11,000 jobs.

Table 3: Solar Worker Demographic Breakdown 2013 vs. 2014

	2013	2014
Women	18.7%	21.6%
Latino or Hispanic	15.6%	16.3%
Veterans of the U.S. Armed Forces	9.2%	9.7%
Asian or Pacific Islanders	6.7%	7.0%
African-American	5.9%	6.0%

Installation

The installation sector represents the end of the solar value chain and is the largest sector of the U.S. solar industry. Nearly 9 out of 10 new solar jobs since *Census 2013* were created by the installation sector. Composed of companies that primarily install photovoltaic, solar water heating, and other solar energy technologies, the installation sector's growth is primarily driven by installed solar capacity gains.

The installation sector is still primarily comprised of small firms – more than half of all installers have 10 or fewer employees – yet since the first *National Solar Jobs Census* was conducted in 2010, the number of large firms, defined as having more than 100 employees, has more than doubled to almost 10%.

Solar installers employ a wide range of workers, though the majority are connected to the building trades, particularly electricians, construction laborers, and plumbers. They work on systems of all sizes, including smaller residential systems as well as large commercial and utility-scale systems.

Big News in Installation:

- **Leading market research suggests that 2014 was a banner year for solar installations across the U.S.** Over 7,200 megawatts (MW) of solar energy are expected to have been installed in 2014, enough to power nearly 1.2 million U.S. homes. If achieved, this capacity figure will represent 40% growth over the total new solar capacity installed throughout 2013.[11]

- **Installation growth was particularly strong in certain market segments in several states,** including California, North Carolina, Massachusetts, New Jersey, Arizona, Nevada, New York, and New Mexico. This continued growth in capacity, however, is seeing solar spread to new states. Georgia, for example, is expected to have installed over 100 MW of solar this past year for the first time ever, narrowly edging out Hawaii for a spot in the top 10 states for 2014. Driven by large amounts of utility-scale solar, states like Indiana, Virginia, and Tennessee will install more solar capacity this year than in all previous years combined. In addition, some major solar markets are experiencing precipitous growth in the residential market segment, with New York, Texas, and Massachusetts seeing capacity grow by 100% or more compared with the previous year.[12]

11 SEIA/GTM Research Solar Market Insight Q3 2014

12 SEIA/GTM Research Solar Market Insight Q3 2014 and IREC Solar Market Trends 2013

Tina Long

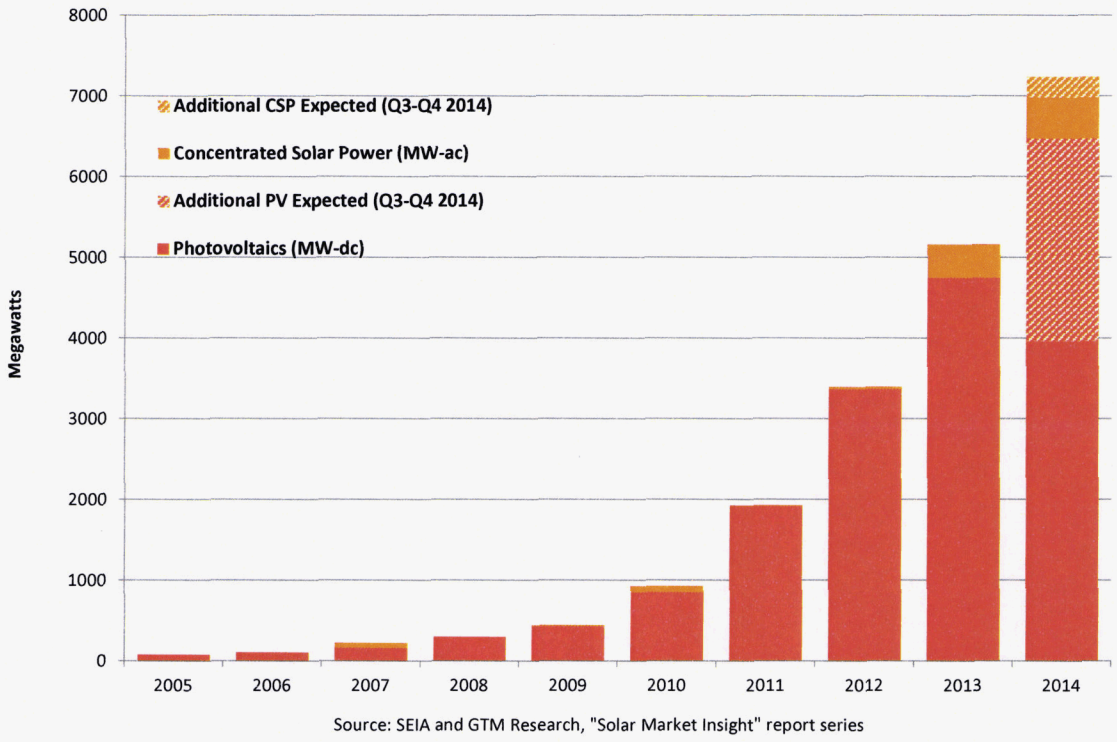
Occupation: Electrician Foreman
Company: Bombard Electric
Years at Occupation: 8
Location: Las Vegas, NV

Tina Long serves as the foreman of a two-man crew that installs solar on residences throughout the Las Vegas Valley and in Mesquite, Nevada. Her work entails designing efficient PV array layouts for customers, ordering materials, performing safety checks on her crew, and working directly with homeowners to ensure they are satisfied with their systems and experience in going solar. Ms. Long is an active leader, providing hands-on support to every facet of the installation process, including getting on the roof and installing the racking system for the array and bending the conduit and electrical tie-ins to the main service panels.

Before joining the company, Ms. Long completed a 5 year apprenticeship through the IBEW local 357, through which she obtained her full-time job. She has attended 2 photovoltaic courses through the local Joint Apprenticeship and Training Committee and passed the local OSHA-required test to obtain the state-required PV installers certification card. Most of her solar-specific training occurred while on the job. She is currently preparing to take the North American Board of Certified Energy Practitioners (NABCEP) entry-level exam in April.

Her favorite part of her job is having a satisfied customer. "I enjoy seeing the customer happy when they see their system running and feeling relief when they can save on energy costs," she explained. She also enjoys the physical and mental challenges presented by her work, and being able to overcome these with the focus on craftsmanship provided by her training. For other workers looking to get into the installation field, she recommends not allowing oneself to be intimated by the physical or mental demands of the work, noting that the pride she receives in knowing she has the knowledge and skills to capture power from the sun makes the challenges worth it. As a concluding thought, she had this to say "I would advise people not to give up, especially women in the solar workforce; women can do this job as well as men."

Figure 4: Annual Solar Power Capacity Installations, 2005-2014



Source: SEIA and GTM Research, "Solar Market Insight" report series

- **Several big players in the installation sector made major announcements in 2014.** In August, Verengo Solar was recognized by Inc. Magazine as one of the fastest-growing companies in the nation. Shortly thereafter, the company announced plans to expand to new markets on both coasts.[13] Throughout the year, SolarCity has continued to make progress toward its goal of opening 20 new operations centers across seven states, an expansion that is expected to create 600 new jobs.[14]

- **Growth in annual installed capacity continues to be primarily driven by the falling installed costs of solar energy.** As shown in Figure 5 below, capacity-weighted average installed costs have declined by nearly 35% for residential installations, 49% for non-residential systems, and 61% for utility-scale projects since the beginning of 2010.[15]

This decline in installed costs continues to make solar more cost-competitive with conventional electricity generation. For utility-scale solar PV projects, a 5-year average percentage decrease of 78% was observed in the unsubsidized levelized cost of energy (LCOE), with the latest averages ranging from $0.072 - $0.086/kWh.[16]

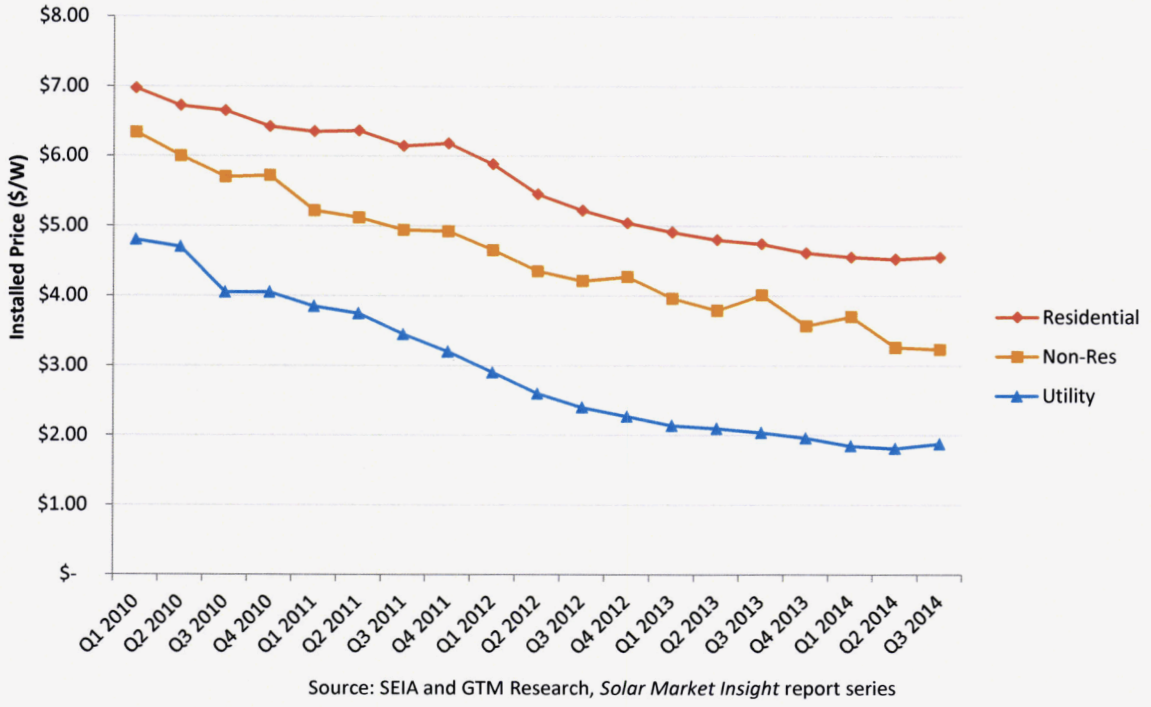
13 See: "Verengo Reaches 75 MW Residential Solar Milestone", from Energy Industry Today at: http://energy.einnews.com/pr_news/224038570/verengo-reaches-75-mw-residential-solar-milestone

14 See: "SolarCity is opening a Baltimore County operations center", from Baltimore Business Journal at: http://www.bizjournals.com/baltimore/news/2014/09/05/solarcity-is-opening-a-baltimore-county-operations.html

15 SEIA/GTM Research Solar Market Insight report series, 2010-2014

16 Lazard Levelized Cost of Energy Analysis - Version 8.0

Figure 5: Capacity-Weighted Average for Installed Costs of Solar Energy Systems, 2010-2013



Source: SEIA and GTM Research, *Solar Market Insight* report series

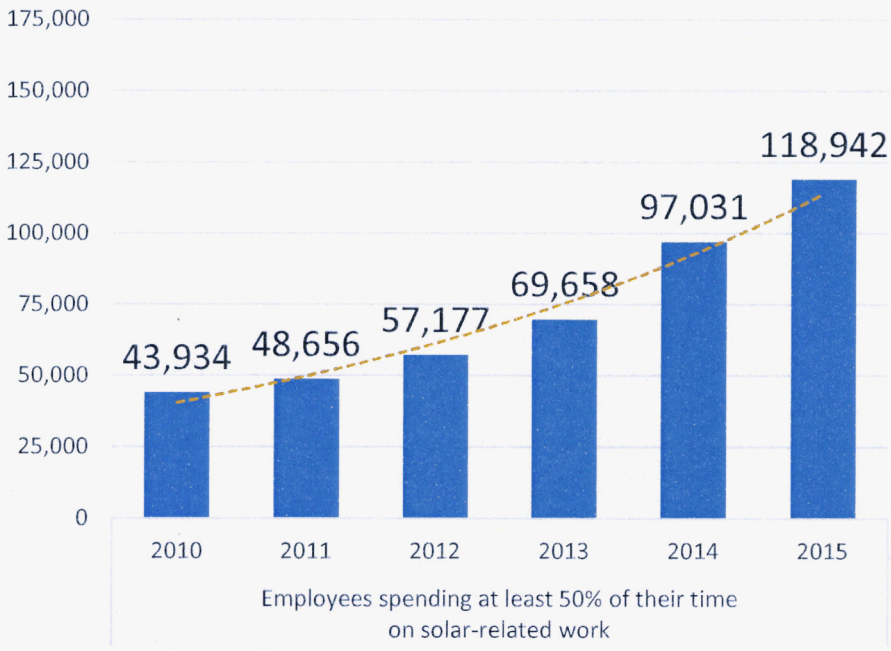
This section includes a summary of key findings from information gathered from nearly 1,000 U.S. solar installation companies.

Installation companies now employ 97,031 workers, growing by nearly 40% since November 2013 and 120% since September 2010, and now account for 56% of total industry employment.

More Americans work at solar installation companies than work at petroleum refineries in the United States.[17] The installation sector anticipates adding the most new jobs in 2015 as well, reaching nearly 120,000 jobs by year's end with an expected employment growth rate of 22.6%.

17 EMSI Class of Worker Employment, 2014.3

Figure 6: Installation Employment Growth from 2010 to 2015 (Projected)



59.6% of solar installers work primarily on residential systems, while another 23.6% report working on small to medium commercial systems up to 200 kW.

There are some significant differences between these types of establishments, including that installer median wages are about 20% higher at firms that predominantly work on utility-scale projects than those that install commercial or residential systems.

Table 4: Installation Market Segments

	Median Labor Hours for 5kW Residential PV	%Pure Solar	%Experienced Difficulty Obtaining Financing	Average Solar Workers Hired per Firm in last 12 Months
Overall	32.0	53.5%	62.3%	7.31
Residential	32.0	62.7%	64.6%	9.39
Commercial	40.0	50.6%	66.1%	4.30
Utility-Scale	24.0	50.0%	16.7%	7.79

Nationally, installers report that about half of residential systems are financed or leased through the company (as opposed to purchased outright), while about 70% of commercial systems are financed/leased as opposed to purchased.

These results correspond with established trends and observations in financing for various market segments. In six states representing approximately 75% of the total capacity expected in the national residential market in 2014, third-party ownership accounts for approximately 70-90% of all new residential installations.[18] Taken together, third-party owned residential systems in these states will account for nearly 60% of all residential installations projected nationwide this year.

Commercial projects seem to rely more on third-party owned systems, presumably due to the comparatively greater upfront cost of these systems and the greater responsibility for system operation and maintenance that would fall onto a commercial owner-operator. For example, companies such as Walmart – the largest single corporate user of solar energy – has financed most, if not all, of these installations through third-party ownership.[19] The same is true of Walgreen's, another top corporate user of commercial solar, which recently contracted a developer to install, own, operate, and maintain systems on 200 of its stores. There are, of course, notable exceptions to this trend. IKEA has nearly 40 MW of solar installed on its facilities around the country, and it owns and operates each of these installations.[20]

While third-party ownership has driven significant growth, many installation companies are also offering zero-down loans as part of their sales strategy. Current monthly costs for zero-down loans and solar leases (power purchase agreements) are strikingly similar in many markets,[21] and the popularity of loan versus leased systems will be an important trend to watch in 2015.

18 SEIA/GTM Research Solar Market Insight Q3 2014

19 SEIA Solar Means Business Report, available at http://www.seia.org/research-resources/solar-means-business-report

20 See: "Financing Options Open Up for Commercial Solar", from Solar Industry Magazine at http://www.solarindustrymag.com/issues/SI1401/FEAT_01_Financing-Options-Open-Up-For-Commercial-Solar.html

21 See: "Solar Leasing vs. $0-down Solar Loan – Scenarios in 10 States" from CleanTechnica at http://cleantechnica.com/2014/02/09/solar-leasing-vs-0-solar-loan-scenarios-10-states/

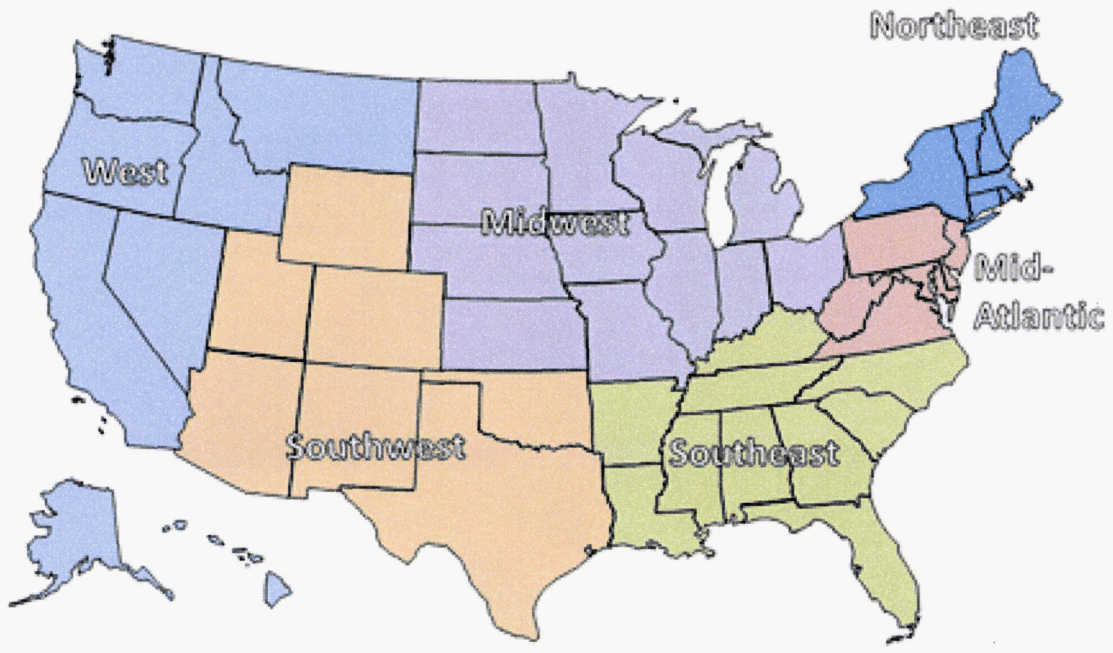
While PV dominates in all markets, nearly half of all installation firms in the Southeast work with solar water heating technologies, including pool heaters.

Table 5 below shows the breakdown of installer companies' reported activities by region. Installers of solar photovoltaic systems account for most activity in all regions of the country. Solar water heating installers are more likely to be found in the Southeast, which (in the last year for which data are available) accounted for over one-third of cumulative installed solar water and pool heating in the U.S.[22]

Table 5: Installed Products by Region[23]

	Overall	Northwest	Pacific	Southwest	Midwest	Southeast	Mid-Atlantic	Northeast
Photovoltaic	92.1%	97.2%	96.3%	84.4%	94.1%	92.1%	92.0%	89.6%
Water heating, which includes pool heating	28.4%	22.2%	23.2%	27.2%	22.0%	48.2%	26.8%	29.9%
Concentrating solar power	5.9%	5.6%	8.3%	4.8%	2.5%	9.6%	3.6%	4.9%
Other	7.5%	8.3%	5.0%	6.8%	9.3%	9.6%	9.8%	6.9%

*Does not equal 100% as many companies work across multiple technologies.



22 SEIA/GTM Research Solar Market Insight 2010 Year-In-Review

23 For this analysis, the West region was split into the Northwest (Oregon, Washington, Idaho, Montana, and Alaska) and the Pacific (California, Nevada, and Hawaii) regions.

Installers were the most concerned that changes to the ITC would force job losses.

Almost every installer company surveyed (94%) believes the 30% ITC has significantly improved their business. When asked how eliminating the residential credit and reducing the commercial credit after 2016 would impact their hiring decisions, 61.7% said they would likely lay off staff and/or contractors.

Such a dramatic expected decrease in employment in this sector makes sense as annual capacity additions in a given state are highly correlated with the number of solar jobs in that state (the single largest category of which are installation jobs), and that nearly every market segment in every state is expected to experience a decrease in annual installed capacity in 2017, when substantial changes to the ITC are scheduled to take effect.[24]

About half of all solar installer firms receive all of their income from solar goods and services.

Compared with previous *Census* reports, this figure has grown over the past several years and demonstrates that more companies are "pure-play" solar firms as the industry continues to trend toward consolidation and maturation.

Installer companies employ more African-Americans and Latinos than their counterparts in other solar sectors, and are generally more diverse than related sectors such as oil, gas, coal, and construction.

In addition, 8.9% of the installation sector's solar employment in 2014 are veterans of the U.S. armed forces, and 9.4% are members of a union. While the solar installation sector employs a higher percentage of women than the construction industry, the coal industry and the oil and gas extraction industries, there are fewer women working in the installation sector than in other solar sectors. Table 6 below includes additional information on the demographics of solar workers in the installation sector in 2014.

24 SEIA/GTM Research Solar Market Insight Q3 2014

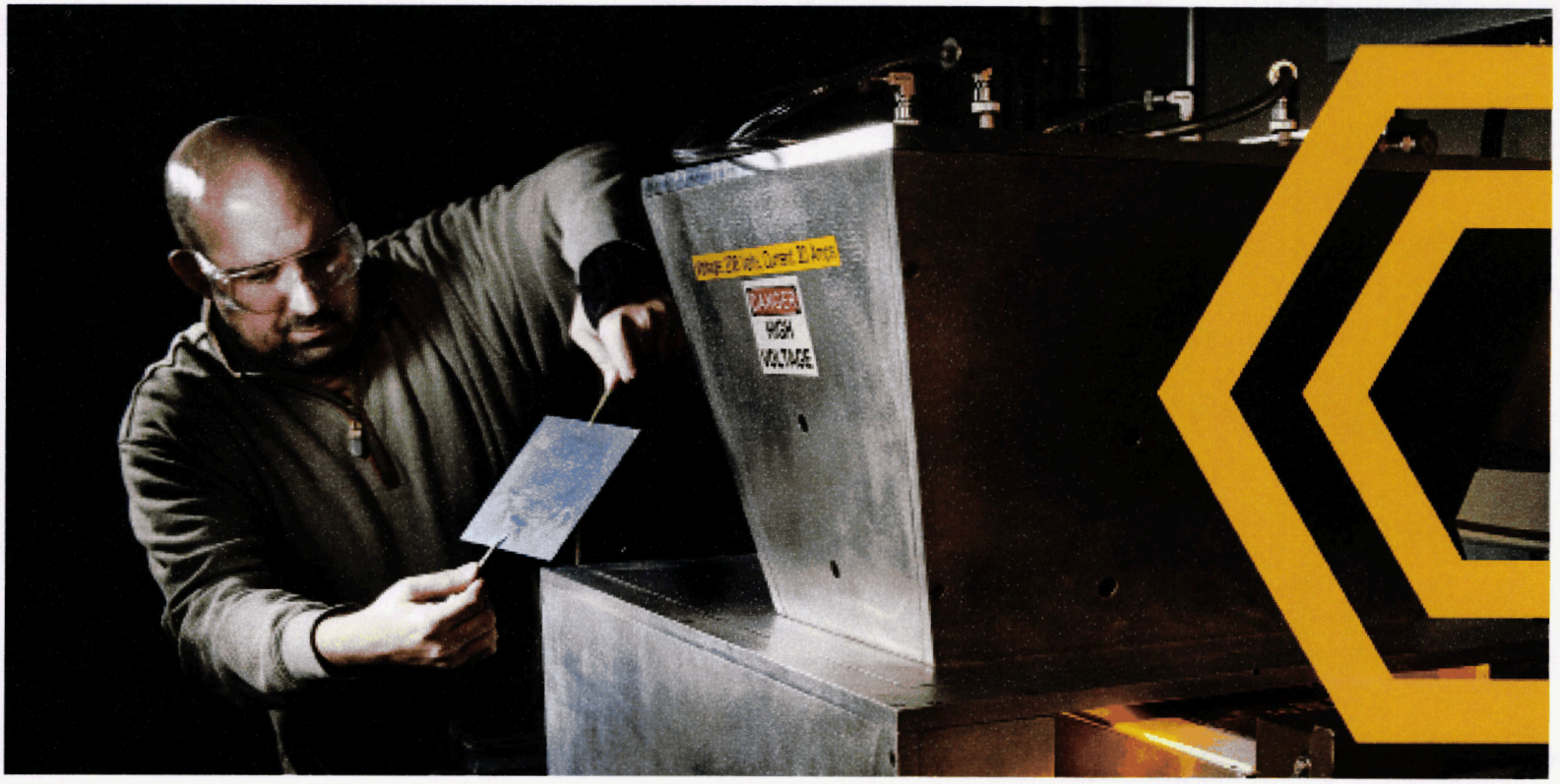


Table 6: 2014 Installation Solar Worker Demographic Breakdown[25]

	Employment	% of Installation Employment	% of total U.S. Workforce	% of Construction Industry Employment	% Oil and Gas Extraction Indus Empl.	% of Coal Industry Employment
Latino or Hispanic	18,821	19.4%	13.0%	16.7%	19.1%	3.0%
Women	17,137	17.7%	49.6%	14.4%	16.6%	6.3%
Belong to a Union	9,105	9.4%	n/a	n/a	n/a	n/a
Veterans of the U.S. Armed Forces	8,649	8.9%	7.0%	n/a	n/a	n/a
African-American	6,269	6.5%	11.7%	5.3%	5.1%	2.4%
Asian or Pacific Islanders	6,013	6.2%	5.2%	2.1%	2.1%	0.4%

25 See: EMSI Class of Worker 2013.4; The Employment Situation – November 2014, Bureau of Labor Statistics, available at: http://www.bls.gov/news.release/pdf/empsit.pdf.

Manufacturing

Solar manufacturers produce a variety of finished products and components for domestic and international markets. From solar water heaters to photovoltaic modules, U.S. production of solar goods and services is growing, thanks to a rapidly expanding global market.

Big News in Domestic Manufacturing:

- **An improved balance of supply and demand in global markets has benefited domestic module manufacturing.** As shown in Figure 7 below, Q3 2014 saw the greatest domestic module production in two years, with output up over 275% since the low levels observed in mid-2012.[26]

  Domestic production of PV components (e.g., polysilicon, cells, wafers, inverters) is also up year over year and/or quarter over quarter.[27]

Figure 7: U.S. Domestic Solar Module Production, 2010-2014

Source: SEIA and GTM Research, *Solar Market Insight* report series

- **2014 saw several notable additions or announcements of new domestic manufacturing capacity.**
  - Mission Solar Energy opened a new 100 MW cell and module facility in fall 2014 in San Antonio, Texas, which is expected to create over 400 new jobs in the area.[28]
  - Georgia-based Suniva announced it plans to open a second U.S. manufacturing facility in Michigan. Once fully-operational, the 200 MW facility is

26 SEIA/GTM Research Solar Market Insight series, 2012-2014
27 SEIA/GTM Research Solar Market Insight Q3 2014
28 See "Mission Solar producing solar panels" from My San Antonio at http://www.mysanantonio.com/business/local/article/Mission-Solar-producing-solar-panels-5768001.php

expected to create 350 new jobs in the community.[29]

- In November 2014, REC Silicon announced its plans to expand polysilicon production capacity at its Moses Lake, Washington facility by 3,000 metric tons. Though not expected to be completed until late 2016, this expansion will represent a 20% increase in overall U.S. polysilicon capacity (compared with Q3 2014 figures).[30, 31]
- In June of 2014, Solar City announced its acquisition of solar manufacturer Silevo and its plans to build a 1 GW module production facility in New York State. Construction began on the facility in September 2014.[32]
- This year also saw progress made on plans for a Wacker Chemie production facility in Charleston, Tennessee. Thus far, 200 employees have been hired to staff the facility, with an additional 450 people expected to be brought on through 2015.[33]
- In November 2014, First Solar announced plans to add two new production lines and hire 120 employees at its manufacturing facility in Perrysburg, Ohio.[34]
- Also during the fall, SolarWorld announced its plans to add a new module production line at its Oregon factory, increasing production capacity at the facility by nearly 40%. This expansion, along with the addition of 100 MW of cell production capacity, is expected to create 200 jobs in early 2015.[35]

29 See "New Tariffs on Chinese Solar-Panel Makers Split the US Solar Industry" from GreenTech Media at http://www.greentechmedia.com/articles/read/commerce-department-hits-chinese-panel-makers-with-higher-tariffs

30 See "REC Silicon ExpandingPpolysilicon Production and Mulling 20,000MT JV in Saudi Arabia" from PVTech at http://www.pv-tech.org/news/rec_silicon_expanding_polysilicon_production_and_mulling_20000mt_jv_in_saud

31 SEIA/GTM Research Solar Market Insight Q3 2014

32 See "SolarCity Breaks Ground on 1GW Silveo fab in New York" from PV Tech at http://www.pv-tech.org/news/solarcity_breaks_ground_on_1gw_silevo_fab_in_new_york

33 See "Wacker Still Looks for 2015 Start-up" from Cleveland Daily Banner at http://clevelandbanner.com/view/full_story/25935045/article-Wacker--still-looks-for-2015-start-up?instance=yourstories

34 See "First Solar to Add 120 Workers at Perrysburg Township Plant" from The Toledo Blade at http://www.toledoblade.com/Energy/2014/11/13/First-Solar-to-add-120-employees-at-local-plant.html

35 See "SolarWorld Announces Expansions of Solar Panel and Advanced Cell production in Oregon" from SolarWorld at http://www.solarworld-usa.com/newsroom/news-releases/news/2014/solarworld-announces-expansions-in-oregon

- **Given current trends, U.S. module manufacturing capacity could increase to more than 3.5 GW by 2018 (compared with 1.6 GW currently), and cell manufacturing capacity could increase to 2.0 GW (up from 0.7 GW) in the same time frame.**[36] Such efforts stand to benefit from additional investments aimed at manufacturing process improvements. One example is the Smart Manufacturing Innovation Institute announced by the White House in December. This public-private partnership will seek to leverage $140 million to improve the energy efficiency of manufacturing processes in energy intensive industries, including solar cell manufacturing.[37]

- **Unfortunately, the ongoing U.S.-China solar trade conflict created unintended consequences for some of the U.S. solar industry.** In December 2014, U.S. polysilicon manufacturer Hemlock Semiconductor was forced to close its Clarksville, Tennessee production facility largely due to retaliatory restraints on U.S. polysilicon exports to China.[38] The new $1.2 billion dollar facility had yet to enter commercial production. Most of the approximately 50 affected employees will have the opportunity to relocate to other Hemlock Semiconductor or Dow Corning sites.[39] Hemlock Semiconductor will continue to manufacture and sell materials from its Hemlock, Michigan, site, which has been in operation for more than 53 years, and has received more than $2.5 billion of investment in the last 10 years.

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36 See "SunShot Q2/Q3 '14 Solar Industry Update (October 31, 2014)" from U.S. Department of Energy SunShot Initiative at http://ny-sun.ny.gov/-/media/NYSun/files/Meetings/2014-11-06/SunShot-Solar-Industry-Update.pdf

37 See: "FACT SHEET: President Obama Launches Competitions for New Manufacturing Innovation Hubs and American Apprenticeship Grants" from the White House at: http://www.whitehouse.gov/the-press-office/2014/12/11/fact-sheet-president-obama-launches-competitions-new-manufacturing-innov

38 See "Hemlock Semiconductor Group Closes Tennessee Manufacturing Facility as a Result of Industry Oversupply, International Trade Disputes" from Hemlock Semiconductor at http://www.hscpoly.com/content/hsc_comp/hsc-tennessee-manufacutring-facility-closure.aspx

39 Id.

Worker Profile

Sina Khiev

Occupation: Production Technician Lead
Company: SolarWorld USA
Years at Occupation: 6
Location: Hillsboro, OR

As a lead production technician at SolarWorld, Mr. Khiev is the subject matter expert responsible for the operation and troubleshooting of automated equipment and tools for PV module assembly, as well as for driving tactical scheduling and decision making for specific work groups on the production floor.

Before obtaining his current position, Mr. Khiev studied construction engineering management and electronics in college. However, much of his training has been through the hands-on experiences received during his twenty years in the semiconductor industry. Some of that training has included company trips to Germany to build PV modules by hand. After moving into the region, he wanted a job with an exciting company that valued his experience, which he has found at SolarWorld.

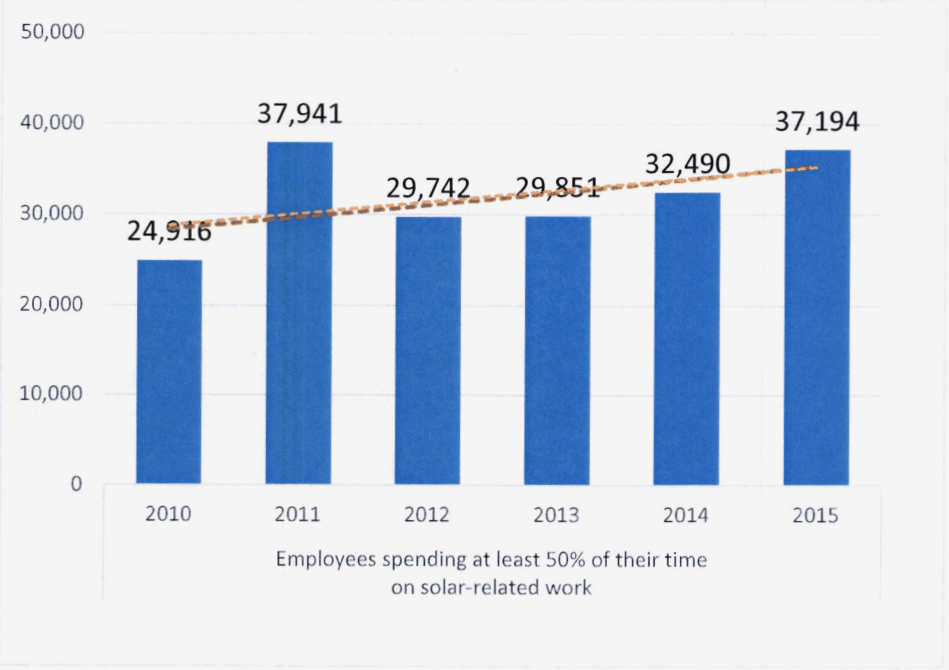
The part of his job he enjoys the most is the fact that, though he and his coworkers all have their own tasks and areas of focus, they all share a deep feeling of teamwork as they all rely on each other to successfully coordinate module assembly. His advice for jobseekers is to "focus on finding what you like to do, then do it to the best of your ability. With enough passion you can acquire the skills to do whatever you hope to achieve."

This section includes the key findings from the data gathered from more than 250 solar manufacturers.

Manufacturers currently employ 32,490 solar workers, equating to growth of 8.8% since November 2013 and 30% since September 2010.

By way of comparison, overall manufacturing employment in the United States has grown by only 3.2% since 2010 and declined between 2013 and 2014 by 1.6%.[40] Solar manufacturers predict strong employment growth of 14.5% through the end of 2015, adding about 4,700 new jobs. Meanwhile, the overall manufacturing sector in the United States is expected to shed more than 130,000 jobs, a decline of 1.1%, over the same period.[41]

Figure 8: Manufacturing Employment Growth from 2010 to 2015 (Projected)



Manufacturers largely produce photovoltaic modules or components.

Seven in ten manufacturers produce photovoltaic modules or components, while another 18.4% report producing goods related to solar water heating. This figure has been relatively consistent over the last few years, with 19.9% of manufacturing firms involved in solar water heating in 2012, and 18.8% in 2013.

As shown in Table 7 below, the majority of solar manufacturers across all regions of the country produce photovoltaic modules or components, reflecting the fact that solar electric systems are currently in higher demand not only nationally, but globally. While manufac-

40 EMSI Class of Worker Employment 2014.3.
41 Id.

turers are not constrained by local demand considerations, the large concentration of manufacturers producing solar water heating equipment and components in the Southeast may be due to the fact that Florida led the nation in cumulative total solar water heating (SWH) and solar pool heating (SPH) installations in 2010 (the last year for which reliable data is available). At the time, Florida had installed 80% more SWH systems and 27% more SPH systems than California, the next largest state market for solar thermal systems.[42]

Table 7: Manufactured Products by Region

	Overall	West	Southwest	Midwest	Southeast	Mid-Atlantic	Northeast
Photovoltaic	70.7%	74.0%	69.4%	65.2%	66.7%	87.1%	59.3%
Water heating, which includes po	18.4%	18.2%	13.9%	17.4%	25.6%	16.1%	18.5%
Concentrating solar power	8.2%	7.8%	11.1%	10.9%	5.1%	9.7%	3.7%
Other	19.9%	19.5%	13.9%	26.1%	20.5%	19.4%	18.5%

*Does not equal 100% as many companies work across multiple technologies.

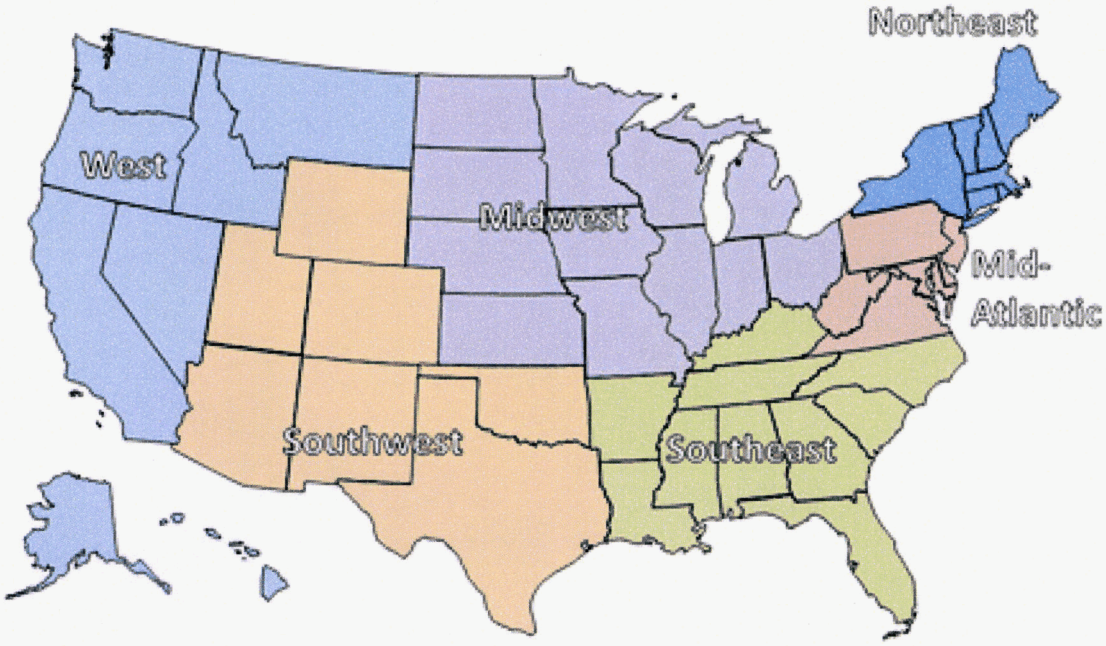


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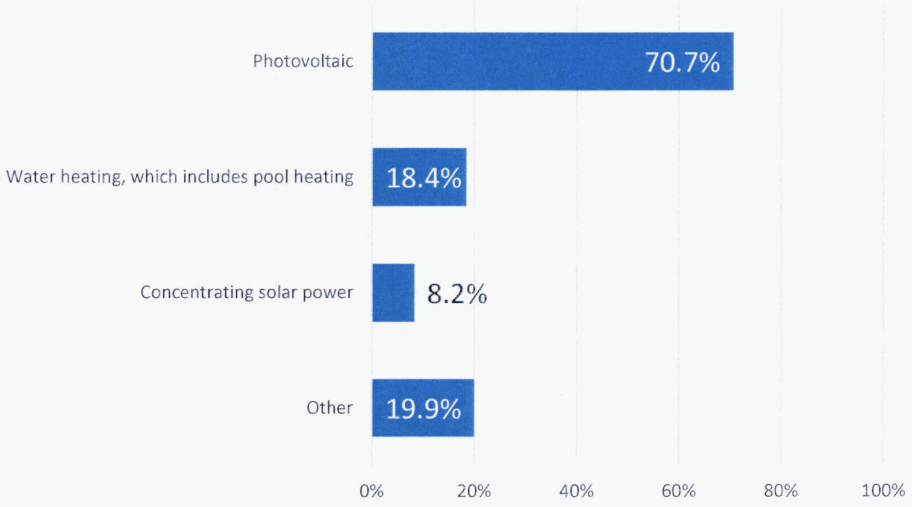
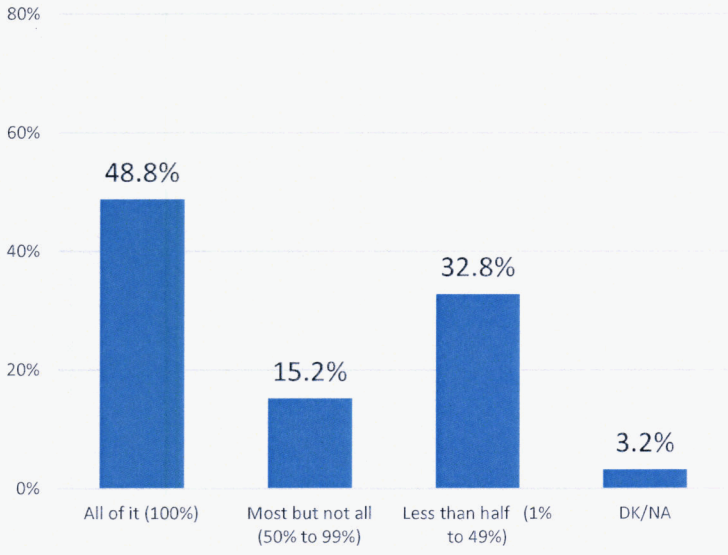
Figure 9: Solar Products Produced by Manufacturers



About half of all solar manufacturing establishments exclusively produce solar goods and services.

Only one in three solar manufacturing establishments derive less than half of their revenues from solar products. As with other sectors within the solar industry, more manufacturing firms report that solar represents a majority source of revenue. This figure correlates with an increase in the number of large solar manufacturers, suggesting that solar is becoming more integrated into mainstream production by firms that offer multiple, related products rather than remaining a niche industry. This movement is similar to other production industries that have had comparable trajectories, such as organic food production, mobile software application development, and LED light bulb manufacturing.

Figure 10: Company Revenues Attributable to Solar



Compared with the installation sector, many fewer manufacturers expect to be impacted by the ITC expiration.

Domestic manufacturers will likely see little impact with the expiration of the ITC because they sell the bulk of their product as components or feedstock to foreign manufacturers (e.g. polysilicon, backsheets, metal pastes) or because the products they sell are not eligible for the ITC (e.g. solar pool heaters). Moreover, a significant portion of the companies are not "pure-play" solar manufacturers, and over half of these establishments expect to not be impacted by the ITC decline. By comparison, firms focusing solely on solar see themselves as less likely to not be impacted by changes to the ITC, with some domestic manufacturers of heavy products for mostly domestic consumption (including module, racking, and inverter manufacturers) potentially face a more challenging market in 2017.

Table 8: Solar Manufacturer Action for Anticipated ITC Decline by Amount of Firm Revenue Attributable to Solar Products

Action	100% Solar	99% or less Solar	Combined Results
No impact	31.9%	55.6%	42.6%
Expect to increase our workforce in 2017	14.9%	6.2%	10.8%
Expect to lay off staff	20.2%	13.6%	17.0%
Expect to lay off subcontractors	3.2%	2.5%	2.8%
Expect to lay off staff and subcontractors	29.8%	22.2%	26.1%

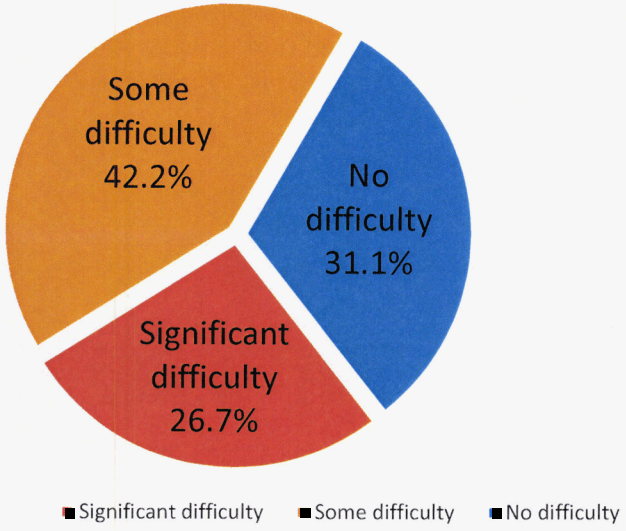
Table 9: Percent of Manufacturers that Work with Solar Products by Amount of Firm Revenue Attributable to Solar Products[43]

Solar Products	100% Solar	99% or less Solar
Photovoltaic	74.6%	67.2%
Water heating, which includes pool heating	19.7%	17.2%
Concentrating solar power	7.4%	9.4%
Other	18.0%	21.9%

43 Multiple responses permitted, may sum to more than 100%

About 30% of solar manufacturers sought financing over the last 12 months, seeking both loans and equity investments. About one in four experienced significant difficulty obtaining financing, a trend that bears watching to ensure that lack of capital does not derail potential growth in the sector.

Figure 11: Difficulty Trying to Obtain Financing over Past 12 Months



The manufacturer workforce is more diverse than other segments, particularly for women, Latino/Hispanic workers, and veterans. Table 10 illustrates the 2014 demographics of solar workers in the manufacturing sector.

Table 10: 2014 Manufacturing Solar Worker Demographic Breakdown[44]

	Employment	% of Manufacturing Employment	% of U.S. Workforce	% of U.S. Manufacturing Industry
Women	7,929	[redacted]	[redacted]	28.4%
Latino or Hispanic	6,072	18.7%	13.0%	13.9%
Veterans of the U.S. Armed Forces	3,853	11.9%	7.0%	n/a
Asian or Pacific Islanders	3,063	9.4%	5.2%	5.8%
African-American	2,382	7.3%	11.7%	9.3%

44 See EMSI Class of Worker 2014.3; The Employment Situation – November 2014, Bureau of Labor Statistics, available at: http://www.bls.gov/news.release/pdf/empsit.pdf.

Sales and Distribution

The solar sales and distribution sector is made up primarily of wholesale and retail trade establishments 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. Because this report delineates companies by the activities at each business location to gather the most accurate employment information, much of the data for this section includes data from sales offices and distribution warehouses from companies across other segments of the value chain.

As the industry matures and companies grow, much of this work is carried out in-house, while developing markets are likely to be more reliant on distributors – since such markets may not be sufficiently large to account for direct sales.

Big News in Sales and Distribution:

- **2014 saw continued federal support for firms seeking to streamline solar sales efforts, helping to reduce soft costs.** Through its SunShot Incubator Program, the U.S. Department of Energy (DOE) has continued to make investments in firms with promising ideas for reducing customer acquisition soft costs, thus enabling greater efficiency in sales efforts for solar firms and lower installed costs for customers. Since fall 2013, DOE has invested nearly $6 million in a half dozen firms developing new tools to reduce customer acquisition costs.[45]

- **A number of solar companies with establishments active in the sales and distribution sector announced new expansions or partnerships.**

    - Oakland-based Sungevity is in the process of building out a new sales and service center in Kansas City, Missouri.[46] Once fully staffed, the new location will employ nearly 600 workers – approximately 20% of the total number of solar jobs in the state in 2013.

    - This past summer, the solar crowd-funding company Mosaic announced a partnership with microinverter manufacturer Enphase aimed at offering $100 million in solar loans designed to help homeowners finance new installations.[47]

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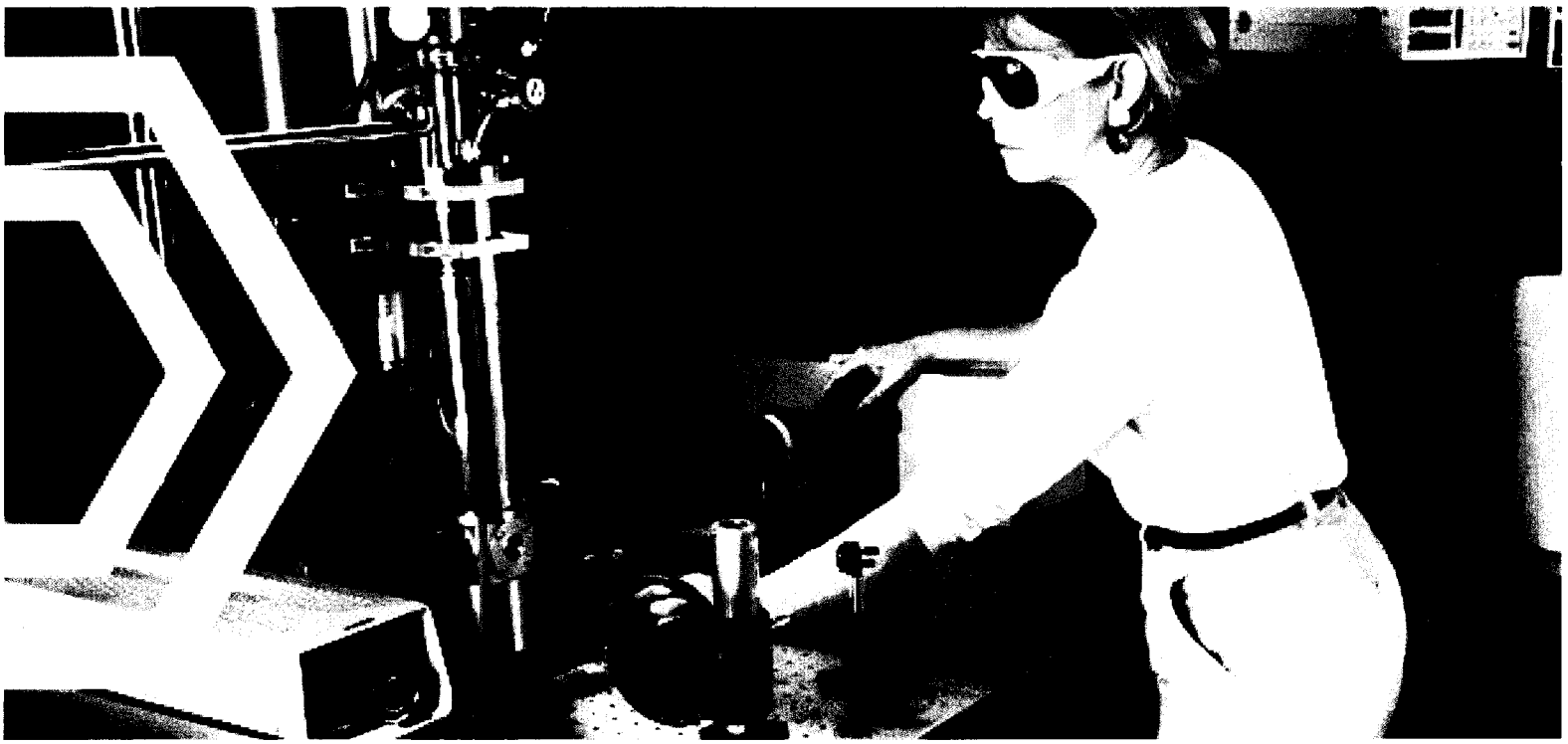
45 See "Current SunShot Incubator Projects" from U.S. Department of Energy Office of Energy Efficiency and Renewable Energy at http://energy.gov/eere/sunshot/current-sunshot-incubator-projects

46 See "Sungevity Shines on with Office Build, Hiring Spree" from the Kansas City Business Journal at http://www.bizjournals.com/kansascity/news/2015/01/06/sungevity-shines-on-with-office-build-hiring-spree.html

47 See "Enphase and Mosaic Join Forces in a Bid to Push Solar Loans and Supplant the Lease" from GreenTech Media at http://www.greentechmedia.com/articles/read/how-to-take-the-risk-out-of-residential-solar-loans



- Late 2014 saw the announcement of a strategic partnership between First Solar and Colorado-based Clean Energy Collective to expand CEC's efforts to develop and market utility-owned community solar projects.[48]

- In October 2014, the nation's largest independent power producer, NRG Energy, acquired Pure Energies Group, which created an online and telephone-based solar customer acquisition platform. The acquisition, along with other recent acquisitions by NRG Energy, position it as potentially one of the nation's largest vertically integrated solar company featuring sales, financing, and installation services.[49] These types of acquisitions illustrate the growing trend that many sales and distribution establishments are offices or subsidiaries of firms that belong to other sectors (e.g., most of NRG Energy's establishments focus on project development).

- EnergySage, based in Cambridge, Massachusetts, announced several new partnerships in 2014. East Coast Petroleum, Staples, Walgreens, World Wildlife Fund, and many local chambers of commerce and cities have partnered with EnergySage in the last year to provide their employees, customers, and other constituents with a central marketplace for receiving and comparing price estimates from multiple solar installers at the same time.[50]

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48 See "First Solar takes stake in Louisville-based Clean Energy Collective" from The Denver Post at http://www.denverpost.com/business/ci_27104211/first-solar-takes-stake-louisville-based-clean-energy

49 See "NRG Acquires Pure Energies to Lower the Cost of Winning Solar Customers" from GreenTech Media at http://www.greentechmedia.com/articles/read/NRG-Acquires-Pure-Energies-to-Lower-the-Cost-of-Winning-Solar-Customers

50 See "News/Press" page from EnergySage at https://www.energysage.com/news

Worker Profile

Melinda Kershaw

Occupation: Director of Marketing
Company: Day and Night Solar
Years at Occupation: 5
Location: Collinsville, IL

As Director of Marketing, Ms. Kershaw is responsible for driving the marketing and sales operations for Day and Night Solar. With her 22 years of experience in sales, marketing, and operational management and a key focus on sales and operation infrastructure for emerging technologies, she was a natural fit for the position, which she obtained through the company's regular application process.

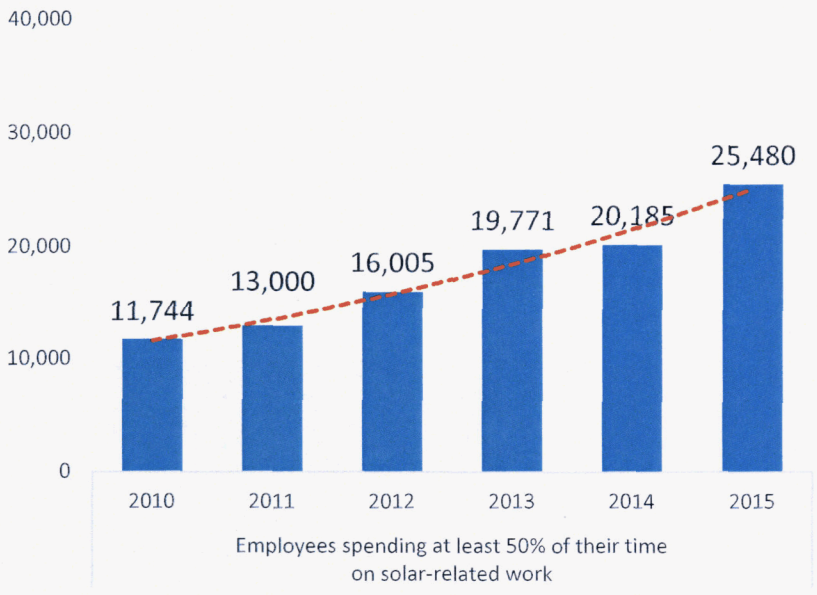
Her favorite aspects of her job are the changing nature of the challenges it presents, as well as the opportunity to be involved in an industry that she believes is helping to change the nation's energy landscape. To job seekers looking to replicate her success, she offers this advice: "Have the ability to be flexible. Changes are daily in this exciting industry and if you are not able to adapt, it will become overwhelming."

This section includes highlights from the responses of nearly 300 solar sales firms.

Solar firms primarily engaged in sales and distribution currently employ 20,185 solar workers, an increase of 72% since September 2010.

By comparison, the national wholesale and retail trade sectors grew by a rate less than 1/10th of the solar sales and distribution sector, showing just over 6% growth over the same period.[51] However, solar sales firms posted the weakest growth of any solar sector at 2.1% over the past 12 months, though this is still three times the growth expected in the national retail and wholesale sectors over the same period.[52]

Figure 12: Sales and Distribution Employment Growth from 2010 to 2015 (Projected)

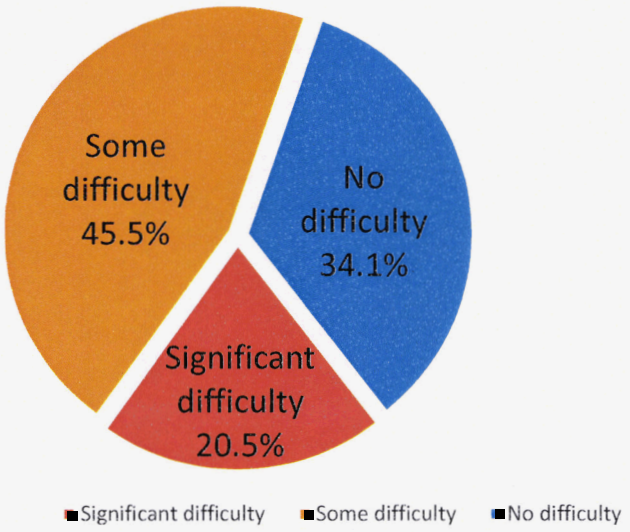


Employers are optimistic, expecting gains of 26.2% (5,295) through 2015, the fastest growth rate of any sector.

About one in three sales and distribution firms applied for financing and nearly two-thirds of those had at least some difficulty obtaining financing (with 20.5% experiencing significant difficulty).

51 EMSI Class of Worker Employment 2014.3
52 Id.

Figure 13: Difficulty Trying to Obtain Financing over Past 12 Months

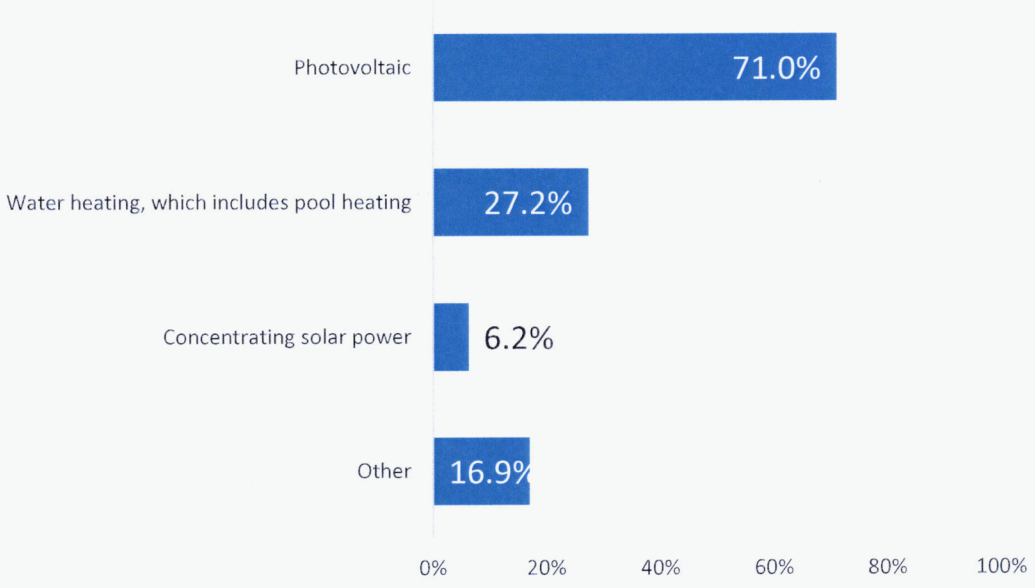


Solar sales and distribution firms most typically pursued loans or other debt financing when seeking capital over the past year. It will be important to determine whether and to what extent lack of capital is to blame for the weaker performance of the solar sales sector, and whether policies or incentives could help free capital for these businesses. Alternatively, it is likely that solar is comprising a larger share of business for existing distributors. Thus, despite demand for solar products growing in the last year, increasing efficiency and labor productivity among these established businesses may have been largely sufficient to meet the higher volume of sales.

Fewer sales and distribution firms indicated that they fully understand the Investment Tax Credit and the impact it has on their business. Perhaps as a result, the majority believe that it will not harm their business prospects.

A growing number of sales and distribution firms are working with solar water heating products (though the percentage of the total is declining as the number of PV firms is growing at an even faster rate). Currently, about one quarter (27.2%) of solar sales and distribution firms work with solar water heating products, while the overwhelming majority work with photovoltaics.

Figure 14: Solar Products Sold by Sales and Distribution Firms



Sales and distribution firms offer many opportunities for women, but are less diverse than other sectors of the solar industry.

Table 11 demonstrates the demographic breakdown of the solar sales workers over the past year.

Table 11: 2014 Sales and Distribution Solar Worker Demographic Breakdown[53]

	Employment	% of Sales & Distribution Employment	% of U.S. Workforce	% U.S. Wholesale Trade Industry
Women	4,850	24.0%	49.6%	30.5%
Veterans of the U.S. Armed Forces	1,525	7.6%	7.0%	n/a
Latino or Hispanic	1,385	6.9%	13.0%	12.9%
Asian or Pacific Islanders	1,352	6.7%	5.2%	5.6%
African-American	682	3.4%	11.7%	6.9%

53 See EMSI Class of Worker 2014.3; The Employment Situation – November 2014, Bureau of Labor Statistics, available at: http://www.bls.gov/news.release/pdf/empsit.pdf.

Project Development

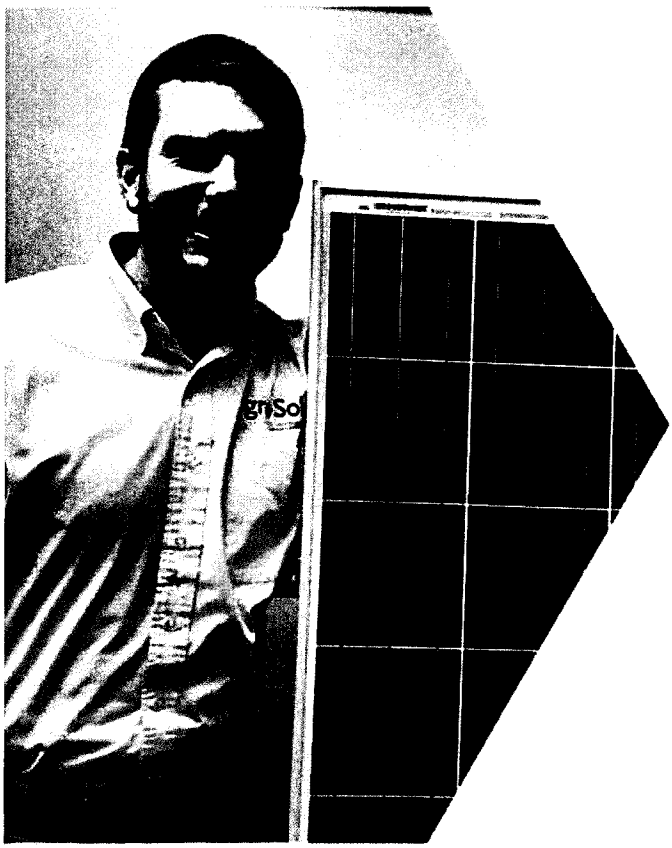
The project development sector includes companies that work on the largest, utility-scale solar projects. Predominantly using photovoltaic or thermal electric generation (concentrating solar power or CSP), these facilities generate and sell bulk power to utilities or directly to consumers as part of the electricity grid system.

Project developers and utilities require a wider range of workers and contractors, including civil engineers, land surveyors, and power plant operators. Permitting, finance, and land acquisition is more complex, requiring more administrative and professional workers as well. Employers in the sector tend to be larger and highly efficient with specialized labor for each component of the project.

Big News in Project Development

- **By the end of 2014, the U.S. is expected to install a record-high 4,900 MW of utility-scale solar capacity** (including both PV and CSP), approximately 50% more than was installed in the previous year.[54]
- **A number of noteworthy utility-scale solar projects came online in 2014.** Near the start of the year, BrightSource's Ivanpah Solar Electric Generating System – a 392 MW concentrating solar power plant – came online, with the capacity to provide enough solar electricity to power 140,000 average U.S. homes.[55] Also this year, First Solar's Topaz Solar Farm, currently the largest solar project in the world at 550 MW, began producing electricity.[56]
- **Drivers of this growth** include the sharp decline in installed costs observed since 2010, the value of solar in providing a hedge against fuel price volatility (possible with competing conventional technologies), the use of solar energy to replace retired coal capacity, and the desire of some utilities to "front load" large projects in their RPS compliance timeline to ensure these facilities will be completed in time to benefit from the 30% ITC.[57]
- **The short-term outlook for utility-scale installations remains healthy,** with still greater levels of annual installed capacity expected in this market segment in 2015 and 2016. These projections are in line with employers' expectations of continued employment growth over the next few months. **However, a reduction in the federal ITC to 10% at the end of 2016 can be expected to result in 2017 annual capacity additions that are over 80% lower than those expected in 2016, leading to a large contraction in employment in this sector.[58]**

54 SEIA/GTM Research Solar Market Insight Q3 2014
55 See "What You Should Know: The 7 Notable Solar Power Plants of 2014" from Forbes at http://www.forbes.com/sites/uciliawang/2014/12/31/what-you-should-know-the-7-notable-solar-power-plants-of-2014/.
56 Id.
57 SEIA/GTM Research Solar Market Insight Q3 2014
58 Id.



Ryan Marlborough

Occupation: Commercian Sales Analyst
Company: groSolar
Years at Occupation: 2
Location: Columbia, MD

As a Commercial Sales Analyst for the project developer groSolar, Mr. Marlborough moves projects along the sales and development process, including site walks and assessment, financial modeling, proposal writing, contract negotiations, and other project due diligence activities. He's been in his current position for two years, and before then he worked for an electrical distributor selling solar equipment to installers throughout the country. Much of Mr. Marlborough's solar expertise came from experience on the job and attending numerous solar training classes over his six years in the solar industry.

Mr. Marlborough made the transition from equipment sales to project developer through an opening he discovered on an online solar job board. When asked about his favorite aspects of his job, Mr. Marlborough noted that "the dynamic nature of the solar industry keeps the job both exciting and challenging. There is never a day where I am not trying to solve a problem or learn something new." For others looking to follow a similar career path in solar, Mr. Marlborough recommends jobseekers think about the sector of the industry that most interests them, research firms in that sector, and identify positions within those firms that align with their skills and passions. He added: "The industry has scaled to the point where there are positions available for a wide assortment of backgrounds and interests."

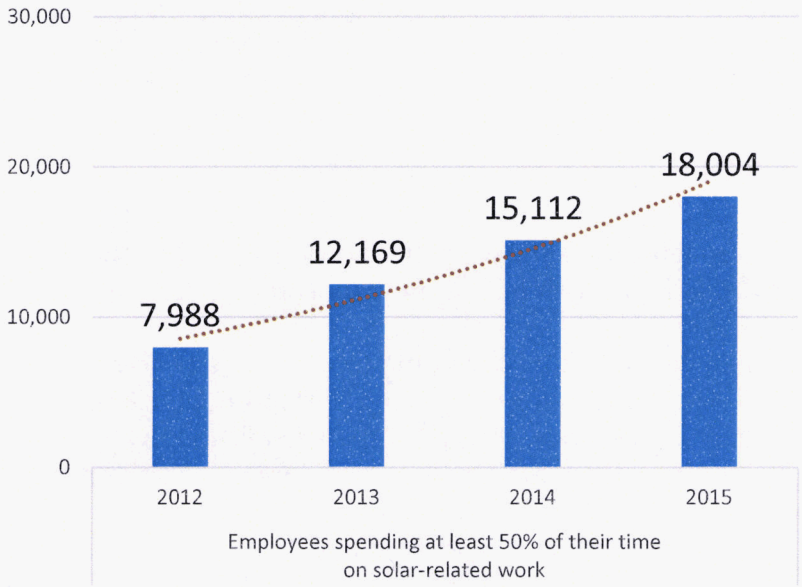
Annual utility-scale installed capacity has grown by nearly 170% since 2012, while employment has grown by 89%.[59] At the same time, these installations represent 63% of solar capacity added over the same period,[60] yet due to the efficiencies of scale associated with these larger systems as well as increased labor efficiency,[61] only 13% of all new jobs since November 2012 were created in this sector.

This section includes the key findings from nearly 200 project developers and utilities.

Project development is one of the fastest growing solar sectors, gaining nearly 3,000 jobs to total 15,112 solar workers, a growth rate of 24.2% from November 2013 to November 2014.

Developers expect to add approximately 3,000 more solar jobs over the coming 12 months, at a growth rate of 19.1%.

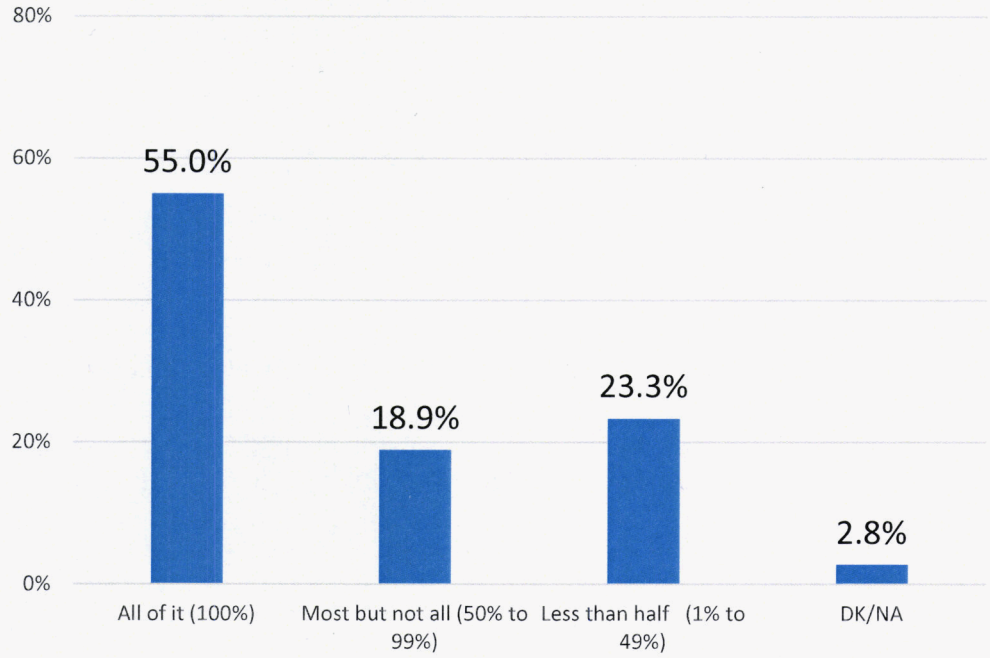
Figure 15: Project Developer Employment Growth from 2012 to 2015 (Projected)[62]



Developers are more likely to be "pure-play" solar firms, with over half receiving all of their revenue from solar. This is logical given the large size of the projects they work on; however, about one in four receives less than half of their revenue from solar projects.

59 Id.
60 Id.
61 In 2014, employers reported that 74.3% of the installation workforce spends a majority of their time on installing systems, nearly double the amount reported in 2013 of 37.5%.
62 2012 was the first year that project developers were counted as a separate category.

Figure 16: Percentage of Establishments by Portion of Solar Revenue

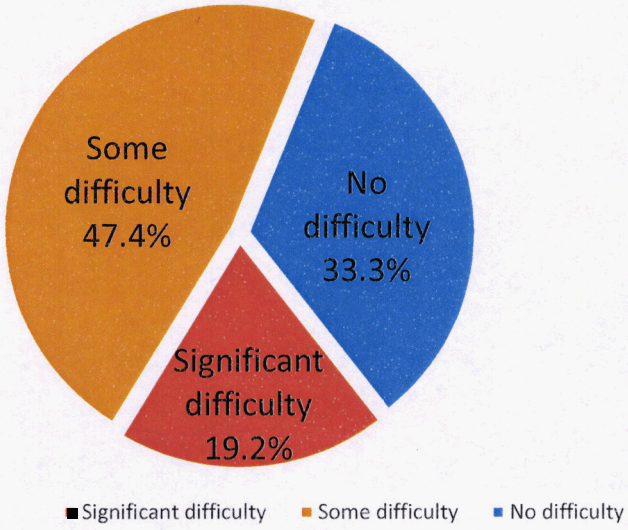


Nearly half of developers sought financing over the last year (48.3%), and over two-thirds (66.7%) had difficulty obtaining it, with one in five reporting significant difficulty.

Employers' stated difficulties in obtaining financing may be a reflection of the limited financing options available to solar developers, forcing them to continue to pursue existing financing mechanisms with higher costs of capital than would be available with greater alternatives. Significant work has been done by numerous organizations on the prospect of financing alternatives to "traditional" tax equity partnerships, such as Master Limited Partnerships, Solar Real Estate Investment Trusts, and "yieldcos."[63] Nevertheless, broad adoption of any of these or other financing arrangements among developers and lenders does not yet appear to have occurred. Continued reliance on tax equity partnerships may result in unrealized development without an increase in the tax appetite of lenders, particularly as developers rush to begin projects before the expiration of the ITC.

63 See: "Master Limited Partnerships and Real Estate Investment Trusts: Opportunities and Potential Complications for Renewable Energy" from the National Renewable Energy Laboratory at http://www.nrel.gov/docs/fy14osti/60413.pdf and "Solar YieldCos: Proven Concept or Hype?" from GreenTech Media at http://www.greentechmedia.com/articles/read/solar-yieldcos-proven-concept-or-hype, among others.

Figure 17: Difficulty Trying to Obtain Financing over Past 12 Months



Not surprisingly, about half of the firms who sought financing looked for project finance, which is most typically a combination of debt and equity.

Nearly 60% of developers expect to lay off workers if the ITC is reduced as planned. Again, this significant reduction in employment is likely tied to the fact that project economics for utility-scale solar installations stand to be impacted the greatest by reductions in the ITC. With industry analysts projecting an 80% decline in these installations in 2017 (when the commercial ITC is scheduled to decrease to 10% and some major utilities are expected to have mostly fulfilled their renewable portfolio standard targets), it should come as no surprise that employment in this sector will also be affected dramatically.[64]

Project developers employ a large proportion of women and veterans, but solar workers are less racially and ethnically diverse in this sector than in other solar sectors.

64 SEIA/GTM Research Solar Market Insight Q3 2014

Table 12 shows the recent hires of project developers by demographic group.

Table 12: 2014 Project Developer Solar Worker Demographic Breakdown[65]

	Employment	% of Project Development Employment	% of U.S. Workforce	% of Utility System Construction Industry
Women	3,657	24.2%	49.6%	11.2%
Veterans of the U.S. Armed Forces	1,932	12.8%	7.0%	n/a
Latino or Hispanic	1,283	8.5%	13.0%	18.0%
Asian or Pacific Islanders	1,130	7.5%	5.2%	1.4%
African-American	699	4.6%	11.7%	5.8%

65 See EMSI Class of Worker 2014.3; The Employment Situation – November 2014, Bureau of Labor Statistics, available at: http://www.bls.gov/news.release/pdf/empsit.pdf.

George Ashton

Occupation: CFO
Company: Sol Systems
Years at Occupation: 6
Location: Washington, DC

As an executive at Sol Systems, Mr. Ashton performs business development and corporate strategies, operations, and colleague training. He co-founded Sol Systems in 2008 after receiving his MBA; Sol Systems is Mr. Ashton's first foray in the solar energy industry.

When asked about what he likes best about his job, he noted that solar is a "great industry, and there are great folks at the company. There is a common sense of purpose and a common drive to succeed in the right ways." Mr. Ashton's advice for others looking to enter the solar field is that they should seek out as many informational interviews as needed to "figure out where you want to be." He added that new entrants to the solar field "should be willing to think creatively and work hard"

Other

Entities such as research and development firms, nonprofits, government agencies, and academic research centers play a small but important role in the U.S. solar industry.

Big News in the "Other" Sector:

- **The U.S. solar industry has continued to expand its efforts to create and employ new forms of project financing.** 2014 saw the creation of a number of "yieldco" structures designed to provide investors with an attractive investment opportunity and companies with a means of financing new projects with cheaper capital. Based on the success of the half dozen or so yieldcos created to date, some analysts are predicting the creation of several more in the coming year.[66] The last year has seen companies take further steps toward large scale securitization[67] of solar assets and the first-ever registered offering of "solar bonds" to public investors.[68] In addition, more lending institutions – whether in partnership with solar companies or independently[69] – have been offering new financial products for solar or have increased the amount they are willing to finance through existing financing options (including home equity lines of credit, which have become an option for more homeowners since the housing market has improved).

- **Early-stage investment in pre-commercial firms rose sharply through 2011, but has since fallen to pre-2007 levels.** Private investment at the early stages (Seed, Series A, and Series B) has dropped most significantly.[70] While there are many potential reasons for this decline, such as high-profile bankruptcies and declines in traditional PV, the need for innovation in the long-term is unchanged.

About 5.2% of the solar workforce, or 8,989 workers, are engaged in other solar activities such as research and development, nonprofit advocacy, academic research, or government oversight.

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66 See "Deutsche Bank expects more publicly traded PV-based yield cos" from PVTech at http://www.pv-tech.org/news/deutsche_bank_expects_more_publicly_traded_pv_based_yield_cos

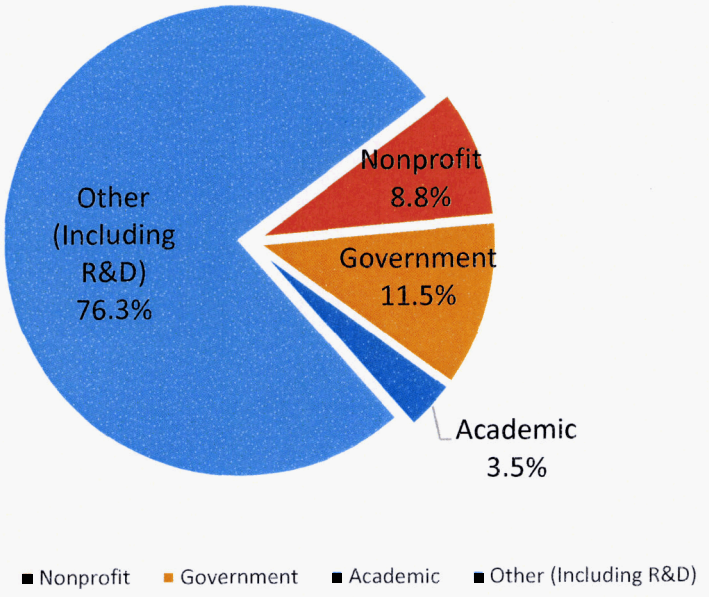
67 See "Debt Financing Tied to Solar Project Pools Will Spur Growth for Residential Developers" from GreenTech Media at http://www.greentechmedia.com/articles/read/Debt-Financing-Tied-to-Solar-Project-Pools-Will-Spur-Growth-For-Residential

68 See "SolarCity Starts Selling 'Solar Bonds' Online to Public Investors" from GreenTech Media at http://www.greentechmedia.com/articles/read/SolarCity-Innovates-Again-With-a-Public-Offering-of-Solar-Bonds

69 See "Admirals Bank and SunPower Partnership Announces $200 Million Loan Funding Program for Residential Solar Systems" from Admirals Bank at http://www.admiralsbank.com/news/press-releases/admirals-bank-and-sunpower-finance-home-solar-systems

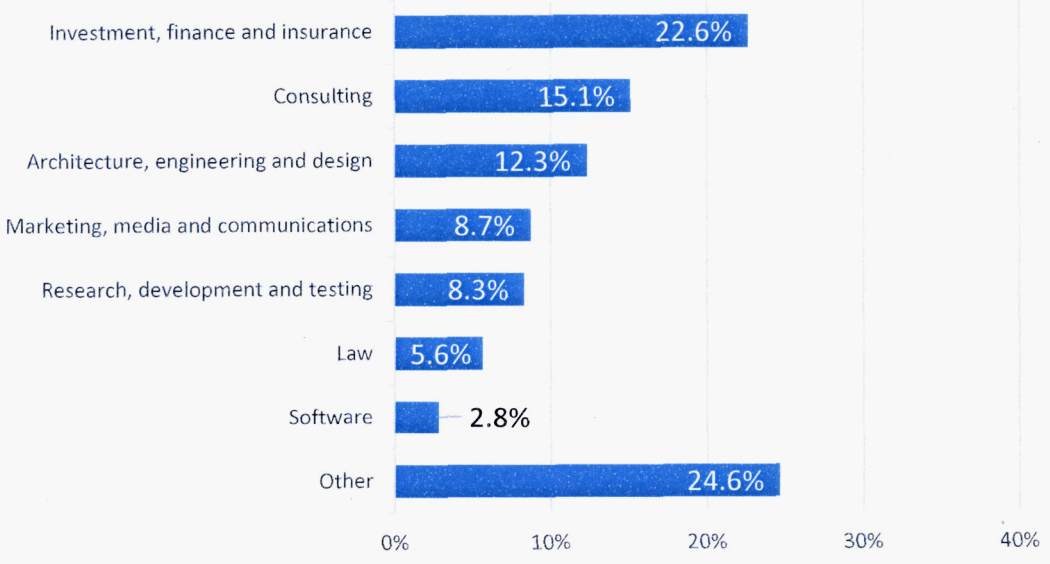
70 Cleantech Group's i3 data.

Figure 18: Percentage Breakdown of "Other" Employment



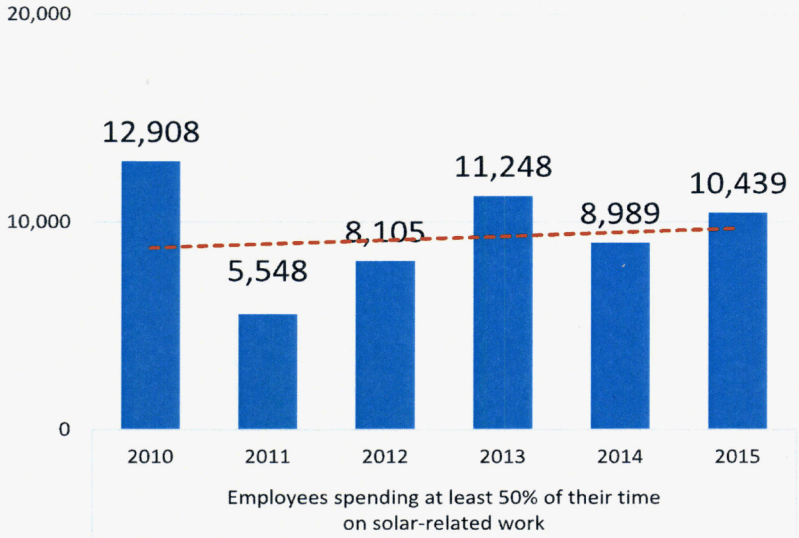
The "other" sector declined from November 2013 to November 2014 and has declined by more than 30% since September 2010.

Figure 19: Percentage Breakdown of "All Other" Establishments



*In the chart above, "other" includes any activities that had two or fewer responses in the survey.

Figure 20: "Other" Employment Growth from September 2010 to November 2015 (Projected)



Some of this contraction can be attributed to declines in research and development (evident from declining public and private research investments), while a large portion is due to the maturation of the industry. As more "pure play" solar firms proliferate, many of the ancillary support functions previously provided by "other" firms are now being brought in-house.

Two areas that seem to be growing are project and bank financing and international consulting. This may be fueling the sector's anticipated 16% growth over the coming year.

Women account for more than 40% of solar workers among these "other" solar firms. Veterans also make up a greater share of employment in the "other" category as compared to the overall industry, though Latino, Asian and Pacific Islander, and African-American employment is lower than average, as seen in Table 13 below.

Table 13: 2014 "Other" Solar Worker Demographic Breakdown[71]

	Employment	% of Other Employment	% of U.S. Workforce
Women	3,928	43.7%	49.6%
Veterans of the U.S. Armed Forces	966	10.7%	7.0%
Latino or Hispanic	848	9.4%	13.0%
Asian or Pacific Islanders	622	6.9%	5.2%
African-American	477	5.3%	11.7%

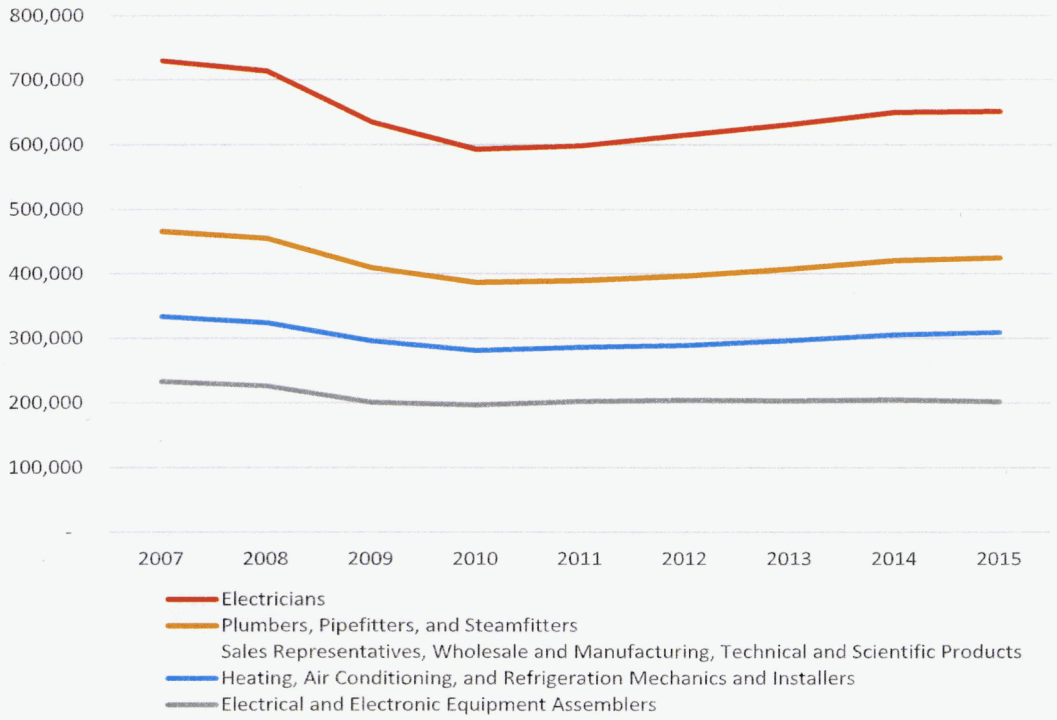
71 See EMSI Class of Worker 2014.3; The Employment Situation – November 2014, Bureau of Labor Statistics, available at: http://www.bls.gov/news.release/pdf/empsit.pdf.

Workforce Development

The solar industry has added tens of thousands of jobs over the past five years in a variety of occupational categories including engineering, sales, production, and, most abundantly, the construction trades. This growth has occurred during a time of slow economic recovery in the United States, as other industries have struggled to add jobs. With historically high unemployment rates – particularly in the trades – following the economic recession, solar employers had little difficulty finding qualified applicants with abundant related experience in their fields. In fact, 2010 (the year of the first *National Solar Jobs Census*) was the worst year for employment across five related, traditional occupations: electricians, plumbers, HVAC technicians, electrical equipment assemblers, and technical and scientific product sales representatives.

Electricians, which are particularly valuable to solar installation firms, were hit hard. Between 2007 and 2010, almost 19% of electricians (about 136,000) across the United States lost their jobs. Since 2010, about 40,000 of these jobs have been recovered, but there are still 93,000 fewer electrician jobs today than there were in 2007.

Figure 20: Comparison Occupational Employment 2007-2015



These statistics illustrate the key role that the solar industry has played in providing employment for many of the hardest hit occupations and a road to recovery for thousands who were out of work. At the same time, the surplus of experienced workers made for

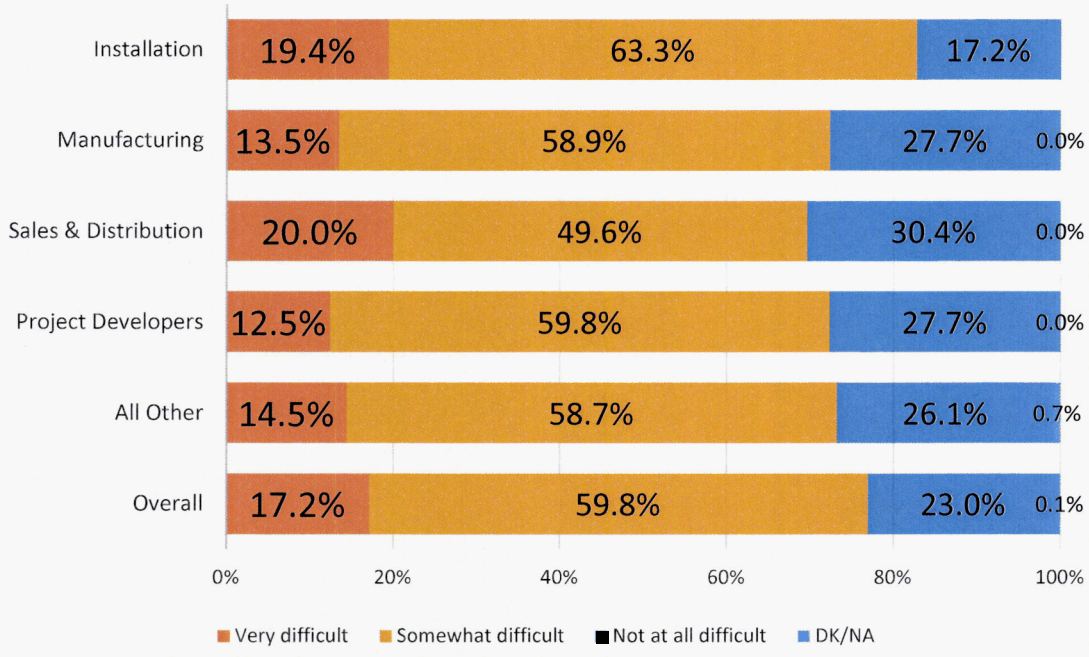
a very competitive solar labor market for some job seekers. Inexperienced trainees, for example, have faced very long odds when competing against applicants with licensure, experience, and a solid track record in related industries.

The tide is slowly turning and much of the slack of the construction-trade and broader solar labor market is being quickly absorbed. **As this trend accelerates, there will be fewer experienced candidates available, and employers will be more likely to turn to education and training (both on-the-job and with outside training providers) to meet their needs for a skilled workforce.** Two key metrics for understanding the supply and demand of the workforce are employers' reported difficulties in finding qualified workers and the wages paid to employees in different industry sectors, both of which are reviewed in detail in this section.

Difficulty Hiring

One of the most important metrics for understanding potential gaps and surpluses in the labor market is employers' reported difficulty in hiring. Overall, solar employers report increasing difficulty in finding qualified workers as compared to previous *Census* reports, though it is not yet to a critical level. Nearly one in four solar employers overall report that they have no difficulty finding the employees they need, and about one in six report that it is very difficult to find qualified employees.

Figure 21: Difficulty finding solar employees over the last 12 months



Difficulty finding qualified employees was highest among solar installation firms, with 83% of employers reporting at least some difficulty (63% somewhat difficult and 19% very difficult). Of the installation firms having difficulty, one-third reported that it is most difficult to find electricians with solar expertise (33%), solar installers (29%), finance staff (19%), and software engineers (18%). The most frequently cited reasons for the difficulty are lack of appropriate skills (24%), competition with other firms (21%), and general lack of qualifications in the workforce (21%).

Employers in the Pacific Region note the greatest difficulty finding workers, followed closely by the Northeast and Southeast.

Table 14: Difficulty finding solar employees by region.

	Overall	Northwest	Pacific	Southwest	Midwest	Southeast	Mid-Atlantic	Northeast
Very difficult	**17.2%**	20.5%	16.1%	14.7%	20.0%	29.4%	10.4%	15.1%
Somewhat difficult	**59.8%**	51.3%	64.2%	58.3%	50.5%	48.0%	65.2%	65.1%
Not at all difficult	**23.0%**	28.2%	19.7%	26.9%	29.5%	22.5%	24.3%	19.7%

Manufacturers and project developers note great difficulty finding engineers (non-electrical), while sales firms most frequently cite issues with hiring salespeople. Lack of relevant skills and experience are the most frequently cited reasons for these difficulties.

Wages

In addition to the trends for employer-reported hiring difficulties, changes in wages paid offer insight into supply and demand as wages rise in response to the scarcity of talent. Wages for installers have risen slightly since 2013, with the mean rising $0.38 per hour (a 1.6% increase). At the same time, wages for production/assembly workers fell $0.63, a decline of 3.5%.

For the first time, this year's *Census* survey asked firms about their average pay for solar designers and salespeople. Solar designers earn $30-40 per hour on average, while salespeople have a wider range of pay, from about $30 to more than $60 per hour. From a sector standpoint, developers and utilities pay the highest wages to sales staff, followed by manufacturers, sales firms, and installers.

Table 15: 2014 Average Hourly Wage by Solar Sector

	Installer	Salesperson[1]	Production/ Assembly	Designer
Overall	$24.01	$36.25	$17.60	$36.16
Installation	$24.01	$34.50	n/a	$32.25
Manufacturing	n/a	$44.05	$17.60	$31.63
Sales and Distribution	n/a	$36.15	n/a	$30.35
Developers/Utilities	n/a	$53.15	n/a	$40.78

The median wage for installers at utility-scale firms is approximately 20% higher than at firms working on commercial or residential scale projects. There are several other key differences, noted in the table below.

Table 16: 2014 Difficulty Hiring, Use of On-the-Job Training, and Views on the Importance of Credentials by Solar Installation Sectors

	Difficulty hiring %very/some/not	OJT %yes/no	Credentials %yes/no
Overall	19/63/17	89/11	75/25
Residential	18/68/14	90/10	81/19
Commercial	20/60/20	89/11	75/25
Utility-Scale	14/68/18	81/19	36/64

Workforce Profiles

Solar employers were asked to provide information regarding the background of their hires over the last 12 months in order to determine how many had previous experience related to the position or college degrees. More than two-thirds of all solar workers hired over the last 12 months had previous experience, but only 27.3% have at least an associate's degree. This is quite low when compared to other fast-growing industries.

Previous experience is most important for developers and installers, and less so for manufacturers and salespeople. These groups differ dramatically in terms of education requirements, however, as more than 70% of new hires at developer/utilities had a bachelor's degree, compared to only 10.9% of those hired by installers.

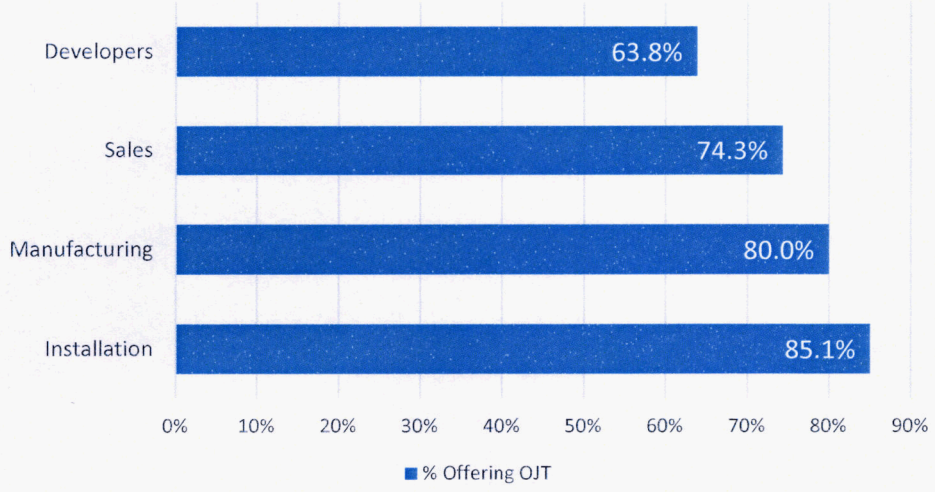
Table 17: 2014 New Solar Employees Experience and Education Requirements by Sector

Sector	% with Experience	% with Bachelor's or Higher	% with Associate's or credential but not BA
Overall	67.3	21.4	5.9
Installation	68.4	10.9	2.6
Manufacturing	59.9	40.7	17.3
Sales	45.5	43.9	20.4
Developers	85.5	70.3	12.9

Employers were also asked about the value they place on technical credentials, such as the North American Board of Certified Energy Practitioners (NABCEP) and Underwriters Laboratories (UL), as well as training program accreditation from the Interstate Renewable Energy Council (IREC). Credentials have more value to installers and developers, while manufacturers and sales firms place less importance on them during the hiring process. Some employers remain somewhat skeptical about the importance of such credentials, but over 50% of respondents indicated that they think credentials either "definitely" or "probably" help them find higher-quality employees. Both credentialing bodies and the industry should continue to work together to recognize and demonstrate the value of credentials in hiring practices and workforce training programs.

About three quarters of all solar firms offer formal on-the-job training to supplement the skills of their workers.

Figure 22: Use of On-the-Job Training by Solar Sector



The infographic (on the next page) illustrates the typical solar photovoltaic installer career pathway. The information is drawn from Monster Government Solutions and PayScale data and reviews the most frequently reported occupation, wage, education, and skill data for photovoltaic installers. The data also include the most prevalently held occupations prior to becoming a solar installer (within five years), as well as the most typical five year progressions.

A distinct career progression has yet to form for photovoltaic installers. A large number of PV installers worked previously in higher wage positions in the past five years. Given the high unemployment in the construction industry five years ago, it is likely that the solar industry has helped to reemploy laid-off tradespeople such as roofers, construction managers and foremen, and other laborers. The data clearly indicate that, at least in the short-term, experience in the construction industry is a must for solar installers.

PV Installer Career Pathway

Jobs 5 Years Later

Solar Panel Installer

$41,300

Typical Degree
High School Education

Certificates
- NABCEP Entry Level Certificate of Knowledge
- NABCEP Solar PV Installer Certification

Construction Manager

$67,900

Typical Degree
Bachelor's Degree

Certificates
- OSHA 30 Hour
- OSHA 10 Hour
- LEED Accredited Professional (LEED AP)
- Project Management Certificate
- Occupational Safety & Health Administration
- Project Management Professional (PMP)

Construction Foreman

$45,200

Typical Degree
High School Education

Certificates
- Occupational Safety and Health Administration (OSHA)
- OSHA Forklift Operator Certification
- OSHA 30 Hour
- Commercial Driver License (CDL)- Class A

Roofer

$32,800

Typical Degree
Less than High School

Certificates
- OSHA Forklift Operator Certification
- OSHA 10 Hour
- Commercial Driver License (CDL)- Class B

Solar Energy/ Power Engineer

$72,600

Typical Degree
Bachelor's Degree

Certificates
- NABCEP Solar PV Installer Certification
- Certified Professional Engineer (PE)

Solar Panel Installer

$33,200

Typical Degree
High School Education

Certificates
NABCEP Entry Level Certificate of Knowledge
NABCEP Solar PV Installer Certification

Skills
Solar Energy/Solar Power
Electronic Troubleshooting

Jobs 5 Years Before

Solar Panel Installer

$33,200

Typical Degree
High School Education

Certificates
- NABCEP Entry Level Certificate of Knowledge
- NABCEP Solar PV Installer Certification

Construction Laborer

$27,000

Typical Degree
High School Education

Certificates
- OSHA 10 Hour
- OSHA Forklift Operator Certification
- Commercial Driver License (CDL)-Class A
- Occupational Safety and Health Administration (OSHA)

Electrician

$33,900

Typical Degree
Certificate

Certificates
- General Journeyman Electrician
- Master Electrician
- Apprentice Electrician
- Journeyman's Certificate in Non-Destructive Testing

Roofer

$28,400

Typical Degree
Less than High School

Certificates
- OSHA Forklift Operator Certification
- OSHA 10 Hour
- Commericial Driver License (CDL)- Class B

Construction Foreman

$41,000

Typical Degree
High School Education

Certificates
- Occupational Safety and Health Administration (OSHA)
- OSHA Forklift Operator Certification
- OSHA 30 hour
- Commercial Driver License (CDL)- Class A

Construction Manager

$51,600

Typical Degree
Bachelor's Degree

Certificates
- OSHA 30 hour
- OSHA 10 Hour
- LEED Accredited Professional (LEED AP)
- Project Management Certificate
- Occupational Safety & Health Administration
- Project Management Professional (PMP)

Conclusions & Recommendations

The U.S. solar industry continues on its well-documented positive growth trajectory, posting 22% employment growth from November 2013 to November 2014, and 86% job growth since September 2010. Firms across the entire value chain of solar goods and services have noted significant employment gains, though none more so than the installation sector, driven by the historic increases in installed solar capacity across the country. Given the relationship between installed capacity and employment growth, the next couple of years – when annual installed capacity is expected to be 18% (2015) and 69% (2016) greater than that coming on-line in 2014 – will surely see this upward growth trend continue in the short term.

Though employers remain optimistic about near-term growth – anticipating 20.9% job growth when employment in the national economy is expected to increase by only 1% - results and trends from the Census series reveal challenges and opportunities for future growth.

The greatest looming threat for continued employment growth is the expiration of the 30% federal Investment Tax Credit (ITC) at the end of 2016. With this policy in place, approximately half of all employers have reported job growth in each of the last several years, with only a few (typically 2-3% of all firms) experiencing declines in employment. In Census 2014, only less than 40% of solar employers stated reductions in the ITC would not impact their workforce. Installation and project development firms – which together employ nearly two-thirds of the entire solar workforce – stand to be affected the greatest, with 62% of installation firms and 60% of project developers expecting to shed workers once the current ITC expires.

Even as employment continues to grow in the next two years, improvements in labor efficiency (the amount of capacity installed by each worker) may start reducing the rate at which new solar workers are added. In 2012, the U.S. solar industry required about 19.5 workers per installed megawatt. This number dropped sharply in 2013 to 16 jobs per megawatt, and continued to decline by about a half of a worker to 15.5.

On the bright side, solar jobs are becoming increasingly available to workers of differing backgrounds. Overall, the solar industry places greater emphasis on previous related experience (which two-thirds of new hires in 2014 possessed) than on education (with only 21% of new workers holding a bachelor's degree or higher and less than 6% having an associate's degree or credential). Though certain sectors are more likely to require employees with higher education (such as project development), firms in every sector still place greater weight on experience over education. In the installation sector, nearly 70% of new hires had some form of previous experience, whereas less than 14% had some form of higher education, suggesting these jobs – which constitute the bulk of total solar employment – may be filled by workers with little or no formal higher education.

The industry is also becoming increasingly diverse in terms of worker gender, racial/ethnic background, and veteran status. In 2014, each of these demographics represented a larger proportion of the solar workforce than in the previous year, indicating more members of these groups are seeking employment in the solar industry, and that these jobs are becoming more available to them.

Analysis of industry trends across the entire Census series indicates that the observed solar employment growth has not come without some growing pains. As the national employment situation continues to improve and electricians, roofers, and workers in other trades related to solar find work in their respective industries, this pool of qualified workers will become less available to the solar industry. This phenomenon may already be impacting industry growth. Over three-quarters of solar employers experience at least some difficulty in finding the employees they seek, with about one in six reporting it has been very difficult to find qualified workers.

An increase in demand for qualified workers relative to supply can be expected to compel employers to offer higher wages in order to attract the talent they seek, as seen in the 1.6% increase in average wages for installers (the sector reporting the greatest difficulty in finding new workers) over the previous year. While welcome news for solar workers, rising wages could also drive up labor installation costs, which constitute the single largest category of solar soft costs.

One obvious way to limit the impact of rising wages is by increasing the supply of qualified workers through education, training, and apprenticeship. Given the stark differences among employers in their reporting regarding the use of on-the-job training, third-party training, and credentials, it is becoming clearer that the solar industry is one that is searching for a consistent framework for training and evaluating talent. This may become a problem quickly as the growth of the industry accelerates.

Based on these conclusions, we make the following recommendations:

Promote stability in federal policy. The U.S. solar industry continues to demonstrate its strength across most of the value chain. Although this may change as labor efficiencies improve, there is currently a very strong link between solar adoption and job creation. As has been the case with every domestic energy industry in our nation's history, the solar industry continues to benefit from policies and incentives that accelerate growth and help bring the industry to scale, particularly those policies with the multiyear certainty needed to leverage project financing. In Census 2012, employers cited federal tax incentives for solar investment as one of the top three drivers of industry and employment growth. Similarly in Census 2014, three out four employers reported that the ITC had helped their business. Given the importance of such policies to the deployment of solar technology, it is not unreasonable to expect that the continuation of demand-side incentives will continue to have a strong, positive impact on job creation and competitiveness. Given the incredi ble history of job creation by the solar industry over the last several years, there seems little reason to change the status quo at the federal level.

Increase access to financing. Approximately two-thirds of firms in each of the installation, manufacturing, sales and distribution, and project development sectors experienced difficulty in obtaining financing. These difficulties are likely a reflection of the limited financing options available to solar companies, forcing them to continue to pursue existing financing mechanisms with higher costs of capital than would be available with some alternatives. For installation and project development firms, an increased ability to leverage promising financing arrangements such as Master Limited Partnerships, Solar Real Estate Investment Trusts, yieldcos, and securitization of solar assets may help alleviate this problem.

While access to capital is important for solar companies, it is also key for consumers. Increasing the number and availability of solar financing options for home and business owners will help further drive solar adoption, in turn leading to increased solar employment. Though the solar industry has continually proven its ability to develop and offer innovative financing solutions, there remain many key un(der)addressed markets. As one example, consider that the solar boom has not spread uniformly across the spectrum of household incomes because, unlike many more affluent families, lower-income households face a number of inherent barriers to going solar. These barriers include being less likely to own their roof, having limited access to affordable financing, being more likely to live in buildings with deferred maintenance, and being unable to realize the financial benefits of fuel-free electricity because their utility bills are partially or fully subsidized. Finding ways to serve the low-income markets is essential for the solar industry to expand beyond its current market of relatively affluent early technology adopters. At the same time, many of the more affluent households in the U.S. are aging, and less likely to remain in their homes for the number of years that may be required for full-payback of their systems. Programs that allow loans to follow the home rather than the owner (such as property assessed clean energy, or PACE) could unlock this untapped potential.

Continue to develop bridge programs for veterans. Veterans of the U.S. Armed Forces continue to represent a larger proportion of the solar workforce as compared to the overall economy. This strong representation may be driven in part by a high degree of skill transferability between military occupations and solar jobs, which has been supported by interviews with select solar employers conducted for the 2014 report Veterans in Solar: Securing America's Energy Future, co-authored by The Solar Foundation and the Truman National Security Project. Despite this potential skills overlap, some groups of veterans – especially those in the 18 to 24 age group – continue to grapple with high unemployment. A deeper understanding of the skills developed in military occupations – especially non-technical workplace skills that are in high demand in the solar industry – can help these former service members transition into jobs in the solar industry. Workforce training providers are aware of this opportunity but need greater support to further develop the solar industry as a strong employer of military veterans.

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

Online portals such as the "Veteran's Employment Center" (https://www.ebenefits.va.gov/ebenefits/jobs), provided by the Department of Veterans Affairs and the Department of Defense, as well as "America's Job Centers" run by the Department of Labor (http://www.servicelocator.org/onestopcenters.asp), can help employers identify and connect with veterans seeking employment. Finally, The Solar Foundation encourages industry to participate in the White House's Joining Forces initiative and publically commit to hiring increasing numbers of veterans.

Support worker evaluation efforts and the development of comprehensive assessment tools. As the supply and demand balance for qualified workers continues to shift, the industry will have a growing need for workers able to meet their technical, educational, and soft skill requirements. As documented in this report, solar employers most frequently focus on a candidate's experience when determining whether they would make a good fit. An overreliance on experience can cause companies to overlook otherwise qualified – though inexperienced – candidates, and may cause them to face even greater difficulty in recruiting talent in the face of contracting pools of experienced workers. The development of a comprehensive set of assessment tools that evaluate all aspects of a candidate's suitability for employment (not just technical skills) can be of great value in overcoming or avoiding these issues.

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

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APPENDIX: Census Methodology and Data Sources

The *National Solar Jobs Census* methodology is the most closely aligned with the Bureau of Labor Statistics' methodology for its Quarterly Census of Employment and Wages (QCEW) and Current Employment Statistics (CES). Like BLS, this study uses survey questionnaires and employer- reported data, though ours are administered by phone and email, as opposed to mail.

Also like BLS, we develop a hierarchy of various categories that represent solar value chain activities (within their broader NAICS framework), develop representative sample frames, and use statistical analysis and extrapolation in a very similar manner to BLS. We also constrain our universe of establishments by relying on the most recent data from the BLS or the state departments of labor, depending on which is collected most recently. We believe that the categories that we have developed could be readily adopted by BLS should it choose to begin to quantify solar employment in its QCEW and CES series.

The results from the Census are based on rigorous survey efforts that include 66,986 telephone calls and over 25,655 emails to known and potential solar establishments across the United States, resulting in a margin of error +/- 2.03% at a 95% confidence interval. Unlike economic impact models that generate employment estimates based on economic data or jobs-per-megawatt (or jobs-per-dollar) assumptions, the National Solar Jobs Census series provides statistically valid and current data gathered from actual employers.

The survey was administered to a known universe of solar employers that includes 15,552 establishments and is derived from SEIA's National Solar Database as well as other public and private sources. Of these establishments, 2,839 provided information about their solar activities (or lack thereof), and 1,634 completed full or substantially completed surveys. The margin of error for the known universe is than +/-2.26%.

The survey was also administered to a stratified, clustered, random sampling from various industries that are potentially solar-related (unknown universe) that include a total of 260,824 establishments nationwide. After an extensive cleaning and de-duplication process, a sampling plan was developed that gathered information on the level of solar activity (including none) from 6,230 establishments. Of these, 435 establishments qualified for and completed full surveys. The margin of error for the unknown universe is 1.1%.

The indirect and induced job figures were gathered using averaged figures from EMSI's input output model (see Data Sources, above). The industries selected for installation were electrical contractors and power and communication line construction; for manufacturers, semiconductor equipment manufacturing and other electronic and electrical assembly; for sales and distribution, wholesale trade of electronic appliances and wholesale trade of heating and hot water apparatus; and for project development, heavy civil construction and engineering and power and communication line construction.

The following three-phased methodology describes the survey process used to gather employer information from both self-identified or known solar employers, those establishments that are connected to solar industry associations and can be found on solar employer databases, and unknown solar employers that are found in industry classifications that are more likely to have solar employers. This methodology describes the process that was followed for all of the solar employer surveys except for those completed by utilities in earlier editions of the *Census.*

Phase 1: Develop, classify and analyze a database of self-identified or known solar employer

The first phase created a comprehensive database of all known or self-identified solar employers across the country. This database was developed by SEIA and its partners. The comprehensive database was developed from all of the partners' contact information of employers. Duplicates were identified and removed following a stringent evaluation of firm phone numbers, locations, and firm names.

The database of employers did not include variables that consistently identified which sector (manufacturing, installation, sales and distribution, project development, and other) each employer was involved in, the size of the employer, or whether the employer had a single location or represented multiple locations.

Phase 2: Survey of self-identified or known solar employers.

The second phase of the survey research was a census, using online and telephone surveys of all solar employers from the database developed in phase one. Employers were asked which sector they were involved in (installation, manufacturing, wholesale trade, research & development and other) and based on their response they were forwarded to the appropriate survey instrument. All employers in the database with email information were sent multiple online invitations and for those that did not complete an online survey, they were called up to three times. The employers without email information were called up to five times and asked to participate in the survey by completing a brief phone survey. These results represent the solar employer community that is connected to regional and national solar trade associations.

It is important to note that surveys were completed for each employment location and not necessarily for each firm. So if a solar employer was asked to participate in a survey, s/he would be asked about the employment profile of a given location and not of the entire firm.

Phase 3: A random sampling of employers in industry classifications that are most likely to have unknown solar employers.

The final phase of the survey research was a sampling of employers in specific industries within wholesale trade, manufacturing, and the construction (installation) industries. The survey was completed over the phone and the sample was stratified by industry, region, and firm size (4 or fewer employees or 5 or more employees). These results represent the solar employers that make up the wholesale trade, manufacturing, and construction industry employers within the industry classifications noted below.

It is important to note that the percentage of overlap between the known and unknown universe of solar employers was calculated based on a thorough search of the known firm database to the unknown universe file or establishments that indicated they had already completed a similar survey. The resulting calculation of overlapping establishments was taken out of the total estimate of establishments in the unknown universe of solar employers.

Data for the "other" category does not capture all jobs or establishments in the category. Although some "other" establishments are included in the known universe (see section accounting, legal, finance, and other ancillary establishments spend only a very small portion of their time on solar activities. Thus, full inclusion would lead to inflated employment counts.

This report cites comparison data from the Bureau of Labor Statistics Current Employment Statistics and Economic Modeling Specialists International Class of Worker data for 2014. EMSI is typically selected for instances where self-employed and covered total employment comparisons (such as past and future growth rates) are required. BLS data are used for monthly absolute jobs figures.

EMSI Data Sources and Calculations

Industry Data

In order to capture a complete picture of industry employment, EMSI basically combines covered employment data from Quarterly Census of Employment and Wages (QCEW) produced by the Department of Labor with total employment data in Regional Economic Information System (REIS) published by the Bureau of Economic Analysis (BEA), augmented with County Business Patterns (CBP) and Nonemployer Statistics (NES) published by the U.S. Census Bureau. Projections are based on the latest available EMSI industry data, 15-year past local trends in each industry, growth rates in statewide and (where available) sub-state area industry projections published by individual state agencies, and (in part) growth rates in national projections from the Bureau of Labor Statistics.

This report uses state data from the following agencies: Alabama Department of Industrial Relations; Alaska Department of Labor and Workforce Development; Arizona Department of Commerce, Research Administration; Arkansas Department of Workforce Services; California Labor Market Information Department; Colorado Department of Labor and Employment; Connecticut did not provide us with a data source; Delaware Office of Occupational and Labor Market Information, Delaware Wages 2004; District of Columbia did not provide us with a data source; Florida Agency for Workforce Innovation; Georgia Department of Labor, Workforce Information and Analysis, Occupational Information Services Unit; Hawaii Department of Labor and Industrial Relations, Research and Statistics Office; Idaho Department of Labor; Illinois Department of Employment Security, Employment Projections; Indiana Department of Workforce Development; Iowa Workforce Development; Kansas Department of Labor, Labor Market Information Services, Kansas Wage Survey; Kentucky Office of Employment and Training; Louisiana Department of Labor; Maine did not provide us with a data source; Maryland Department of Labor, Licensing and Regulation, Office of Labor Market Analysis and Information; Massachusetts did not provide us with a data source; Michigan Department of Labor and Economic Growth, Bureau of Labor Market Information and Strategic Initiatives; Minnesota Department of Employment and Economic Development; Mississippi Department of Employment Security; Missouri Department of Economic Development; Montana Department of Labor and Industry, Research and Analysis Bureau; Nebraska Workforce Development; Nevada Department of Employment, Training and Rehabilitation, Information Development and Processing Division, Research and Analysis Bureau; New Hampshire Department of Employment Security; New Jersey Department of Labor and Workforce Development; New Mexico Department of Labor, Bureau of Economic Research and Analysis; New York Department of Labor, Division of Research and Statistics; North Carolina Employment Security Commission, Labor Market Information Division; North Dakota Job Service, Labor Market Information Center; Ohio Department of Job and Family.

State Data Sources

Services, Labor Market Information Division; Oklahoma Employment Security Commission; Oregon Employment Department, Oregon Labor Market Information System; Pennsylvania Department of Labor and Industry, Center for Workforce Information and Analysis; Rhode Island did not provide us with a data source; South Carolina Employment Security Commission, Labor Market Information Department; South Dakota Department of Labor, Labor Market Information Division; Tennessee Department of Labor and Workforce Development, Research and Statistics Division; Texas Workforce Commission; Utah Department of Workforce Services; Vermont did not provide us with a data source; Virginia Employment Commission, Economic Information Services; Washington State Employment Security Department, Labor Market and Economic Analysis Branch; West Virginia Bureau of Employment Programs, Research Information & Analysis Division; Wisconsin Department of Workforce Development, Bureau of Workforce Information; Wyoming Department of Employment, Research and Planning.

Input-Output Data

The input-output model in this report is EMSI's gravitational flows multi-regional social account matrix model (MR-SAM). It is based on data from the Census Bureau's Current Population Survey and American Community Survey; as well as the Bureau of Economic Analysis' National Income and Product Accounts, Input-Output Make and Use Tables, and Gross State Product data. In addition, several EMSI in-house data sets are used, as well as data from Oak Ridge National Labs on the cost of transportation between counties.

This report uses data release EMSI Complete Employment 2014.3

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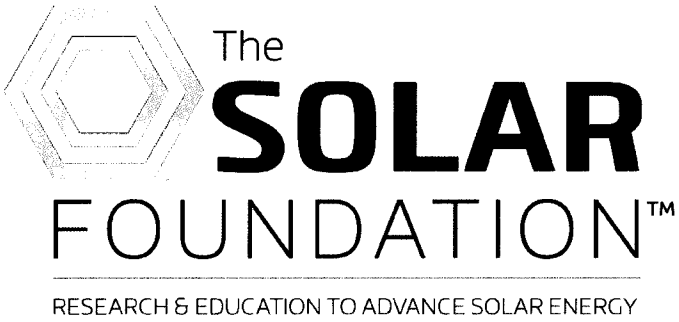
For questions about this report or to explore options for an in-depth solar jobs study for your state/region, please contact Andrea Luecke at The Solar Foundation, aluecke@solarfound.org.



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